Appendix A
Scoping Report

Troy Mine Revised Reclamation Plan
Environmental Assessment

Scoping Report

March 10, 2008

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Section 1
Introduction

CDM was contracted by the Montana Department of Environmental Quality (DEQ) in October 2007 to begin the first phases of an Environmental Assessment (EA) for the proposed reclamation at the Troy Mine near Troy, Montana. The contract includes four task orders:

- Task Order 1 –Reclamation Plan Review and Public Scoping Activities
- Task Order 2 – Administrative Record and Project Management Plan
- Task Order 3 – Data Gap Analysis
- Task Order 4 – Alternatives Development, Initial Evaluations, and Environmental Assessment

Task Order 1 includes two subtasks: Review Permit and Proposed Reclamation Plan and Public Scoping and Public Input Activities. CDM has completed the first task order and is submitting this scoping report in accordance with the deliverables list provided in Task Order 1.

Public scoping is the first step in conducting an EA. It is a process for determining the scope of issues to be addressed and identifying the significant issues related to a proposed action. The scoping process helps in determining what will be reviewed in the EA and the level of analysis, in part, through the collection of written and verbal comments from the public. Scoping helps agencies identify environmental issues associated with the project and aids in the development of reasonable reclamation alternatives. It also allows effective public and stakeholder involvement prior to the submittal of the draft EA.

This report describes the results of the scoping activities conducted between October and December 2007 as part of the EA. It includes:

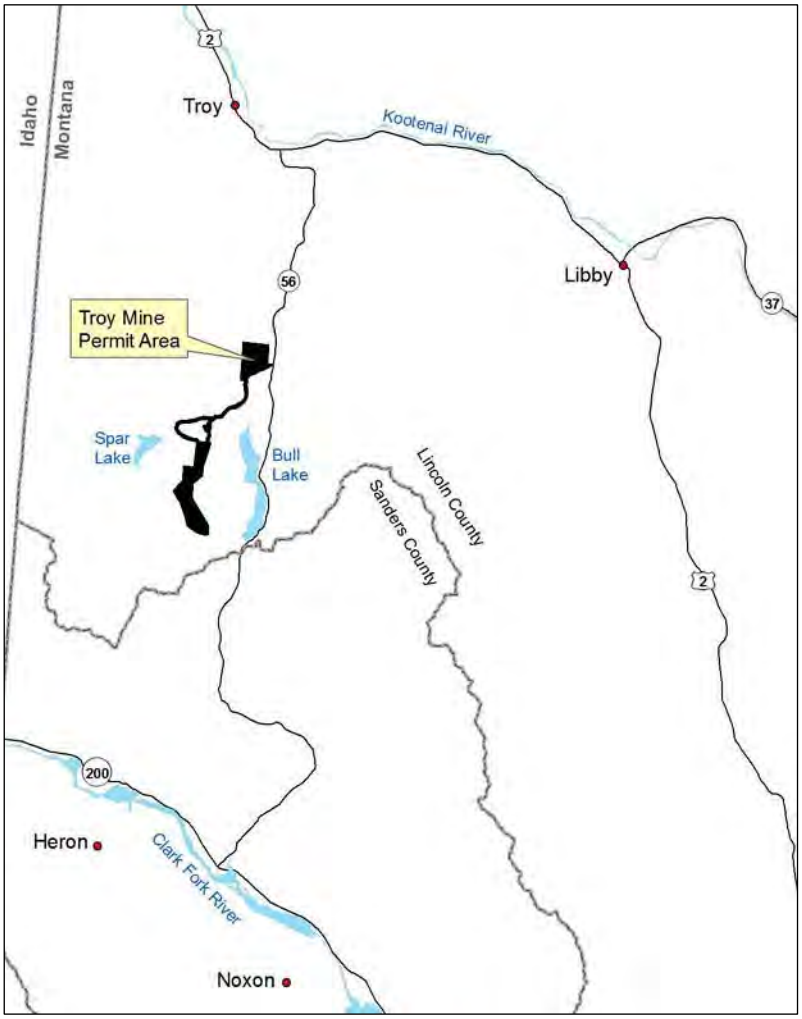
- Introduction
- Background
- Implementation of the Scoping Process
- Results of the Scoping Process
- Identification of Data Gaps

Section 2
Background

2.1 Troy Mine History

The Troy Mine is located in Lincoln County, Montana, about 15 miles south of Troy. The mine permit area covers 2,635 acres of public and private land off MT Highway 56 (see figure below). It consists of an underground mine, mill, and office facilities; tailings and water pipelines; power line; tailings impoundment; and associated support facilities.

The ASARCO, Inc. Troy Mine project was permitted in 1978 by the U.S. Forest Service (USFS) and State of Montana as a 20,000 ton-per-year underground copper/silver mine. The ore was and is mined using the "room-and-pillar method." ASARCO began full production in 1982 but put the mine on standby mode in 1993 due to depressed metal prices. During the shut-down period, ASARCO sold its interest to Sterling Mining Company, which became Revett Silver Company (Revett). Production resumed in 2005 under Genesis (a wholly owned subsidiary of Revett) and is projected to continue at least 5 years until the ore body is depleted.



The Troy Mine is now permitted and operated by Genesis. Genesis currently has posted a $10.5 million reclamation bond for the project. The reclamation bond is being updated to $12.9 million. Genesis submitted the Revised Reclamation Plan in March of 2006. The revised plan describes proposed reclamation elements for final closure of the Troy Mine following cessation of mining activities.

Over the course of mine operation, knowledge has been gained through studies, data collection, revegetation test plots, prior reclamation plan development and reviews, and bonding determinations. In addition, some conditions have changed since the 1979 planning

and permitting documents were prepared. One changed condition is the presence of toe ponds at the perimeter of the tailings facility dam. Another is the change in state water discharge standards which do not allow direct discharge of produced mine water into Stanley Creek. The Revised Reclamation Plan attempts to incorporate and address all of the above issues and changes.

The Revised Reclamation Plan addresses facility removal for many developmental and operational features including:

- Roads
- Waste rock dumps
- Mine portals
- Underground facilities
- Mill and plant site
- Soil borrow sites
- Power supply—transmission line, generators, fuel tanks, etc.
- Water supply and pump facilities
- Sewage treatment facility
- Pipelines
- Tailings impoundment
- Monitoring wells
- Fences

The Revised Reclamation Plan proposes to use concrete plugs in the service and conveyor adits. These plugs would be designed to avoid the possibility of large-scale mine discharge or overflow from one of the adits. Other water treatment options include piping the mine water discharge to the tailings decant ponds for direct groundwater discharge.

The Revised Reclamation Plan also contains reports and plans including:

- Mine Flooding Report
- Revegetation Status Report
- Assessment of Fate and Transport of Copper in Decant Pond Disposal System
- Soil Investigation Results
- Weed Control Plan
- Water Monitoring Plan
- Revegetation Plan
- Geotechnical Monitoring Plan
- Tailing Facility Stability Report
- Conceptual Portal Plug Study

In addition, a report has been prepared that discusses the cause of two surface subsidence events and potential future subsidence issues.

2.2 Project Management Plan

The project management plan serves as a guide for the Troy Mine Revised Reclamation Plan EA process. It establishes responsibilities, schedules, and procedures for the project team. It includes a description of the project team and potential cooperating agencies, contact information, project tasks, a task schedule, known data gaps, issues of concern, the public involvement strategy, a preliminary draft of the proposed action and alternatives, the format for the EA, and a description of how the Administrative Record will be compiled.

2.3 Public Involvement Process

Early attention to consensus building generally makes the project move more smoothly by ensuring that the public has an opportunity to voice their concerns and to be part of the overall decision making process. CDM and DEQ will gather public input using various components of the scoping process.

The public involvement program also includes the preparation of a scoping document to be distributed before the open house and the preparation of this scoping report. CDM will also assist DEQ in compiling important EA-related documents for an information repository. This will include fact sheets and newspaper articles, as well as copies of the draft and final EA.

Section 3
Implementation of the Scoping Process

The following scoping activities were completed between October and December 2007 as part of the scoping process for the Troy Mine Revised Reclamation Plan EA:

- Press Release
- Scoping Document
- Open House / Public Meeting

The scope of each of these elements and their implementation is discussed below. The issues identified during the scoping process are provided in Section 4.

3.1 Press Release

A press release was published by the DEQ on October 11, 2007. The press release provided notice of the scoping period for the Troy Mine Revised Reclamation Plan EA process. The press release is shown in Appendix A.

3.2 Scoping Document

A scoping document (Appendix B) was prepared and distributed prior to the open house and public meeting. The scoping document included the following topics:

- Opportunities for public involvement
- Troy Mine history
- Components of the Revised Reclamation Plan
- Initial issues of concern
- Overview of the EA process
- EA schedule and deliverables
- Sources of additional information

The scoping document was reviewed and approved by DEQ and USFS prior to being finalized. It was distributed by mail to approximately 88 individuals on the mailing list provided by DEQ. The mailing occurred on October 15, 2007. Approximately 20 individuals and 68 government organizations, elected officials, or private interest groups were included on the mailing list (Appendix C).

3.3 Open House and Public Meeting

The public meeting and open house were held at the Kootenai Senior Citizens Center in Troy, Montana on Tuesday, October 30, 2007. The public meeting began at 6:30 pm with a half-hour presentation. An open house followed the presentation and continued until 8:30 pm when the meeting was closed.

An advertisement was prepared by USFS for publication in four area newspapers: the *Western News* on October 24, 2007, the *Sanders County Ledger* on October 25, 2007, the *Daily Inter Lake* on October 21, 2007, and the *Bonner County Daily Bee* on October 24, 2007. These four ads are included in Appendix D.

The format for the public meeting was agreed upon with DEQ prior to the event. CDM started the meeting with a 20-minute presentation that introduced the EA team and discussed the scope of the EA, history of the mine, and potential remedial alternatives. Gwen Pozega of CDM led this presentation.

Seven tables, each representing a particular topic, were set up in a large meeting room. Each table was staffed by one or more CDM, AMEC, USFS, or DEQ employees. Two copies of the revised reclamation plan were available for review. Individual topic areas and their respective representatives were:

- MEPA/NEPA - Kathy Johnson (DEQ) and John Gubel (USFS)
- Engineering/Geotechnical – Charlie Freshman (DEQ) and Darrel Stordahl (CDM)
- Hydrogeology/Water Quality - Wayne Jepson (DEQ), Jim Castro (DEQ), Rebecca Ridenour (DEQ), John McKay (USFS), and Kent Whiting (CDM)
- Reclamation/Soils/Vegetation – Patrick Plantenberg (DEQ), Lisa Boettcher (DEQ), and Steve Prieve (USFS)
- Permit Amendment Process – Herb Rolfes (DEQ)
- Wildlife/Fisheries – Pat Mullen (AMEC) and John Carlson (USFS)
- Troy Mine/Genesis Inc.- Genesis Inc. Representative

Thirty-three people registered on the sign in sheet for the open house (Appendix E). Attendees were encouraged to move freely from table to table, depending upon their interests. During discussion with the technical representative at each table, notes of the discussions were recorded on a flip chart for use in summarizing the event.

Section 4
Results of the Scoping Process

The comments received during the scoping process have been summarized into major issues. Copies of the written comments are provided in Appendix F. This section presents the major issues and identifies those that will be carried forward for further evaluation in the EA. Issues that will not be carried forward were eliminated because of technical impracticability. Although issues may have been eliminated from further evaluation, they will still have an impact on the EA process because of the background information and community insight they provided.

4.1 Issues Raised During the Scoping Process

Issues raised during the scoping process are summarized by major topic area in Sections 4.1.1 through 4.1.6. The topic areas are:

- Water Quality
- Cover Source Materials
- Impoundment Stability
- Buried Drums
- Subsidence
- Other

4.1.1 Water Quality

Water quality issues and concerns identified during the scoping activities include:

- Mine Water –Will there be increased flows to the impoundment area? What are the potential impacts of increased flows on water quality, the toe ponds, etc? What is the level inside the mine that water would reach (at a "sustainable" rate) using portal plugs? Why not replicate the decant ponds at the mill site and remove the seven-plus miles of tailings pipelines?

- Groundwater Protection – How does the Reclamation Plan address long-term seepage/groundwater discharge to Lake Creek? Why is groundwater an issue at this time, after 20 years of water being diverted to the decant ponds? Sealing mine openings is not reasonable; may pose future threat of releasing contaminated water should structural failure occur. Toe ponds leak directly into Lake Creek. Discharges from the mine have begun to appear in the vicinity of Ross Creek. An MPDES permit should be required for discharge of mine water.

- Long Term Prognosis/Monitoring – What will copper concentrations be in the future? Will copper reach Lake Creek? If so, when? The monitoring proposed in the Revised Reclamation Plan is inadequate in every respect; monitoring "in perpetuity" is impossible.

- Water Treatment - Can mine water be treated in the service adit prior to discharge? Is there any treatment of discharged mine water? Several comments stated a preference for treatment water now rather than long-term (indefinitely). Perpetual discharge of polluted water is a poorly conceived idea.

4.1.2 Cover Source Materials

- The impacts would be lessened if the topsoil stockpiles at the toe ponds are not disturbed, but where would cover material come from?

- Comment to use topsoil stockpiles at toe ponds instead of disturbing a new area.

4.1.3 Impoundment Stability

- How will continued discharge of mine water affect the stability of the tailings impoundment?

- Stability of the tailings impoundment is tied to its dewatering; sinkholes and recent field reports indicate inherent instability features that should be investigated.

- Instability of the impoundment and failure of the dam may negatively impact operation of the Northern Lights dam; this should be assessed and mitigated.

4.1.4 Buried Drums

- Are the buried drums addressed in the revised Reclamation Plan?

- Will the buried drums be unearthed and sampled?

4.1.5 Subsidence

- How would hydrology be affected by future occurrences of subsidence?

- How will future occurrences of mining-related subsidence be addressed?

- A bond commensurate with the possibility of further incidents and their mitigation should be considered.

- Closure of the mine will result in a small underground lake; further faulting in the area may produce blowouts or rupture the mine plugs, causing discharges of polluted water to surface waters.

4.1.6 Other

Other issues and concerns identified during the scoping process that do not concern the other primary disciplines include:

- Request for Forest Service to require an Environmental Impact Statement, as an Environmental Assessment is not adequate to cover Genesis' proposal.

- A cash bond should be required to cover all obvious and potential problems that could be associated with reclamation and perpetual maintenance, including mandatory review at ten-year intervals.

- Request for copies of the Reclamation Plan to be placed at Heron Library, Noxon High School Library, and Libby Library.

- No reclamation other than tree planting should occur – the mine should be left open to be used as an educational resource and a tourist attraction.

- Comment stating concern regarding blowing dust from the tailings impoundment area.

- Releasing water down pipelines to tailings impoundment provides water needed for revegetation.

- Discharge of mine water to tailings impoundment would provide incentives for wise development and re-use of tailings area.

- The Northern Lights Dam at the mouth of Lake Creek traps sediment; it has been dredged twice, but no analysis of sediments has been conducted to determine extent of contamination from Troy Mine operations.

- The milling process uses iron, but occurrences of 'iron flock' have been attributed to natural processes; fate and transport of iron should be studied as carefully as copper.

- The amount of topsoil currently stockpiled is unsubstantiated, as some of the stockpile was used in creation of toe ponds, which hide violations of the Clean Water Act.

4.2 Issues Considered But Not Recommended For Further Evaluation

The scoping process has provided opportunities for the public to present concerns and issues to be considered during the EA process. Most of the technical issues raised will be carried forward for further consideration in the EA process. However, several issues were not recommended for further evaluation by consensus during the IDT meetings. These issues will be discussed and summarized in the EA, but no additional analysis is anticipated for these issues which are described below.

In December 2002 the Cabinet Resource Group (CRG) initiated a lawsuit against ASARCO and Sterling Mining Company (now Revett Silver Company) that alleged that barrels of hazardous waste were buried within the tailings impoundment during ASARCO's operation of the Troy Mine. CRG also claimed that barrels containing solvents and waste oil and grease were buried in the tailings impoundment. The allegations were never substantiated, and in July 2006, U.S. District Court Judge Donald Molloy dismissed the case without prejudice.

ASARCO has admitted to burying the drums but has also stated that the drums did not contain contaminants. The DEQ has reviewed water quality data and determined that CRG claims were not substantiated. The water quality analysis to be conducted for this EA will provide additional data to determine whether there is any merit to the claim of contamination in the buried drums.

Blowing dust from the impoundment area would only be a concern during operation of the mine. Once the mine has closed and ceases to place additional lifts of tailings in the impoundment, the area will be covered with topsoil and seeded with native plant species. The revegetated areas will be irrigated during the first growing season to ensure plant growth. Establishment of vegetation will control erosion and blowing dust.

The suggestion to leave the Troy Mine open as a tourist attraction does not meet the purpose and need for the reclamation project. Public health and safety, water quality concerns, and habitat for wildlife and threatened and endangered species would not be improved by leaving the Troy Mine open.

Subsidence has been addressed in previous technical reports. Previous occurrences of subsidence have been dealt with operationally, and a bond is in place for any future occurrences. The EA will discuss the potential environmental consequences of future occurrences, but the issue would not be included in the Reclamation Plan.

The purpose of the environmental assessment process is to determine whether significant impacts are likely to occur. The preparation of an EA for the Troy Mine Revised Reclamation Plan does not preclude the preparation of an Environmental Impact Statement (EIS). The EA will assist the agencies in identifying any potential impacts that should be considered and analyzed in more detail. Should significant impacts be identified during the EA process, an EIS will be prepared to assess the impacts, identify mitigation measures, and involve the public in resolution of adverse effects.

4.3 Issues to be Considered in the EA

Issues not dismissed for technical reasons will be addressed during the alternatives evaluation process in the EA. They are:

- Mine Water – Should hydraulic plugs be used to close adits? How much water will be held in the mine when it floods, and where will mine water drain to?

- Groundwater Protection – Will the copper attenuation process continue to function indefinitely ? Will groundwater be protected from elevated copper levels, and for how long? Will continued transmission of mine water through the tailings lines to the tailings impoundment/decant ponds cause any environmental impacts after the mine ceases operations?

- Long Term Water Quality Prognosis/Monitoring – what will copper concentrations be in the future? Will copper reach Lake Creek? If so, when? Will the toe ponds continue to drain

to Lake Creek? What are the effects to Ross Creek? How long can/should monitoring realistically be continued?

- Water Treatment - Can mine water be treated in the service adit prior to discharge? Is there any treatment of discharged mine water? Why not replicate the decant ponds at the mill site and remove the seven-plus miles of tailings pipelines? Will an MPDES permit be required and obtained?

- Cover Source Materials – Are the impacts of using the stockpiled topsoil greater than using another source of cover material?

- Impoundment stability - How will continued discharge of mine water affect the stability of the tailings impoundment? How will future placement of additional tailings lifts affect stability?

Section 5
Identification of Data Gaps

Most of the information needed to conduct the NEPA/MEPA evaluation is available from existing sources. The following information will be needed to analyze the issues and prepare the EA:

- An analysis of water treatment alternatives related to 1) mine water discharge through tailings pipelines and 2) hydraulic/non-hydraulic plugging of adits and mine flooding

- An analysis of the sustainability of the copper attenuation process

- Hydrology information, i.e., sampling data for Ross Creek and its tributaries

- A cultural resource survey for any additional borrow areas identified

5.1 Water Treatment Alternatives

Evaluation of the method of mine water discharge and its potential impacts to local hydrology and water quality will require additional studies to acquire the necessary data:

- Further study of alternative water treatment approaches, e.g., water might be treated prior to leaving the mine, allowing discharge not necessarily through the tailings pipelines; or water might be treated after exiting the mine in a series of constructed wetlands near the mill site.

- Analysis of hydraulic versus non-hydraulic plugs - Genesis initially proposed the use of hydraulic plugs in the service and conveyor adits to prevent discharge of adit water to the portal patio. This proposal has been dropped **in favor of non-hydraulic plug**s consisting of concrete and backfill from the portal patios. Water would be piped from the adit (through the plug) to the decant ponds for discharge. Non-hydraulic plugs would provide control of the flow rate of water discharging from the mine, would prevent access to the underground workings, and could potentially result in lower oxygen concentrations in the flooded mine and less oxidation of copper minerals (although reduction of oxygen concentration would be greater with hydraulic plugs).

5.2 Copper Attenuation Process

A phased technical study is proposed to evaluate the copper attenuation process. The attenuation of copper via adsorption within the upper portions of the decant pond is likely to continue for a very long time due to the low loading rate of copper onto the organic matter. The precipitation of copper minerals could continue indefinitely, provided that the geochemical conditions that allow the precipitation to occur are maintained. Should those conditions change and become less effective in the future, an additional attenuation mechanism within the aquifer may become important. An analysis will be conducted of the copper attenuation process and any additional mechanisms that can be used to prevent contamination of groundwater or Lake Creek.

5.3 Surface Water Quality

Surface water quality data will be used to evaluate the quality of water present in drainages. Additional data needs identified during the scoping process include:

- Water quality and flow rates of Ross Creek and its tributaries, which have not been routinely monitored under the operating permit, are needed to identify potential impacts from mining operations and assess mitigation measures, if necessary

- Storm water data for drainage are needed to assess impacts of mine features on quantity and quality of storm water and potential re-routing or catchment options

Data gap gathering activities will commence as the particular data are required and as the necessary funds to gather these data are available. DEQ will request water sampling data from Genesis, Inc. to expand upon the existing water quality database and to determine if additional water quality sampling data are needed.

Section 6
References

Genesis, Inc. 2005. Troy Mine Operating Permit #00093.

Genesis, Inc. 2006. Troy Mine Revised Reclamation Plan.

Appendix A
Press Release

REQUEST FOR COMMENT and NOTICE of PUBLIC MEETING
Genesis Incorporated Troy Mine Revised Reclamation Plan

USDA Forest Service, Kootenai National Forest

Three Rivers Ranger District, Troy Ranger Station
Lincoln County, Montana

Genesis, Inc. submitted a Troy Mine Revised Reclamation Plan which outlines their closure adit water management and modified reclamation proposal when the mine ceases operations in approximately six years, according to the latest estimate. The Plan describes their proposal including closure of facilities, revegetation, water management, and maintenance/monitoring. The Kootenai National Forest (KNF), and Montana Department of Environmental Quality (DEQ) are beginning the formal process of environmental analysis, and would like your input on the proposal. Your input is important to identify any concerns with the proposed activity.

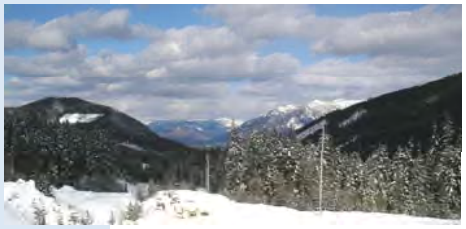
Copies of the Troy Mine Revised Reclamation Plan are available for review at the KNF Supervisors Office, 1101 Hwy 2 West, Libby, MT 59923, at the DEQ, Environmental Management Bureau, 1520 East 6th Avenue, Helena, MT 59620. Copies are also available for review at the public library in Troy, MT, and at the Three Rivers Ranger District, 1437 Hwy 2 West, Troy, MT., or on the KNF web page at the address shown below.

Comments concerning the proposed action must be postmarked by December 28, 2007, to be considered in the draft environmental document. The draft is expected by August, 2008, and the final by February, 2009. Send written comments concerning the Proposed Action to Paul Bradford, Forest Supervisor, Troy Mine Reclamation Project, Kootenai National Forest, 1101 U.S. Hwy 2 West, Libby, MT 59923. Send e-mail comments to: comments-northern-kootenai@fs.fed.us. All comments must contain name of commenter, postal service address, and date of comment. A copy on a computer generated CD should accompany all comments over one page in length.

For further information contact the Project Coordinators John McKay, Kootenai National Forest, 1101 U.S. Hwy 2 West, Libby, MT 59923, Phone (406) 283-7691, e-mail jmckay@fs.fed.us, or Kathy Johnson, DEQ, PO Box 200901, Helena, MT 59620, Phone (406) 444-1760, e-mail katjohnson@mt.gov or consult the Kootenai National Forest web page at http://www.fs.fed.us/r1/kootenai/resources/minerals/index.shtml.

An open house informational and scoping meeting will be held on Tuesday, October 30, 2007, at the Senior Citizens Center, Troy, MT, from 6:30 – 8:30 p.m.

Appendix B
Scoping Document



Troy Mine Revised Reclamation Plan Environmental Assessment

Kootenai National Forest and the Montana Department of Environmental Quality *October 2007*

Site Background

The Troy Mine is located in Lincoln County Montana, about 15 miles south of Troy. ASARCO, Inc. originally permitted the copper and silver mine in 1978, commencing full production in the fall of 1982. By 1993, ASARCO stopped production at the mine in the wake of low metals prices. Genesis, Inc. bought the mine during the shutdown period and production resumed in 2005.

In March 2006, Genesis, Inc. submitted their final revised reclamation plan which describes proposed reclamation elements for final mine closure. Closure is anticipated in five to six years, after the ore deposit runs out. The revised plan was needed as a result of new information from studies, data collection, revegetation test plots, prior reclamation plan development reviews, and bonding determinations. Changed conditions (e.g., the toe ponds at the perimeter of the tailings facility dikes) and new regulations (e.g., state water discharge standards that prohibit the direct discharge of produced mine water into Stanley Creek) were also a factor in the need for a revised plan.

DEQ and KNF are reviewing the revised reclamation plan and all of the associated information accumulated during the mine's nearly 30-year life. Through the EA process, they will analyze the impacts of implementing the reclamation plan and all of the developed alternatives.

The Troy Mine has submitted a revised plan for mine reclamation. As required by the ***Metal Mine Reclamation Act*** (MMRA), an ***Environmental Assessment*** (EA) must be prepared to ensure the actions proposed are protective of the environment.

This fact sheet provides a brief description of the mine, its history, and the proposed reclamation plan. It also discusses the purpose, scope, and schedule of the EA and describes how the public can provide general information about the project or specific comments on the plan. Sources for copies of the plan and additional information are also provided.

Open House and Public Meeting

The ***Kootenai National Forest*** (KNF) and the ***Montana Department of Environmental Quality*** (DEQ) are seeking public comments prior to preparing an EA for the Revised Reclamation Plan for the Troy Mine. Public input is important to identify any concerns with the proposed plan.

Tuesday, October 30, 2007
Senior Citizens Center in Troy
Open house - 6:30 to 7:30 pm
Public meeting - 7:30 to 8:30 pm

The open house is an opportunity for the public to chat one-on-one with technical staff about various areas (such as water quality or mine reclamation) and view maps, posters, etc. At the public meeting, DEQ and KNF will bring everyone up to date with what's going on. People with an interest in the mine are encouraged to attend these events.

DEQ will make reasonable accommodations for persons with disabilities who wish to participate in the open house. If you require accommodation, please contact Kathy Johnson at 406-444-1760.

Everyone is welcome!

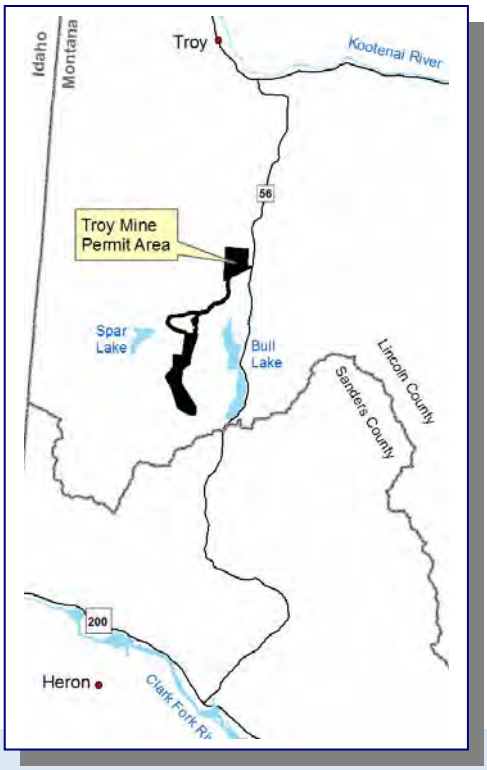
About the Troy Mine

The mine is located on 780 acres of public and private land south of Troy, Montana on US Highway 56 (see map). It consists of an underground mine, mill, and office facilities; tailings and water pipelines; power line; tailings impoundment; and associated support facilities (see pictures at right). The tailings facility and associated disturbances are on private land, and the tailings and water pipelines and the power line are on federal and private land.

Development of the underground copper/silver mine started in 1979 and production of ore concentrate started in 1981. During production, the mine produced approximately 8,500 tons/day of ore. In April 1993, ASARCO suspended mining and milling and placed the Troy Mine on care and maintenance status due to low metal prices. In November 2004, Genesis Inc. reinitiated mining which has focused on development of the East Ore Body portion of the mine.

From 1993 through 2004, the primary activities included:

- Care and maintenance of equipment and facilities
- Reclamation of portions of the tailing facility
- Evaluation of revegetation success
- Testing of methods for tailing reclamation
- Geotechnical monitoring of the tailing facility
- Monitoring of creeks and groundwater
- Initiation of fate and transport studies for mine water
- Preliminary assessment of tunnel-plugging methods
- Evaluation of water treatment methods
- Evaluation of mine flooding during pump shutdown period



What is an EA?

An EA is a detailed study that analyzes the environmental effects of a proposed action and its alternatives. It compares the impacts of the proposed action against those of “no action.” DEQ and KNF have committed to preparing an EA to determine the nature and extent of impacts to the environment that may occur with implementation of the proposed revised reclamation plan. An EA provides for a thorough investigation of the potential impacts of a proposed action and also delineates measures that may be implemented to lessen any identified impacts.

The EA has two potential outcomes. If significant impacts to the environment are identified that cannot be avoided or mitigated, an Environmental Impact Statement (EIS) will be prepared. If no significant impacts are identified, a ***Finding of No Significant Impact*** (FONSI) will be prepared that will state all of the mitigation measures identified, especially those required to make the recommended alternative environmentally acceptable.

Components of the Plan

The original reclamation plan was submitted in the mine permit application in 1978. The revised plan for reclamation submitted by Genesis, Inc. describes their proposals for closure of facilities, revegetation, water management, and maintenance/monitoring.

Modifications to the original reclamation plan include:

- Modification of the adit water management plan
- A reclamation cap for the tailings impoundment
- Identification of new soil borrow areas for the reclamation cap
- Modification of seed mixes
- Incorporation of wetlands and open ponds to be left at closure
- Incorporation of more expansive weed control and weed prevention measures
- Use of the decant ponds to capture storm water runoff from the impoundment
- Use of toe ponds to capture dike runoff and groundwater seepage

Initial Issues of Concern

DEQ and KNF have identified several potential issues of initial concern:

- Air quality – blowing dust from the tailings impoundment area
- Surface and groundwater quality – long-term treatment/disposal of discharge water and potential for groundwater contamination beneath the tailings impoundment
- Wetlands – the creation of wetlands at the tailings impoundment
- Subsidence – reclamation of any future mining-related subsidence
- Tailings impoundment stability
- Effects on fisheries and wildlife (including threatened, endangered, or sensitive species) – potential long-term impacts from water quality degradation and short-term from plan implementation
- Vegetation and noxious weeds
- Cover soil – quality, location, and available volume of sources
- Potential for buried contaminants in tailings impoundment

These issues, and any other substantive issues identified by the public or the agencies' consultants, will be addressed in the EA. **The public is encouraged to come to the open house to discuss issues or to provide comments in writing about the plan.**

The EA Process

- Conduct scoping activities to make stakeholders (the public and local, state, and federal agencies with an interest in the project) aware of the EA
- Research/analyze existing conditions in project area
- Review proposed alternative and, if needed, develop additional alternatives that more fully address the purpose
- Analyze impacts of the alternatives and develop mitigation measures to lessen or avoid them
- Prepare a draft EA and make available to the public and agencies for review and comment
- Hold a public hearing to solicit comment from stakeholders
- Review all comments and apply, where feasible and reasonable
- Provide responses to stakeholders and revise the EA as necessary to incorporate any needed changes
- If no significant impacts are identified, conclude the EA with a FONSI
- If significant impacts are identified that cannot be mitigated, prepare an EIS and a ***Record of Decision*** (ROD) to document impacts and the decisions made to minimize them

EA Schedule and Deliverables

The EA process began in October 2007 and is anticipated to take approximately 18 months to complete.

Scoping Report.....	**December 2007**
Draft EA.....	**April 2008**
Public Hearing.....	**September 2008**
Comment Period.....	**August-Sept. 2008**
Review of Comments.....	**Sept.-Nov. 2008**
Final EA.....	**February 2009**
FONSI	**March 2009**

This assumes the EA will be sufficient to analyze the environmental impacts, that no significant impacts will occur, and that an EIS will not be required.

Reclamation Plan Goals

- Re-establish wildlife habitat
- Protect groundwater quality and surface water quality in local creeks
- Protect air quality in surrounding areas
- Provide public access to Federal lands
- Protect public health and safety by removing potential hazards

Identity of back page picture: The ball mill from inside the Troy mine. Come to the meeting to find out more.

Do You Want to Learn More?

Copies of the Plan

Copies of the *Troy Mine Revised Reclamation Plan* are available for review at the KNF Supervisors Office, 1101 Highway 2 West, Libby, Montana and at the DEQ Environmental Management Bureau, 1520 East 6th Avenue, Helena, Montana. Copies are also available for review at the public library in Troy and at the Three Rivers Ranger District, 1437 Highway 2 West, Troy, Montana.

Questions or Comments

For further information contact the following Project Coordinators:

- **John McKay,** Kootenai National Forest, 1101 U.S. Hwy 2 West, Libby, MT 59923, (406) 283-7691, jmckay@fs.fed.us
- **Kathy Johnson**, DEQ, PO Box 200901, Helena, MT 59620, (406) 444-1760, katjohnson@mt.gov

Information (including an electronic version of the plan) is also available on the KNF and DEQ websites:

- www.fs.fed.us/r1/kootenai/resources/minerals/index.shtml
- www.deq.mt.gov

How to Comment on the Reclamation Plan

Written comments concerning the proposed action must be postmarked by December 28, 2007, to be considered in the draft EA. Comments should be sent to Paul Bradford, Forest Supervisor, Troy Mine Reclamation Project, Kootenai National Forest, 1101 U.S. Hwy 2 West, Libby, MT 59923, or e-mailed to: **comments-northern-kootenai@fs.fed.us** with "**Troy Mine Revised Reclamation Plan**" in the subject line.

All comments must contain name of commenter, postal service address, and date of comment. A copy on a computer generated CD should accompany all written comments over one page in length.

Montana Department of Environmental Quality
PO Box 200901
Helena, MT 59620
Attn: Kathy Johnson

Return Service Requested

Can you identify this mystery mining picture?
(See inside for answer)

Appendix C
Mailing List for Open House/Public Meeting

Company	First Name	Last Name	Address	City	State	Zip
BUREAU OF MINES & GEOLOGY	ROBIN	McCULLOCH	1300 WEST PARK ST RM 200	BUTTE	MT	59701-8998
DAILY INTERLAKE	BILL	SPENCE	727 E IDAHO ST	KALISPELL	MT	59904
MONTANA DNRC	LIBBY UNIT		14096 HWY 37	LIBBY	MT	59923
NORTHWEST MINING ASSOCIATION		220		SPOKANE	WA	99201-0772
WETA	DON	ALLEN	2301 COLONIAL DR	HELENA	MT	59601
SHPO		DEADHEAD	HELENA			
EARTHWORKS	BONNIE	GESTRING	PO Box 8383	MISSOULA	MT	59807
BLM - DILLON FIELD OFFICE	BOB	GUNDERSON	PO BOX 9431	DILLON	MT	59725
BLM - LEWISTOWN FIELD OFFICE	SCOTT	HAIGHT	PO BOX 1160	LEWISTOWN	MT	59457-1160
MEIC	JIM	JENSEN	PO BOX 1184	HELENA	MT	59624
VALLEY COUNTY RD DEPT	RICK	SEILER	PO BOX 1024	GLASGOW	MT	59230
WETA	DON	SERBA	2301 COLONIAL DR STE 2A	HELENA	MT	59601
WETA	DON	SERBA	216 CENTENNIAL ST	MISSOULA	MT	59801
MONTANA HISTORICAL SOCIETY	STAN	WILMOTH, PhD	PO BOX 2001201	HELENA	MT	59620-1201
MONTANA MINING ASSOCIATION			PO BOX 5567	HELENA	MT	59604
MONTANA TECH Library	Document Dept		1300 W Park	BUTTE	MT	59701-8997
NWEST MINING ASSOCIATION			10 N POST SUITE 220	SPOKANE	WA	99201-0772
MONTANA MINING ASSOCIATION			PO BOX 5567	HELENA	MT	59604
GOVERNOR'S OFFICE	CAPT. BLDG RM 204		DEADHEAD			
BLM - LEWISTOWN FIELD OFFICE			PO BOX 1160	LEWISTOWN	MT	59457-1160
BLM-MALTA FIELD OFFICE			HC 65 BOX 5000	MALTA	MT	59538-0047
CHOTEAU COUNTY			PO BOX 459	FORT BENTON	MT	59442
CITY OF HARLOWTON			PO BOX 292	HARLOWTOWN	MT	59036
DNRC			PO BOX 1021	LEWISTOWN	MT	59457-1021
GALLATIN NATIONAL FOREST			PO BOX 130	BOZEMAN	MT	59771
HELENA NATIONAL FOREST			2880 SKYWAY DR	HELENA	MT	59601
L YELLOWSTONE IRR PROJECT			2327 LINCOLN AVE SE	SIDNEY	MT	59270
WHEATLAND COUNTY			PO BOX 1903	HARLOWTOWN	MT	59036
ENIRONMENTAL QUALITY COUNCIL	Legislative Environmental Policy Office		PO BOX 201704	HELENA	MT	59620-1704
	CHAS	VINCENT	5957 CHAMPION RD	LIBBY	MT	59923
	AUBYN	CURTISS	PO BOX 216	FORTINE	MT	59918-0216
	RALPH	HEINERT	PO BOX 577	LIBBY	MT	59923-0577
COUNTY COMMISSIONER LINCOLN	JOHN	KONZEN	512 CALIFORNIA AVE	LIBBY	MT	59923
COUNTY COMMISSIONER LINCOLN	MARIANNE	ROOSE	PO BOX 2012	EUREKA	MT	59917
COUNTY COMMISSIONER LINCOLN	RITA	WINDOM	512 CALIFORNIA AVE	LIBBY	MT	59923
COUNTY COMMISSIONER SANDERS	CAROL	BROOKER	PO BOX 794	PLAINS	MT	59589
COUNTY COMMISSIONER SANDERS	HAROLD	LAWS	PO BOX 745	THOMPSON FALLS	MT	59873
COUNTY COMMISSIONER SANDERS	JUSTIN	PATTON	129 PATTON RD	LONEPINE	MT	59848
US FISH AND WILDLIFE SERVICE			780 CRESTON HATCHERY RD	KALISPELL	MT	59901
WILDWEST INSTITUTE			PO BOX 7998	MISSOULA	MT	59807
ALLIANCE FOR THE WILD ROCKIES	LIZ	SEDLER	PO BOX 1203	SANDPOINT	ID	83864
CABINET BACK COUNTRY HORSEMEN	ROCKY	SCHAUER	PO BOX 949	LIBBY	MT	59923
CABINET BACK COUNTRY HORSEMEN	LEE	METZGAR	1001 E BROADWAY ST NO 2-206	MISSOULA	MT	59802
MONTANA WILDERNESS ASSOCIATION	CESAR	HERNANDEZ	643 FULKERSON LANE	POLSON	MT	59860
MONTANIANS FOR MULTIPLE USE	STEVE	FUNKE	578 1ST AVE NE	KALISPELL	MT	59901

Company	First Name	Last Name	Address	City	State	Zip
MT CHAPTER AMERICAN FISHERIES SOCIETY	ERIC	REILAND	PO BOX 5186	MISSOULA	MT	59806
MT DEPT OF NATURAL RESOURCES	JOHN	SHOTZBERGER	14096 US HWY 37	LIBBY	MT	59923
MT FISH WILDLIFE AND PARKS	JERRY	BROWN	475 FISH HATCHERY ROAD	LIBBY	MT	59923
UNITED STATES HOUSE OF REPRESENTATIVES	DENNIS	REHBERG	301 E BROADWAY, SUITE 2	MISSOULA	MT	59802
UNITED STATES SENATE	MAX	BAUCUS	8 THIRD STREET EAST	KALISPELL	MT	59901
UNITED STATES SENATE	JON	TESTER	1845 HWY 93 S SUITE 210	KALISPELL	MT	59901
MT STATE REPRESENTATIVE, DIST 13	PAT	INGRAHAM	PO BOX 1151	THOMPSON FALLS	MT	59873
MT STATE SENATOR, DIST 7	JIM	ELLIOT	100 TROUT CREEK RD	TROUT CREEK	MT	59874
ROCK CREEK ALLIANCE	RICK	STERN	210 HIGGINS, SUITE 206	MISSOULA	MT	59802
SOCIETY OF AMERICAN FORESTERS			PO BOX 345	LIBBY	MT	59923
LIBBY MAYOR	TONY	BERGET	PO BOX 1428	LIBBY	MT	59923
TROY MAYOR	JIM	HAMMONS	PO BOX 1030	TROY	MT	59935
US FISH AND WILDLIFE SERVICE	WAYNE	KASWORM	FARM TO MARKET RD	LIBBY	MT	59923
CLARK FORK COALISTION	MATT	CLIFFORD	PO BOX 7593	MISSOULA	MT	59807
	HANNAH	HERNANDEZ	71 FOUR CORNERS S	HERON	MT	59844
	JUDY	HUTCHINS	PO BOX 104	HERON	MT	59844
LINCOLN COUNTY COALITION	WAYNE	HIRST	209 MINERAL AVE	LIBBY	MT	59923
YAAK VALLEY FOREST COUNCIL	ROBIN	KING	155 RIVERVIEW DR	TROY	MT	59935
	STEVE	PRIEVE	PO BOX 213	TROY	MT	59935
ENVIRONMENTAL PROTECTION AGENCY	STEVE	POTTS	10 W 15TH STREET SUITE 3200	HELENA	MT	59626
ENVIRONMENTAL PROTECTION AGENCY	BILL	RILEY	1200 6TH AVE	SEATTLE	WA	98101
MONTANA TROUT UNLIMITED	TIM	LINEHAN	472 UPPER FORD ROAD	TROY	MT	59935
NATIONAL WILDLIFE FEDERATION	HANK	FISHER	3342 BUTLER VIEW LN	MISSOULA	MT	59806
SIERRA CLUB	JIM	CURTISS	1318 KHANABAD DR	MISSOULA	MT	59802
USFWS	MARK	WILSON	100 N PARK SUITE 320	HELENA	MT	59601
ARMY CORPS OF ENGINEERS	BOB	NEBEL	215 N 17TH ST	OMAHA	NE	68102-4978
	RAY	REMP	208 N COLORADO AVE	LIBBY	MT	59923
	DASIOS	FOTULA	PO BOX 723	TROY	MT	59935
MONTANA MOUNTAIN VALLEY, LLC			PO BOX 1626	EAGLE RIVER	WI	54521
	RAY	SAMPSON	8952 BULL LAKE RD	TROY	MT	59935
	RON	COTTON	1011 SHINING MTNS TRAIL	TROY	MT	59935
	STEVE	GIBSON	435712 STATE HWY 20	NEWPORT	WA	99156
	JOHN	NORRIS	PO BOX 456	MT BALDY	CA	91759
	ROBERT	JENKINS	1672 SPAR LAKE ROAD # RE	TROY	MT	59935
	DAVID	REID	PO BOX 257	TROY	MT	59935
	RICHARD	GREENE	1365 STAR GAZE CT	COLFAX	CA	95713
ATHENS INVESTMENTS, INC			201 W MAIN STREET STE 201	MISSOULA	MT	59802
	TOM	BAMFORD	PO BOX 971	TROY	MT	59935
	CAROLE	WRIGHT	9504 BULL LAKE RD	TROY	MT	59935
	NEIL	NEWTON	PO BOX 523	SEELEY LAKE	MT	59868
	DON	WEATHERBY	9564 BULL LAKE RD	TROY	MT	59935
	ALLAN	BACON	9566 BULL LAKE RD	TROY	MT	59935
NORTHWEST PROPERTIES, LLC			103 W LINCOLN BLVD	LIBBY	MT	59923

Appendix D

Newspaper Advertisements for Open House/Public Meeting

Western News

Libby, MT

USDA Forest Service, Kootenai National Forest
Three Rivers Ranger District, Troy Ranger Station
Lincoln County, Montana

The Kootenai National Forest (KNF) and Montana Department of Environmental Quality (DEQ) are beginning the formal process of environmental analysis, and would like your input on the proposal. Your input is important to identify any concerns with the proposed activity.

An open house informational and scoping meeting will be held on Tuesday, October 30, 2007, at the Senior Citizens Center, Troy, MT, from 6:30 - 8:30 p.m.

Comments concerning the proposed action must be postmarked by December 28, 2007, to be considered in the draft environmental document. The draft is expected by August 2008, and the final by February 2009. Send written comments concerning the Proposed Action to Paul Bradford, Forest Supervisor, Troy Mine Reclamation Project, Kootenai National Forest, 1101 U.S. Hwy 2 West, Libby, MT 59923. Send e-mail comments to: **comments-northern-kootenai@fs.fed.us.** All comments must contain name of commenter, postal service address, and date of comment. A copy on a computer generated CD should accompany all comments over one page in length.

Genesis, Inc. submitted a Troy Mine Revised Reclamation Plan, which outlines their closure adit water management and modified reclamation proposal when the mine ceases operations in approximately six years, according to the latest estimate. The Plan describes their proposal including closure of facilities, revegetation, water management, and maintenance/monitoring.

Copies of the Troy Mine Revised Reclamation Plan are available for review at the KNF Supervisor's Office, 1101 Hwy 2 West, Libby, MT 59923, at the DEQ, Environmental Management Bureau, 1520 East 6th Avenue, Helena, MT 59620. Copies are also available for review at the public library in Troy, MT, and at the Three Rivers Ranger District, 1437 Hwy 2 West, Troy, MT., or on the KNF web page at the address shown below.

For further information contact the Project Coordinators John McKay, Kootenai National Forest, 1101 U.S. Hwy 2 West, Libby, MT 59923, Phone (406) 283-7691, e-mail jmckay@fs.fed.us or Kathy Johnson, DEQ, PO Box 200901, Helena, MT 59620, Phone (406) 444-1760, e-mail katjohnson@mt.gov or consult the Kootenai National Forest web page at **http://www.fs.fed.us/r1/kootenai/resources/minerals/index.shtml.**

pt a Family Programs throughout Montana to
iving Program. Fifty $500 Grants are available
ions. Please send a brief letter describing your
lopt A Family Program, P.O. Box 6000, Butte,
ember 9, 2007 for Christmas of 2007

Kootenai National Forest Service 10-24-07

County papers over the years

by Sandra Gubel

From an historical point of view, there have been several newspapers operating through the years in Sanders County--some with a fair amount of longevity.

In a brief stint, Publisher Adam Aulbach published 13 issues of the *Belknap Sun* in the period around 1884. Belknap at that time was the "getting on" point to depart on the train to the Coeur d'Alene gold fields. The temporary town that held some 6,000 people awaiting departure on the trains, soon diminished, and Aulbach himself eventually decided to climb on board awaiting a "golden" opportunity.

Nearby Thompson (only later named Thompson Falls), became the spot that people inhabited more in the days afterward--those who remained here, or returned after finding the life of the gold country not to their liking.

The *Western Montanian*, noted Lorraine Dufresne in her book *A Heritage Remembered*, sprung up in 1896, published in Thompson. Maurice Helterline, who painstakingly researched that publication and several others, gleaning births, deaths and marriages, noted he'd checked all issues of the Montanian during its publication years of 1894 to 1896. D.A. Hendricks was publisher of the paper, which came out each Saturday. Subscriptions were $2.50 per year.

Sanders County Signal was published in the Plains/Hot Springs area from 1906 to 1924. The Plainsman (in Plains) published in 1895 and 1896, and again from 1900 to 1992. The *Sanders County Democrat* was published in 1911 and 1912 from Plains, with C.C. Willis as publisher. The *Hot Springs Sentinel* was published from 1950 to 1960. There was also a newspaper called the *Hot Springs Citizen*.

Also publishing news were the newspapers *Camas Hot Springs Exchange* and *Camas Hot Springs Record*.

It is believed that the newspaper for whom Edith Colby worked (see additional historical article), the *Independent-Enterprise* was published for a period of time and was in operation before and during the time that the reporter stood trial for the shooting of Thompson businessman Atwood C. Thomas. Editor of that paper was J. Manire.

Of the newspapers that remain in business, the *Little*

REQUEST FOR COMMENT and NOTICE of PUBLIC MEETING

Genesis Incorporated Troy Mine Revised Reclamation Plan

USDA Forest Service, Kootenai National Forest
Three Rivers Ranger District, Troy Ranger Station
Lincoln County, Montana

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Genesis, Inc. submitted a Troy Mine Revised Reclamation Plan, which outlines their closure adit water management and modified reclamation proposal when the mine ceases operations in approximately six years, according to the latest estimate. The Plan describes their proposal including closure of facilities, revegetation, water management, and maintenance/monitoring.

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Published in the Sanders County Ledger October 25, 2007

NOTICE

Notice is hereby given th
conjunction with Town of

SHALL THE TOWN COL
ADDITIONAL 75 MILLS
ADDITIONAL FUNDING

The polls will be open
p.m., on election day for

Town of

DATED this 17th day of

Published in th

that a 237-member steering committee led by Hu approved the final candidate list for the Central Committee after two days of consultations with congress delegates. China Central Television showed Hu and other leaders raising their hands in approval.

the town of Musa Qala in Helmand province, sparking a battle that lasted several hours and involved the use of military aircraft, the coalition said in a statement. Nearly three dozen militants were killed.

The battle was the second in two days near Musa

months after British troops left the town following a contentious peace agreement that handed over security responsibilities to Afghan elders. Musa Qala has been in control of Taliban fighters ever since and is in the heart of the world's largest poppy-growing region.

Daily Inter Lake

10/21/07

REQUEST FOR COMMENT and NOTICE of PUBLIC MEETING

Genesis Incorporated Troy Mine Revised Reclamation Plan
USDA Forest Service, Kootenai National Forest
Three Rivers Ranger District, Troy Ranger Station
Lincoln County, Montana

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Kootenai National Forest – Mail 1

GREAT FOOD • GREAT PAPER • D

and receive $10 off any meal at The Landing Restaurant

BONNER COUNTY DAILY BEE

10/24/07

THE LANDING

41 Lakeshore Drive, Sagle • Just across The Long Bridge • 265-2000

452888S-1023

REQUEST FOR COMMENT and NOTICE of PUBLIC MEETING

Genesis Incorporated Troy Mine Revised Reclamation Plan
USDA Forest Service, Kootenai National Forest
Three Rivers Ranger District, Troy Ranger Station
Lincoln County, Montana

The Kootenai National Forest (KNF) and Montana Department of Environmental Quality (DEQ) are beginning the formal process of environmental analysis, and would like your input on the proposal. Your input is important to identify any concerns with the proposed activity. An open house informational and scoping meeting will be held on Tuesday, October 30, 2007, at the Senior Citizens Center, Troy, MT, from 6:30 – 8:30 p.m. Comments concerning the proposed action must be postmarked by December 28, 2007, to be considered in the draft environmental document. The draft is expected by August 2008, and the final by February 2009. Send written comments concerning the Proposed Action to Paul Bradford, Forest Supervisor, Troy Mine Reclamation Project, Kootenai National Forest, 1101 U.S. Hwy 2 West, Libby, MT 59923. Send e-mail comments to: mailto:comments-northern-kootenai@fs.fed.us. All comments must contain name of commenter, postal service address, and date of comment. A copy on a computer generated CD should accompany all comments over one page in length. Genesis, Inc. submitted a Troy Mine Revised Reclamation Plan, which outlines their closure adit water management and modified reclamation proposal when the mine ceases operations in approximately six years, according to the latest estimate. The Plan describes their proposal including closure of facilities, revegetation, water management, and maintenance/monitoring. Copies of the Troy Mine Revised Reclamation Plan are available for review at the KNF Supervisor's Office, 1101 Hwy 2 West, Libby, MT 59923, at the DEQ, Environmental Management Bureau, 1520 East 6th Avenue, Helena, MT 59620. Copies are also available for review at the public library in Troy, MT, and at the Three Rivers Ranger District, 1437 Hwy 2 West, Troy, MT., or on the KNF web page at the address shown below. For further information contact the Project Coordinators John McKay, Kootenai National Forest, 1101 U.S. Hwy 2 West, Libby, MT 59923, Phone (406) 283-7691, e-mail mailto:jmckay@fs.fed.us , or Kathy Johnson, DEQ, PO Box 200901, Helena, MT 59620, Phone (406) 444-1760, e-mail to:katjohnson@mt.gov or consult the Kootenai National Forest web page at http://www.fs.fed.us/r1/kootenai/resources/minerals/index.shtml.

452287S-1024

Kootenai National Forest

Appendix E
Sign in Sheets for Open House/Public Meeting

PLEASE SIGN IN

Name: Kevin & Brenda Goe
Mailing Address: P.O. Box 24
City: Troy State: MT Zip Code: 59935
Phone: 295-7214 Email: —

Name: Doug Paker
Mailing Address: 667 E Beckwith
City: Missoula State: MT Zip Code: 59801
Phone: Email:

Name: Bruce Clark
Mailing Address: PO Box 479
City: Troy State: MT Zip Code: 59935
Phone: 295-4727 Email:

Name: STEVE LLOYD
Mailing Address: Box 874
City: Hot Springs State: MT Zip Code: 59845
Phone: 240-1349 Email:

Name: LINDA Newstrom
Mailing Address: PO BUX 524
City: Troy State: MT Zip Code: 59935
Phone: 406/295 5568 Email: x

Name: Donald W. Baney
Mailing Address: 155 Forest Ave
City: Libby State: MT Zip Code: 59923
Phone: (406) 293-7860 Email:

PLEASE SIGN IN

Name: Derek L. Feeback
Mailing Address: PO Box 1282
City: Libby State: MT Zip Code: 59923
Phone: 293-6151 Email: rx@backadit.com

Name: Paul Cook
Mailing Address: 68 Swanson Lodge Rd
City: Troy State: MT Zip Code: 59935
Phone: 295 9916 Email:

Name: Rep. Chas Vincent
Mailing Address: 5957 Champion Rd
City: Libby State: MT Zip Code: 59923
Phone: 293.1575 Email: cvvincent@hotmail.com

Name: Torin Hasz
Mailing Address: 1688 Iron Creek Rd
City: Troy State: MT Zip Code: 59935
Phone: ~~406~~ (406) 295-9877 Email: Torinhasz@yahoo.com

Name: Joshua Peterson
Mailing Address: Box 1150
City: Troy State: MT Zip Code: 59935
Phone: 295 6015 Email:

Name: James THill
Mailing Address: P.O. Box 250
City: TROY State: MT Zip Code: 59935
Phone: 295-9061 Email:

PLEASE SIGN IN

Name: Judy Hutchins
Mailing Address: P.O. Box 104
City: Heron State: MT Zip Code: 59844
Phone: 406-847-2717 Email: Jhutch7494@aol.com

Name: Jeff Franke
Mailing Address: 851 Lake Creek Road
City: Troy State: M.T. Zip Code: 59935
Phone: 406-295-5232 Email: frankej@troymine.com

Name: Lloyd Doney
Mailing Address: 40 Halo Ct. S.
City: Troy State: MT. Zip Code: 59935
Phone: 295-5882 Email: Doneyl@Troymine.com

Name: Janine Price
Mailing Address: PO Box 180
City: Troy State: MT Zip Code: 59935
Phone: 295-5248 Email:

Name: Carleene Jensen
Mailing Address: 53 Swanson Rdg Rd
City: Troy State: Mt Zip Code: 59935
Phone: Email:

Name: Clint Jensen
Mailing Address: P.O. Box 71
City: Heron State: Mont Zip Code: 59844
Phone: 406-847-2127 Email:

PLEASE SIGN IN

Name: Donald B Davis
Mailing Address: 3945 Bull Lk Rd
City: Troy State: Mont Zip Code: 59935
Phone: 295-4910 Email:

Name: Joe Madaski
Mailing Address: P.O. Box 748
City: Troy State: MT. Zip Code: 59935
Phone: (406) 295-4191 Email:

Name: Allen Layer
Mailing Address: PO 284
City: Troy State: MT Zip Code: 59935
Phone: 406-295-9190 Email:

Name: Hannah Hernandez
Mailing Address: 71 Four Corners Rd
City: Heron State: MT Zip Code: 59844
Phone: Email: mtpaloma@hotmail.com

Name: Keith O'Bleness
Mailing Address: 74 Hamann Ave
City: Libby State: MT Zip Code: 59923
Phone: (406) 293-9832 Email:

Name: Darcy O'Bleness
Mailing Address: 74 Hamann Ave.
City: Libby State: Mt. Zip Code: 59923
Phone: 406-293-9832 Email:

PLEASE SIGN IN

Name: Aubyn Curtiss
Mailing Address: Box 212
City: Fortine State: MT Zip Code: 59918
Phone: 406-882-4448 Email: aubyna@interbel.net

Name: Debbie Lyman
Mailing Address: 34 Beaver Peak Rd
City: Heron State: MT Zip Code: 59844
Phone: 8472388 Email: lastlyman@blackfoot.net

Name: Ruby Miller
Mailing Address: PO Box 548
City: Troy State: MT Zip Code: 59935
Phone: 295-4255 Email: millerra@cdm.com

Name: Glenn Knodle
Mailing Address: 184 Elk Meadow Ln
City: Heron State: MT Zip Code: 59844
Phone: Email:

Name: Paul D Kukay
Mailing Address: 343 Warren Road
City: Libby State: MT Zip Code: 59923
Phone: 406-293-6989 Email: PKukay@hotmail.com

Name: Robert Winstron
Mailing Address: PO Box 775
City: Troy State: MT Zip Code: 59935
Phone: 406-295-5018 Email: info@troutfitters.com

PLEASE SIGN IN

Name: Colleen Hinds
Mailing Address: 21 Four Corners Rd S
City: Heron State: MT Zip Code: 59844
Phone: Email:

Name: Floyd Beck
Mailing Address: 813 Wisconsin Ave
City: Libby State: MT Zip Code: 59923
Phone: (406) 293-8681 Email:

Name:
Mailing Address:
City: State: Zip Code:
Phone: Email:

Name:
Mailing Address:
City: State: Zip Code:
Phone: Email:

Name:
Mailing Address:
City: State: Zip Code:
Phone: Email:

Name:
Mailing Address:
City: State: Zip Code:
Phone: Email:

Appendix F
Written Comments Received During the Scoping Process

PB

COMMENT ON TROY MINE RECLIMATION PROJECT
IN CARE OF PAUL BRADFORD FOREST SUPERVISOR
KOOTENAI N.F. 1101 US. HWY 2 WEST LIBBY MT 59923

NOV 28 2007

Dear Sir: I beleive The Troy Mine Should NOT be Reclaimed, I beleive it Should be Kept As is Except For certain Landscapes which could be Reclaimed With Tree Plants and grass Restoration. I beleive This Mine The only One of its Kind of Caveren And Pillar on Silver and copper Minerals, Should be Used As A Education Facility For Children of Elementry Levels As well As Colleges, And Also Could be Used As A great Tourist Attraction Also,

I several Years Ago while Visiting A Open Copper Pit Mine which was NOT Operating AT This Time, had A Chance As A Tourist To Tour A underground Mine which was Also Idle, A Retired Miner who had worked There was The Tour guide who Explained The History Of The Mine, The Troy Mine could Also be A great Tourist Attraction if Left Mostly As is. Thank you

Harvey H. Frederickson
120 Middle Thompson Lake Rd.
Libby MT 59923 Ph 293-4959

PB
McKy

321 Shaugnessy Rd
Libby, MT 59923
26 November 2007

Paul Bradford
Forest Supervisor
Troy Mine Reclamation Project
Kootenai NF
1101 US Hwy 2 W
Libby, MT 59923

NOV 2007
RECEIVED

Dear Mr. Bradford,

I am asking you to consider several issues of concern regarding the Troy Mine. These include:
air quality (especially blowing dust from tailings impoundment)
surface and groundwater quality-perpetual treatment of discharge water and potential groundwater contamination underneath the tailings
subsidence-reclamation of future mining related subsidence
tailing impoundment stability
effects n fisheries and wildlife
buried contaminants in the tailings impoundment (buried barrels)

Goals of a reclamation plan should include protecting the groundwater and surface water quality
protecting public health by removing potential hazards
protecting air quality and reestablishing wildlife habitat.

I urge you to consider these issues of impact to the environment. Thank you

sincerely,
Julie Waters-Barcomb

Paul Bradford, Forest Supervisor
Troy Mine Reclamation Project
Libby, MT 59923

12/26/07

RE: Troy mine Reclamation

Dear Mr. Bradford

The most important consideration should be a cash bond to cover all obvious and potential problems that could possibly be associated with reclamation and perpetual maintenance of that reclamation with inflation rates calculated in the initial bond amount. This could have a mandatory review at ten-year intervals to assess the needs for the future. This bonding requirement would be particularly appropriate for: 1) tailings ponds integrity including sub- permeability to ground water, dike leakage, toe pond integrity, and toxic materials from containers that become apparent at a later date; 2) treatment of mine water that may change in chemistry and volume at a later date; 3) subsidence that may occur in the future due to climate changes and geologic events.

The following concerns identified by the agencies should definitely be addressed and returned to the same or better standards that existed prior to the mine, in a natural self sustaining to perpetuity condition:

1. Air quality in a pristine forest condition through appropriate state-of-the-art restoration of all tailings impoundments.
2. Perpetual monitoring and, if necessary, treatment of ground water and surface water to a purity standard of unimpacted streams of the of the area.
3. Potential for subsidence should be eliminated through any mining technology necessary.
4. The stability and total integrity of all tailings ponds (toe ponds) should be established through testing, analyzing soil conditions and whatever process is necessary to guarantee that total integrity.
5. There should be no negative impacts to fisheries and/or wildlife in the entire area of mine activity, after reclamation.
6. Sub soils, cover soils of the depth and forest soils type, consistent with that forest community, should be established and natural vegetation – grasses, forbs, shrubs and trees of that community restored.
7. All buried containers (many have been located and to the satisfaction of the science, proven to exist), should be located and with any contaminants or other contaminating objects, removed from the tailings and/or any other site in the mine area. These materials or objects should be properly disposed of in accordance with toxic waste disposal.

In addition to the above specific concerns, the entire mine site area should be returned to its natural condition with removal of all objects and materials extrinsic to a natural condition with exception of only, those objects or conditions necessary for access and monitoring the site.

Thank you for the opportunity to participate in this scoping procedure.

Sincerely

Cal Ryder
PO Box 1628
Noxon, MT 59853-1628 406-847-2535 <calrene@blackfoot.net>

My Concerns About the Troy Mine Revised Reclamation Plan

Dear Mr. Bradford,

I wish to express some 'heartfelt thoughts' on this subject at this time of year. As folks ponder "peace on earth and goodwill towards all', the immediate welfare of our surroundings takes on special signifigance. I am requesting the Forest Service to live up to it's name and serve the forests of our nation by doing everything in it's power to make thorough, conscientous, and far reaching choices.

Within the strictures of the law, there are options you may select that can make a huge difference in the outcome of projects. I have no wish to detail 'all of my objections' to the proposed Reclamation Plan, other than to state a few obvious shortcomings in it's overall scope. I believe the monitoring is inadequate in every aspect. I believe the Revett-Troy proposals will require the least output by the company, without the future welfare of the land being of much consequence to them.

The history of this mine and the companies that have operated it does not inspire confidence. After watching this operation for over 25 years, I am left with a bad taste concerning the honesty and transparency of it's actions.

I wish to have the Forest Service require an Environmental Impact Statement for the reclamation plan. I do not believe an Environmental Assessment will be adequate to cover their proposal. When one refers to "in perpetuity", I wonder if that term is understood by the speaker/writer. It means 'FOREVER' and that is a difficult concept to grasp. Monitoring leakages, dust, vegetation, erosion, subsidence etc. " in perpetuity" is impossible.

It is of critical importance to have the Reclamation Plan be held to the highest standards. There is no reason to allow for minimum oversight when the welfare of the land is being decided. I ask that you consider my words. Thank you.

Wishing you a Happy New Year,

Debbie Lyman

Debbie Lyman
34 Beaver Peak Road
Heron, MT 59844
December 26, 2007

lastlyman
<lastlyman@blackfoot.net>

12/26/2007 04:24 PM

To: Paul Bradford <comments-northern-kootenai@fs.fed.us>
cc:
Subject: Troy Mine Revised Reclamation Plan

Concerns About the Troy Mine Revised Reclamation Plan

Dear Mr. Bradford,
I will be brief. There is no need to enumerate all the faults and shortcomings in the Revett 'revised reclamation plan'. I will focus on one subject that lies at the core of this 'reclamation'. Water and watersheds are soon to be recognized as the single most important element of our forests. How water is affected will be the primary concern in all land use (and abuse) decision making. We will be spending billions on water conservation and reclamation of damaged watersheds. The idea of perpetual discharge of polluted water will be considered barbaric and stupid. A global paradigm shift, driven by climate change, will make the strategy of disposing of any waste or toxic materials into a watershed a truly criminal act. Clean water will be more valuable than the resources that have been extracted using wasteful and polluting methods. I will remind you that good money is being made mining the tailings piles left over from mining activities abandoned a century ago. Those who look back on our mining practices and our disregard for fresh, clean water will wonder at the incredible waste, the inefficiency and the greed that caused the mess that they will have to clean up.
Please do the right thing and hold Revett to the highest standards for reclamation of their Troy mine. A full EIS. Revett should be held to the highest standard.
Sincerely,
David R. Lyman
34 Beaver Peak Road
Heron, MT 59844
Dec. 26, 2007

Rec'd 11-9-07

Montana Department of
ENVIRONMENTAL QUALITY

Comment Sheet for the Troy Mine Revised Reclamation Plan

The United States Forest Service – Kootenai National Forest (KNF) and the Montana Department of Environmental Quality (DEQ) would appreciate receiving your thoughts and concerns on the Troy Mine Revised Reclamation Plan proposed by Genesis, Inc. An environmental document will be prepared to evaluate the impacts of the revised reclamation plan as well as the impacts of following the No Action alternative. There are several ways to submit your comments on the revised reclamation plan: 1) leave the comment sheet with a study team member at the public meeting; 2) mail your comments to the address shown on the back of this page; or 3) email your comments to comments_northern_kootenai@fs.fed.us – *please include* "Troy Mine Revised Reclamation Plan" *in the subject line.* All comments must contain name of commenter, postal service address, and date of comment. We would appreciate receiving your comments before **December 28, 2007**. Thank you.

CURRENT PLAN FOR DISCHARGING MINE WATER ONTO TAILING IMPOUNDMENT IS THE MOST LOGICAL PROPOSAL FOR FOLLOWING REASONS:

1) SEALING MINE OPENINGS NOT REASONABLY FEASIBILITY & POSES A FUTURE THREAT OF RELEASING LARGE VOLUMES OF WATER SHOULD THERE BE A STRUCTURAL FAILURE.

2) WATER RELEASE DOWN EXISTING PIPELINES MEETS MT. WATER QUALITY STANDARDS AND IS VITAL TO FACILITATING THE REVEGETATION PROCESS... WHERE WOULD THE WATER COME FROM FOR MAINTAINING GROWTH IF NOT FROM THIS MOST AVAILABLE SOURCE? WHY DEPLETE THE WATER TABLE WHEN NOT NECESSARY.

3) LOOKING INTO THE FUTURE – THIS AVAILABLE RESOURCE WOULD PROVIDE INCENTIVES FOR WISE DEVELOPMENT AND USE OF TAILING AREA.

Name: JANINE PRICE

Mailing Address: PO BOX 180

City: TROY State: MT Zip Code: 59935

Phone: Email:

The Cabinet Resource Group

Dec. 27, 2008

Cathy Johnson
Montana DEQ
P.O.B. 200901
Helena, MT 59620-0901

S.O. Paul Bradford
Kootenai National Forest
1101 Highway 2 West
Libby, MT 59923

Dear Cathy Johnson and Paul Bradford,

Attached are the comments of the Cabinet Resource Group concerning scoping for the Troy Unit Revised Reclamation Plan (TRRP). Hard-copy of these comments will be accompanied by approximately 25 pages of supporting documents which are referenced as attachments in the body of CRG's comments. The three attachments (1,2, 3) reference documents in CRG possession, provided by Asarco regarding the Troy Mine CERCLA Lawsuit. A portion of them dealing with field investigation reports and communications between MT/DHES are (or should be) in the possession of DEQ. CRG will provide Bates # copies of said documents which DEQ/KNF may not have upon written request of the agencies. CRG personnel are available for discussion with the agencies and contractor chosen to write the NEPA / MEPA document these comments pertain to.

CRG would like to remind the agencies responsible for this document that DEQ publicly determined the TRRP amounted to a major amendment (Western News 2/28, 3/7, & 3/14/01) under the MMRA Sec. 82-4-342, which requires an EIS. CRG comments raise issues that would be insufficiently addressed in the context of an EA. On behalf of CRG's 175- members, we remind the agencies of their responsibilities under the law and respectfully request that an EIS be conducted for the TRRP.

Thank you.

Cesar Hernandez
Board Member CRG

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50% post consumer waste

CRG, Troy Mine Revised Reclamation Plan EA Scoping Comments

1. Topsoil
2. Stability
3. Long Term H2O management plan
4. Barrels
5. MPDES
6. NL Troy Dam and sediment analysis
7. Subsidence
8. Other Discharges
9. Reclamation Bond
10. Catastrophic failure bond

1. (TOPSOIL) The existing Troy Mine Reclamation Plan requires the placement of 18 inches of stockpiled topsoil to cover the tailings impoundment surface upon completion of mining. The Revett / Genesis Troy Revised Reclamation Plan (TRRP) proposes the placement of (18") inches of borrowed subsoil and retention of stockpiled topsoil for toe ponds. This revision is prefaced by the claim that years of experimenting indicate that borrowed subsoil is a better cover medium. Unsaid and unsubstantiated are measurements of the currently existing topsoil stockpile and the true purpose of leaving the stockpiled topsoil in place. For numerous years (especially during operation) the phreatic water level in the tailings impoundment has exceeded the height of the starter dam. This situation was warned against at the earliest inception of the Troy Project as posing the possibility of catastrophic failure for the tailings impoundment. This hazard has been mitigated by the presence of nearly 1,000,000 cubic yards of topsoil at the toe of the tailings impoundment.

Significant amounts of the stockpiled topsoil have also been incorporated into the currently existing toe ponds that were not originally permitted with the facility. These toe ponds contain water that leaks from the tailings impoundment. Removing the toe ponds would expose conditions at the Troy Mine tailings impoundment that violate the Clean Water Act. The illegal toe ponds cover the fact the tailings impoundment was not constructed as permitted (with an internal drainage system). Such a system would have required an MPDES permit, containing permit requirements Asarco realized they would be incapable of meeting.

The toe ponds leak directly into Lake Creek despite the best efforts of the mining company and State regulators to avoid this inconvenient truth and despite their best band-aid efforts to hide this discrepancy. Both entities rely on dilution of the discharge as the solution to this problem.

2. (STABILITY) The stability of the Troy Mine tailings impoundment is tied to its dewatering. The current reclamation plan would move towards accomplishing this objective. The TRRP proposes to perpetually deliver mine water to the tailings impoundment as a method of treating mine water that does not meet surface water criteria. This proposal is little more than a financial decision of the mine owners to avoid more costly treatment options and fails to take into

account the long-term stability requirements of the tailings impoundment. The Reichsmuth (1/31/84) Report was denigrated and dismissed by Asarco and the regulatory agencies. However, sinkholes that appeared in 1988 and 91 as well as piping and recent (March 23 and April 14, 2007) field reports indicate instability features inherent in the facility. These features need to be vigorously and independently investigated.

3a. (H2O MANAGEMENT) Long-term water management of discharges from the mine and related facilities is the most important outstanding reclamation feature. Diffuse discharges from the mine itself towards Ross Creek have begun to show up. Ross Creek is the major tributary feeding Bull Lake. Mapping, monitoring and either eliminating or remediating these discharges are a long-term challenge that needs to be thoroughly addressed.

Discharges from the tailings impoundment are equally important because of its proximity to Lake Creek and for reasons outlined at #2 above. Another issue that must be addressed is that of buried material within the tailings impoundment. Attached is documentation indicating the possibility if not probability that hazardous materials (industrial solvents) were disposed of in the tailings impoundment. The attachments contain information gleaned from discovery documents provided by Asarco regarding a CERCLA lawsuit initiated by the Cabinet Resource Group, which was eventually dismissed without prejudice when Asarco went into bankruptcy. The bills of lading indicate that copious quantities (thousands of gallons) of industrial solvents were used at the facility from 1980-90, while a paper trail of their disposal (as required by EPA) is completely lacking. Documentation and the accounts of some former employees at the facility indicate that illegal and regular dumping of the material occurred under cover of darkness at the tailings impoundment. While Asarco initially denied any dumping of material at the facility, subsequent geophysical investigations located several anomalies consistent with the allegations that barrels are buried in the tailings impoundment. Asarco eventually admitted to burying barrels, but insists the material inside is benign flocculant. The adages; "fool me once shame on you, fool me twice shame on me" and "trust but verify" should prominently guide the actions of regulatory agencies here.

Just as it has taken over 25 years for subsidence at the mine to demonstrate itself a viable issue, so to the issue of buried barrels may take similar time. Buried barrels will deteriorate over time as they rust. The release of hazardous materials is a critica issue that DEQ cannot overlook. It's importance increases as development on private lands surrounding the tailings impoundment increases. Prudence dictates caution, as long-term public health concerns may well have to be dealt with long after the mine has closed, and the ability to hold its operators liable possible. The State of Montana and its Department of Environmental Quality need only look as far as Libby, MT and its Tremolite asbestos crisis, that was ignored for decades to see the effects of what burying its head in the sand over an issue can produce.

3b. (ATTENUATION) The RRP Fate and Transport study makes a great deal concerning the attenuation of copper : Pg. 24 *"all data collected to date indicates that copper is very immobile in the groundwater system surrounding the decant pond. Copper in mine water that is disposed in the decant pond becomes primarily bound in shallow soils/sediment in the*

bottom of the decant pond and very little copper is transported beyond a few tens or hundreds of feet in the groundwater system." Continued deposition of mine water to the tailings impoundment for treatment purposes would require long-term maintenance of at least one, if not all three, of the pipelines that service the tailings impoundment. Similarly if such is the case, then why aren't the tailings impoundment decant ponds replicated at the mine mill site, which would not require the maintenance of the more than seven miles of buried pipeline from mine to tailings impoundment? See F&T Study pages 30-31 for more information.

4a. (BARRELS) On March 19, 1996 Tom Reid (DEQ) received a Citizen Complaint from former Asarco Troy Mine employee Jim Meyer regarding a number of concerns that took place over the course of his employment (DEQ/ WQD Individual Activity Report 3/19/96). Mr. Meyers was employed at the Troy unit in excess of 10 years. Among his concerns was an allegation that Asarco routinely disposed of 55 gallon barrels (some containing hazardous wastes) in the tailings impoundment. The disposal of barrels under cover of darkness was corroborated by other Asarco employees. A map of the depositions accompanies the Individual Activity Report of 3/19/96. The Citizen Complaint was turned over to DEQ's Waste Management Division –Hard Rock Bureau; which did nothing.

The Cabinet Resource Group filed a CERCLA Law Suit against Asarco on 12/03. Subsequent geophysical investigations by Eco-Tech Geophysical (Missoula) as a part of discovery in the lawsuit identified several anomalies consistent with buried barrels. Asarco initially denied the allegations but admitted a year later that 17 barrels had been disposed of in the tailings impoundment. Asarco claimed the content of the barrels as benign flocculant. Physical copies of the Eco-Tech report and a plan to excavate the anomalies were turned over to Montana DEQ. DEQ was supposed to evaluate the proposed excavation plan and make a determination as to its feasibility and permitting. It did nothing! Asarco's eventual Bankruptcy filing caused the CERCLA case to be dismissed without prejudice. The issue of the buried barrels remains a liability that DEQ and the State of Montana ignore at their peril.

4b. (ATTACHMENTS) As a result of its CERCLA Lawsuit the Cabinet Resource Group was provided some 3000 pages of discovery documents. Those documents consisted of Bills of Lading and Purchase Orders as well as numerous other documents relating to the use and disposal of all industrial fuels and lubricants capable of generating hazardous waste. CRG broke these documents into three categories.

1) An inventory of all chemical and lubricant materials that were delivered to the mine in 55 gallon barrels.
2) An inventory of industrial solvents use.
3. A list of solvents and other documents possibly indicating their disposition.

From these documents it has been determined that during the 1st decade of Troy Mine operation Asarco relied on local mine personnel to dispose of all mine wastes. Beginning in 1991 (Dave Young tenure) Asarco employed the services of Safety-Kleen to handle the disposal of the mines lubricant waste stream capable of generating hazardous waste.
A synopsis of these documents is provided and some definitive conclusions can be reached.

a. The Troy mine used generous amounts of lubricants / solvents that contained hazardous substances (1.1.1. Trichlorethylene, 1.1.1 Trichloroethane / Bates # 5446, 5341-43, etc.).
b. Asarco filed for and received from the State of Montana (DHES / Hazardous Waste Bureau) a Hazardous Waste Generator Permit.
c. MT/DHES conducted some field inspections concerning use and handling practices of Troy mine generated haz-wastes (Bates # 5263-5410, 5309, 5330-31, etc). Concerns were raised in the field investigation reports regarding the disposal of hazardous materials.
d. Approximate use of material amounts containing hazardous wastes can be determined (Bates # 5446, 5330-31, 5344-45, etc.).
e. Only one Hazardous Waste Shipment Manifest (dated 2/18/93, Bates #5263-5410) was produced as a result of discovery.
f. Documents (Bates # 5297, 5317, 5328, etc.) providing clues that hazardous wastes were disposed of in manner and location violating permit and law.

Actual copies (Bates reg.) of these documents are in possession of CRG and are available for inspection by regulatory agencies. They are also part of the public record in the CERCLA case that was filed.

5. (MPDES) The Troy Mine will discharge into perpetuity. The quantity and quality of that discharge is a responsibility of the operators and a duty they are charged to manage through the MPDES / NPDES process. The regulatory agencies have been entirely deficient in this respect and are only now beginning to acknowledge and move in the direction that the facilities of the mine should have had one.

6. (NORTHERN LIGHTS TROY DAM) The Troy Mine and tailings impoundment has been a source of various discharges since its inception. From tailings line ruptures, storage pad snowplowing, through airborne particulate and piping from the tails impoundment, material from its operations have found their way into the ecosphere. The NL dam at the mouth of Lake Creek acts as a natural sediment trap in the watershed and contains a diary of accumulations in its sediments. The NL dam has been dredged twice since the inception of the Troy Mine yet no analysis of its sediments has been conducted. This is an issue that needs to be addressed. The issue of a catastrophic failure of the Troy mine tailings impoundment on the operation of the NL dam is also an issue that has been overlooked or dismissed.

7. (SUBSIDENCE) Two incidents (2004, 2005) of subsidence reaching the surface at the Troy mine should be regarded as canaries of the coal mine. Several incidents of rock-fall within the mine, one of which recently (2007) resulted in the death of a miner are indicative of the existing poor rock conditions within the mine. Spalling of support pillars is another indicator that stability within the mine may not be what is alleged and needs to be independently assessed. This is critically important given the possibility that removal of some of support pillars is being considered by Revett. Such a situation in a coal mine in Utah resulted in the death of at least six miners and three rescue personnel. Once the mine is closed there will be little opportunity to assess conditions within the mine. A bond commensurate with the possibility of further subsidence incidents and their mitigation for purposes of public safety needs to be considered.

This may be critically important as closure of the mine will result in a small lake forming underground. Rock fall or faulting in the area of the lake may produce pressures that blowout or rupture mine plugs. Subsidence or rock-fall within the mine may also be incidental to the creation of discreet hydrologic discharges to surface waters of the state. A plan and bonding sufficient to cover these possibilities needs to be considered.

8. (DISCHARGES) The issue of iron flock emanating throughout the bluffs between the tailings impoundment and Lake Creek has been blown off as "naturally occurring" throughout the drainage. It is well known the milling process at the Troy Mine utilizes tens of thousands of tons of iron / manganese grind balls. The RRP Fate and Transport Study discusses the use of x-ray spectra and electron microscope technology in the identification of copper-bearing phases important to attenuation. Repeated requests have been made to the regulatory agencies regarding the identification of the iron flock leaching from the Troy tailings impoundment. Identifying the source of the iron flock as native material or coming from the milling process is a relevant issue here. Elevated levels of nitrates, potassium xanthate and some copper have been identified outside of the tailings impoundment adjacent to Lake Creek. It is only reasonable to assume the probability this iron flock comes from the mine milling process. The only way such a definitive identification is possible is if it is investigated as thoroughly as the fate of the copper in the F&T Study.

9. (RECLAMATION BOND) The purpose of a Reclamation Bond is to dismantle the mine facilities after mining has ended and to protect the environment and public from the costs of problems associated with the mining activities. Potential problems that are not addressed and / or thoroughly investigated become public problems when they are dismissed and very serious problems after-the-fact if they have not been bonded for (remember Zortman-Landusky for reference). When viable evidence is provided that an issue should be of concern, it is the public duty and responsibility of the regulatory agencies (in this case DEQ / USFS) to objectively look at the issue and demand viable answers from the entities they are entrusted by the public to issue permits to.

For seven years regulatory agencies (DEQ and the KNF / USFS) have dallied in requiring establishment of a viable long-term Reclamation Bond for the Troy Project Mine.

10. (CATASTROPHIC FAILURE BOND) The Troy Unit Revised Reclamation Plan (Dec. 2000) prepared for Genesis Inc. contains the meeting notes of 10/12/2000 in Appendix I. Under "General Issues" is the quotation: "Forest Service needs a letter of intent to reopen. Their issues are not as problematic as DEQ, since DEQ will eventually **own** the mine and the tailings." These notes were taken by Len Murray of Klohn Crippen Co. a member of the Louis Berger Group. It can be assumed that Mr. Murray is a person of competence and that he accurately recorded the conversations of the meeting. At least there are no public documents contesting or requesting changes to that statement. The reference he records regarding "eventual ownership of the mine and tailings," is in all probability a reference to the fact that Montana DEQ will eventually own final responsibility and liability through its permitting authority for what becomes of permit #00093 once reclamation has occurred.

Notes: from TRRP

1. (Pg. 3-6) • Impoundment site topsoil stockpiles totaling approximately 560,000 cubic yards of salvaged topsoil located on about 44 acres along the western perimeter of the impoundment dike and acting as a dike containing the toe ponds.

2. (Pg. 4-16) Tailing facility cover-soil volume calculations are included in Table 4-1. Approximately 766,600 cubic yards of cover-soil materials will be required for tailing facility reclamation.

3. (Pg. 7-4) Evidence from mine operations indicates that the SOB and EOB have greater potential to dissipate water than the NOB.

4. (Pg. 7-6) Although the static groundwater levels will fluctuate seasonally, as experienced during previous shutdown of the mine, the water level in the mine is expected to reach equilibrium at approximately the 4248 elevation in the SOB and at the 4225 elevation in the NOB and EOB as shown on Exhibit D. The NOB mine pool will flow to the EOB when it reaches the 4186 elevation.

5. (Pg. 13 Fate & Transport Study) Some soil/sediment samples (DP-1 3 3/4 " and DP-1 4") are enriched to the extent that they contain nearly twice the copper content as ore from the Troy mine. Total copper concentrations in decant pond sediments suggest that copper is attenuated in surficial soil/sediments in the decant pond.

Attch. (1)

Troy Mine Barrel Inventory

Invoice #	Bates #	# Barrel dep.	#Barrel dep. rtrn.
1979			
6552	011592	4	
1980			
25495	011456	3	
25861	011492	10	
25588	011497	4	
25589	011498	2	
25586	011503	2	
25764	011505	4	
26578	011509	5	
26437	011510	5	
26412	011512	4	
26411	011513	4	
3570	011514		4
3577	011515		1
26382	011524	4	
3416	011528		6
26349	011529	10	
3806	011530		7*
3384	011536		4
26329	011538	10**	
26331	011539	10	
3352	011543		5
26277	011544	2	
2160	011546		9
25745	011547	5	
25750	011548	5	
25662	011552	5	
25659	011553	5	
25631	011554	5	
	011561	5***	
25981	011582	2	
25904	011565	2	
25905	011568	10	
2320	011570		8****
	011570		1****
2260	011571		1
7752	011575	10*****	
25841	011576	4	
Totals		131	46

* Page appears to have 2 barrel return invoices one on top of other. Cannot make out invoice or bates #, but appears to show 10 barrel return. ** Same superimposition as previous notation (*) only for 10 barrel deposit. *** Same superimposition as previous. Same superimposition as previous explanation. ***** Only notation of junk barrels ($2.00 apiece).

1981			
26601	011348	10	
2103	011349		?*
0189	011350	12	8
0169	011354	1	
0167	011357		9
3702	011359		3
3652	011360		6
928	011361	3	3
937	011363	5	
0247	011364	5	5
0246	011365	5	5
506	011379	2	
893	011381**		
0295	011386	10	5
0299	011387	10	1
747	011389	10	18
0266	011397	10	5
1095	011398	10	21
illegible	011402	5	1
1059	011403	5	1
041	011407	6	
075	011408	10	
074	011408	7	
076	011409		9
8669	011410	6	
8669	011411	100***	
071	011418	10	
063	011421		6
illegible	011428		2
082	011440	10	
6967	011441		8
084	011443	4	
083	011444	6	
080	011448	10	
Totals		252	116

?*Illegible.

** First invoice (dated 7/20/81) that mentions "barrel exchange." Lists 2 barrels but does not indicate in or out.
*** Largest known barrel deposit.

1982			
1589	011201	2	
115	011206		10
111	011206		8
096	011207		11
108	011207	10	
098	011209	6	
093	011209	10	
094	011210	10	
099	011210	3	
100	011214	12	
128	011218	1	
143	011219	2	
142	011219	2	
141	011220	2	
116	011220	8	
117	011221	10	
122	011221	10	
124	011223	10	
121	011223	2	
119	011224	4	
132	011224		10
103	011225	6	
129	011225		7
123	011226		5
125	011227	6	
137	011229		10
140	011229		9
135	011230		10
133	011231	10	
134	011231	10	
138	011232	3	
151	011236	10	
155	011237	3	
205	011239	1	
201	011239	4	
206	011240	6	
175	011241		9
170	011241		10
163	011245		10
150	011245		2
179	011246		11

157	011246		10
221	011249		10
227	011253		8
136	011254	10	
139	011255	7	
146	011255	4	
214	011256	10	
212	011257	10	
148	011258	10	
228	011259	10	
145	011260	7	
218	011262	10	
223	011263	6	
189	011264		5
229	011264		10
235	011265		11
232	011267	10	
161	011274	10	
164	011275	6	
169	011276	4	
174	011278	10	
193	011279		10
167	011279	2	
216	011286		11
197	011287	10	
207	011287	1	
211	011290		11
182	011291	1	
178	011291	10	
181	011292	11	
199	011293		10
196	011293		6
185	011295		7
204	011295		11
188	011296		6
236	011297	9	
242	011298	8	
243	011299		6
2195	011307	4	
246	011313	11	
Illelgible	011320	10	
253	011323		10
250	011325	10	
252	011330	9	
532153	011346	15	
Totals		407	267

1983

532188	011065	2	
532197	011066	10	
532189	011067	7	
532216	011080	2	
532212	011083	1	
503331	011084	1	
00000	011093	7	
503401	011104	2	
503402	011114	12	
503336	011117	5	
192	011128	1	
6974	011129		8
50340*	011133	3	
50340*	011134	5	
50339	011140	9	
01302	011159	3	
503412	011189	20	
503409	011190	2	
Totals		99	8

* Two Texaco invoices same number w/different # of barrel deposits?

1984

013012	010950	2	
5300	010964		3
503547	010981	20	
078277	011006	22	
6157	011060	5	
Totals		49	3

1985

6702	010721	4
078278	010723	10
078268	010724	10
11-05-?	010728	20
078276	010729	10
075875	010806	2
Total		56

1986

Note: This is the year that most invoices are missing. Instead there is a Purchase Order (continued) that is a type of synopsis of total products used.
From this synopsis it can be calculated that 71 / 120lb. grease drums were received, as well as 14 / 400 lb. grease drums for a total of 85 drums. Another 20 drums of transmission fluid, 45 drums of gear lubricant, 10 drums of EP-2 grease and another 40 drums of EP-220 oil were received. Altogether this amounts to **285 drums.**

Note: After 1986 barrel deposits and or returns appear to disappear from petroleum product invoices.

OF SPECIAL NOTE: Petroleum products were not the only thing that came in 55 gallon drums. If you look at the Troy discovery documents listing that I sent much earlier you find the following.
10. 5196-5222 Purchase Order sheets 300,000 lbs. Potassium Amyl Xanthate, pellet form packed 341 lbs. in 55 gal. drums. 7/91-12/93. **Sheet # 5207, item #4 discusses $20.00 drum deposit.** Sheet # 5217 itemizes sale of scrap metal from tailings area @ $25 / ton. Other scrap iron sales on other sheets.

The Potassium Amyl Xanthate (a frother) used at the mill came in approximately 870 barrels.

Some barrel deposit invoices (few in number & quantity) then begin to show up in 1990.

* 1981 - 86 — 554 BARRELS UNACCOUNTED FOR.

Attch (2)

Troy Story solvents use discovery doc. findings 7/9/04

Date / Year	Purchase Invoice	Legal file # (BATES)	Quantity
1979			
11/12/79	6006	011590	110 gal.
8-17-79	4157	011608	57 gal.
Total			167 gal.
1980*			
1-04-80	7308	011471	55 gal.
1-05-80	5109	011475	110 gal.
2-28-80	6955	011500	110 gal.
12-15-80	004	011511	220 gal.
6-10-80	7988	011558	110 gal.
6-05-80	7970	011559	110 gal.
5-19-80	7903	011563	220 gal.
Total			935 gal.

* Extensive and detailed itemization of barrel deposits and returns. #7752 / 011575 even lists "10 whole junk barrels."

1981*			
7-28-81	037	011374	110 gal.
6-24-81	023	011383	220 gal.
9-10-81	053	011422	220 gal.
9-15-81	8001	011424	220 gal.
Total			770 gal.

* Extensive and detailed itemization of barrel deposits and returns. #8669 / 011411 for 100 drums. Deposit of $2000
** Jan.-May and Oct.-Dec. invoices appear to be missing.

1982*			
1-21-82	142	011219	110 gal.**
3-03-82	1694	011254	220 gal.
5-03-82	201	011239	220 gal.
3-11-82	146	011255	110 gal.
6-07-82	223	011263	330 gal.
3-22-82	164	011275	330 gal.
Total			1310 gal.

* Indications barrels being returned for credit. See invoices 111 & 115 and others.

Invoice #098 / 12-31-82 indicates solvent barrel return for credit.
** Amoco Stoddard solvent.
Note: Period month invoices July – Dec. appear to be missing

1983*

1-07-83	3154	011074	500 gal.
6-08-83	3794	011124	142 gal.
7-06-83	3912	011150	1056 gal.
11-02-83	4704	011164	525 gal.
Total			2223 gal.

* Invoice 6974 only invoice showing / indicating barrel (8) return for deposit.
Note: Believe some invoices for period months Feb.- May and Aug. – Oct. missing.

1984*
* Approximately ½ invoices for 1984 photocopied at 200% causing it to be mostly impossible to tell what the product purchase is. Legible ones listed below.

2-01-84	4872	010919	210 gal.
3-08-84	5014	010943	478 gal.
7-09-84	5574	010993	474 gal.
10-05-84	6241	011018	520 gal.
11-20-84**	6544	011036	300 gal.
Total			1982 gal.

** Only invoice with (Hyd.) behind Solvent. Reference should be checked.
Note: Believe some invoices for time April – June may be missing.

1985*
* Approximately ½ invoices for 1985 photocopied at 200% causing it to be mostly impossible to tell what the product purchase is. Legible ones listed below.

7-01-85	7545	010818	300 gal.
8-06-85	7732	010819	480 gal
10-02-85	7995	010845	623 gal.
11-08-85	8165	010869	418 gal.
12-05-85	9692	010902	410 gal.
Total			2231 gal.

1986

***1986 file unlike others years had only 25 invoices. However, in the 1987 file one sheet was found that appeared to be a 1986 purchase order / all materials only solvent listed below.**

7-22-86	**26H-0488B**	**010513**	**3600 gal.**
Total			**3600 gal.**

1987

1-29-87	11158	010378	720 gal.
3-30-87	11479	010448	625 gal.
4-21-87	11557	010442	175 gal.
8-03-87	12216	010607	500 gal.
10-13-87	12741	010551	500 gal.
11-18-87	13130	010620	123 gal.
11-30-87	13215	010628	377 gal.
Total			3020 gal.

1988*

2-08-88	13775	008646	500 gal.
3-30-88	S206114	010187	540 gal.
5-02-88	S258856	010167	500 gal.
9-02-88	S3445830	0102433	400 gal.
11-4-88	S347078	010348	470 gal.
12-6-88	S34314?	010332	400 gal.
Total			2810 gal.

* May be missing some invoices period Jan. – Feb. & June – July.

1989

1-30-89	S347679	008692	380 gal.
3-02-89	S347951	008784	520 gal.
6-02-89	S346541	008862	500 gal.
7-10-89	15683	008909	15 cases*
7-24-89	S348901	008923	500 gal.
10-04-89	S34883	008983	500 gal.
Total			2400 gal.

* Only invoice on solvents by the case and with the designation that solvent is bio-degradable.

Note: Plenty of used oil return invoices.

1990			
2-12-90	S45906?	009077	500 gal.
5-03-90	S459236	009135	500 gal.
3-29-90	S458589	009158	410 gal.
7-24-90	S459372	009224	497 gal.
9-24-90	S460182	009344	500 gal.
11-14-90	L002438	009361	516 gal.*
12-28-90	126079	009858	**
Total			2923 gal.

*Notation on invoice reads:"Returned solvent to bulk plant."
Note: 1) Some drum return deposits and exchanges noticed.
2) Legal file # 009323 – 331 Safety-Kleen setup and product delivery sheets for all divisions of mine ops. (drill, main, ballmill, gas, lube room, secondary crusher). None of these noted in previous years, believe it indicates beginning use of Safety-Kleen services.
** Can not determine gal. or lbs. by sheet.

1991			
12-31-91	7566581	009516	1258 lbs.
1-25-91	449546	009836	1249 lbs.
2-09-91	797286	009903	946 lbs.
3-19-91	142929	009912	946 lbs.
3-21-91	L002805	009920	55 gal.**
4-18-91	490337	009894	946 lbs.
5-15-91	832912	009941	946 lbs.
6-13-91	182273	010068	1032 lbs.
?-17-91	532192	009928	1077 lbs. ***
8-13-91	974743	010054	1261 lbs.
9-11-91	324667	010033	1032 lbs.
10-10-91	78585	010010	1249 lbs.
11-05-91	032781	010124	1175 lbs.
12-03-91	388075	010091	1077 lbs.
Total			14,194 lbs.

* Can not determine amount of gal. to Safety-Kleen
**Not a Safety-Kleen ticket. City Service / Libby, MT.
*** Safety-Kleen ticket copy reprint offset. Paid Jul. 22, probably July ticket.

1992

1-29-92	101127	009570	1163 lbs.
1-29-92	101126	009571	72 lbs.
2-26-92	457973	009582	1077 lbs.
3-25-92	813-250	009598	991 lbs.
4-22-92	225898	009619	991 lbs.
4-22-92	225897	009620	72 lbs.
5-20-92	588356	009637	344 lbs.
5-20-92	M28869	009638	688 lbs.
6-17-92	953027	009675	1118 lbs.
7-15-92	317948	009729	1118 lbs.
7-15-92	317947	009730	72 lbs.
8-13-92	682651	009728	1290 lbs.
9-09-92	046194	009711	1118 lbs.
10-07-92	412064	009774	72 lbs.
10-07-92	412065	009775	1290 lbs.
11-02-92	777754	009806	1290 lbs.
12-02-92	142812	009784	1290 lbs.
Total			14,194 lbs.

*Note: 1 gal. Safety Kleen = 6.8 lb. Costs ran about $1.00 / lb.
* Safety-Kleen appears to be solvents from clean-up terminals???
Note: In reviewing these purchase orders it appears that during the use of Safety-Kleen services no solvents from other sources are being purchased or show up in records. However, the services of Safety-Kleen appear to be rather expensive compared to earlier purchase and use of solvents at mine.

1993

1-27-93	807586	009687	230 gal.*
3-24-93	46813	009480	192 gal.*
2-24-93	139239	009494	193 gal.*
Total			385 gal.

1997

4-23-97	1451	009449	1 drum* 6 drums**

* sorbents???? ** tank bottoms

1999			
9-28-99	934009	009440	30 gal.
2-18-99	841659	009441	30 gal.
Total			60 gal.

2000			
12-22-00	00014866701	009404	30 gal.
8-31-00	00013676781	009410	30 gal.*
5-16-00	00012496466	009412	30 gal.*
1-27-00	0011292014	009415	30 gal.
Total			120 gal.

* Safety-Kleen also attached appears to be waste disposal form for Petroleum Naptha.????

2001			
4-16-01	0017097842	009422	30 gal.*
8-06-01	0018239091	009419	30 gal *.
Total			60 gal.

* Safety-Kleen also attached appears to be waste disposal form for Petroleum Naptha.????

2002			
10-02-02	0021711374	009395	30 gal.
6-08-02	0020893939	009399	30 gal.*
Total			60 gal.

* Safety-Kleen also attached appears to be waste disposal form for Petroleum Naptha.????

2003			
12-19-03	0025003097	009383	30 gal.*
8-29-03	0024182332	009390	30 gal.
01-21-03	0022567153	009391	30 gal.
5-13-03	0023376874	009392	30 gal.
Total			120 gal.

NOTES:

1. From 1979 – 82 there are detailed and extensive records of deposits for barrels and returns of barrels for deposits. This radically changes from 1983 on when only one (1) barrel deposit is noted. After 1983 there are no invoices or documentation that indicate deposits are being placed on barrels or barrels are being returned for deposit.

2. Use of solvents doubles around 1982, doubles again in 1983 and appears to peak and level out in 1986-7 at perhaps 3000 gallons.

3.Safety-Kleen corporation comes on the scene about Dec. 1990, prior to this date invoices appear to indicate Asarco is handling purchase, use and disposal of solvents at Troy mine.

Attch. (3)

Troy Lawsuit Discovery Papers Report

BATES Doc. #	Subject	Remarks

1. 5000-5002 Requisition sheets Only 3 sheets (chemicals) might be useful to see all of them.

2. 5003-5029 Purchase Order sheets Some from 1988 – 91

3. 5030-5058 Purchase Order sheets Safety-Kleen Corp. for purchase and servicing of (3) solvent units used in cleaning mechanic shop parts. 1990-93. Monthly procedure that cost between $800-1500.

4. 5059-5061 Purchase Order sheets Appears to be for lab equipment etc.

5. 5063-5109 Purchase Order sheets Diesel, hydraulic oils, antifreeze and grease, 7/90 –7/91. P.O.S. #5096 for 1-55 Gal. Barrel of safety solvent, no I.D of what type.

6. 5110-5113 Purchase Order sheets Dowfroth 2500 & Orzana 4/90 – 1/91.

7. 5114-5120 Purchase Order sheets Drill grease 7/90 – 5/91

8. 5121-5173 Purchase Order sheets Diesel fuel, oil, transmission fluid and other lubricants. Lubricant comes in 120 lb. barrels.

9.5174-5195 Requisition sheets Antifreeze, diesel, motor oil and used oil pickup. Assorted dates 1993-97. None from before shutdown in 1993.

10. 5196-5222 Purchase Order sheets 300,000 lbs. Potassium Amyl Xanthate, pellet form packed 341 lbs. in 55 gal. drums. 7/91-12/93. **Sheet # 5207, item #4 discusses $20.00 drum deposit.** Sheet # 5217 itemizes sale of scrap metal from tailings area @ $25 / ton. Other scrap iron sales on other sheets.

10.1 5213-14 Purchase Order dated 1/5/92 Safety-Kleen concerning mineral spirits solvents and maintaining 12 machine site wash tanks. Service: solvent replacement, removal, cleaning tanks, waste removal.

11. 5223-5228 Halogenated solvent registration, # 1118 MT Dept. Health & Environmental Services. Registration / reporting form signed by Terry Erskine 10/3/89. Doug Lorentzen listed as Maintenance Supervisor to whom questions may be directed concerning solvent use at facility. **Indicates use of at least 440 gallons per year of halogenated solvents,** w/discharge to drywell, septic tank, lagoon or other industrial sewer.

Note: MDEQ publication "The Small Business Handbook for Managing Hazardous Waste (2/02) on page 9 states: "Small generators may not dispose of hazardous wastes on their property ***without*** *a permit issued by the MDEQ."*

12.5229-5262 Of note: #5244 Letter 11/14/96 about 500 lbs. used grease stored at mill from 4/93 shutdown. Disposed of on 3/94.

#5247, **Material Safety Data Sheet about Surtac Plus (Trichlorethylene), CAS 799-01-6, black paste with solvent odor.** *This wording precisely validates Jim Meyer's description of the contents he claims was in barrels buried at the Troy tailings impoundment.*

13. 5263-5410 Of note : #5295 Field Investigation Report 2/18/93 about Hazaardous Waste Manifest for shipment of 2,225 lbs. of D001/D008 wastes shipped to Romic Chemical Co., Palo Alto, CA. **Shipment of special solvent used to clean ball mill.**

#5297 Memorandum 2/19/93 Re: inspection by Bob Reinke, Solid & Hazardous Waste Bureau. Item. # 4 concerning underground storage of barrels.

#5307 Letter 9/12/91 from DHES to L. Erickson / Asarco about requirement of large and small hazardous waste generators to maintain log books or similar documentation. ***Want to make sure we ask for this log-book.***

#5309 Field Investigation Report, daated 10-28-91, Robt. Reinke. Of note: Discussion on floor drains in last para. Last paragraph, incomplete sentence, " Floor drains do not???????? Following page is missing.

#5317 Memo to file from L.A. Erickson (Unit Manager) dated 8/23/90 concerning inspection by Robert Reinke (MDEQ). **(B) "Solvent tanks / disposal in 55 gal. barrels."**

#5317 Memo to File from L..A Erickson, R.e. Montana Solid & Hazardous Waste Bureau concerning Robt. Reinke inspection of 8-22-90. Item (I)(B) "Solvent tanks / disposal into 55 gal. barrels ? Moore Oil hauls away?. Jan. – Aug. used 1600 gal. 2500 gal./ yr.(1990)."

#5328 Letter from Robert Reinke (DHES) 10/1/90 to L. Erickson. 1. Asarco Troy generating @12,940 lbs. of stoddard solvent per year. Asarco must justify haz-waste exemption or submit notification as small generator. 2. Asarco four drum of stoddard solvent sent to Moore Oil of Libby that qualified as hazardous waste. Moore Oil not allowed to handle such material. "Stoddard solvent is a hazardous waste." ***What was eventual disposition of 4 barrels of stoddard?***

#5330-31 Field Investigation Report (R. Reinke / DHES) 8/22/90 discussing waste practices. Mine generates 2000 gal. stoddard product per year. **6 / 55 gal. barrels (used for stoddard) stored behind shop. Lee McKinney explanation of waste management for assay lab.** Spent acids discharged to float machine.

#5341-43 Solvent consumption sheets. Great explanation: "Trichlorethane – Chlorethane sp. gr.=1.320, consumption: 440 gal. in 1987 = 37 gal. / mo.= 404 lb./mo. Disposal; evaporates; "? sludge goes into sewage treatment facility then to?"

#5344-45 Document dated 7/6/88. Reagents used at Troy Unit regarding Toxic Substances Control Act. #7. Chlorothane (1,1,1, **Trichlorethylene, usage: 450 gallons / yr.** #8 Varasol, solvent / degreaser, usage: 3600 gal. / yr. #9 Stench (Ethanol trichchloroflourmethane, usage 22 lbs. / yr.

#5346 Letter Asarco 7/19/79 Toxic Substances Control Act sheet for various NW mining divisions of Asarco. Couer Unit usage of 1600 lbs. sodium cyanide / yr., Galena Unit 2250 lbs. sodium cyanide / yr., Leadville Unit 10,000 lbs. sodium cyanide / yr.

 # 5350 Material Safety Data Sheet from Dow Chemical concerning Chlorethene VG ® Solvent. Warnings: "Keep out of water supplies. Dumping into sewers, on the ground, or into any body of water is strongly discouraged, and may be illegal."

14. 5411-5634
#5411 Memorandum 7/9/97 Joe Luchini / Asarco; concerning Hazardous Waste disposal at Libby landfill and disposal of vehicle oil filters. Not to be done in one large amount at one time. *Which begs the question of how they were being disposed of at the mine while it was in operation?*

#5414-32 Small Generator Annual Haz-waste Report Form to MDHES for 1993. #5415 speaks to Safety-Kleen issue and Petroleum Naptha waste.
#5431 Part Two (waste description sheet) of 1993 haz-waste Report Form to MDHES. Otber chemicals, Trichloroethylene, Toulene, Sodium Hydroxide. Trichloroethylene waste amount generated 155 lbs. (8 lbs. / gal.) and amount shipped off-site, 155 lbs. does not square with (Item 13, #5344-45 which indicates 450 gallons of Trichloroethylene usage annually. *Explanation and reconciling needed!*

#5433-46 Small Generator Annual Haz-waste Report Form to MDHES for 1992.

#5434 Waste description sheet: Waste Petroleum Naptha Combustible Liquid amount generated 14,886 and amount shipped Off-site 14,886 is considerable and worthy of note!
#5446 Part Two (waste description sheet) reporting on Tetrachloroethylene, Toulene, Sodium Hydroxide. **Tetrachloroethylene waste amount generated 155 lbs. (8 lbs. / gal.) and amount shipped off-site, 155 lbs. does not square with (Item 13, #5344-45 which indicates 440 gallons of Trichloroethylene usage annually**. *Explanation and reconciling needed!*

#5470-84 Small Generator Annual Haz-waste Report Form to MDHES for 1991.

#5472 Waste description sheet: Waste Petroleum Naptha Combustible Liquid, 14796.

No other haz-waste reported, No Part Two waste description sheet for Trichloroethylene, Toulene, Sodium Hydroxide. Hard to believe use of such chemicals at mine would have changed so radically. Explanation and reconciling needed

#5485-93 Small Generator Annual Haz-waste Report Form to MDHES for 1990.

#5487 Waste description sheet. Waste Petroleum Naptha Combustible Liquid, 5209. *No other haz-waste reported, No Part Two waste description sheet for Trichloroethylene, Toulene, Sodium Hydroxide. Hard to believe use of such at mine would have changed so radically. Explanation and reconciling needed*

#5545- Invoice & Report for Professional Services / Maxim Technologies. "Chemical analysis of soil for Benzene and TCLP Metals. ***Invoice is addressed Ken. O'Toole, Northern Lights, Inc., P.O.B. 310, Sandpoint, ID 83864.*** Appears to be related to work done at Troy mine.

#5576-5634 Asarco letter dated 7/3/96 Environmental Practices Survey for the IRRC Environmental Profile on Asarco's Troy Unit. "A possible omission to the supporting detail for the IRRC profile is an environmental lawsuit filed against the Asarco Troy Unit (EPA ID. No. MTDO96199989). The accusation states water is being discharged from the tailings impoundment area without an MPDES permit."

#5583 Para. 6. Discussion on severe water pollution at Squirrel & Kerber Creek Mine near Bonanza, CO. "The wastewater, which resulted from the mine contamination, contains 75 times the safe level of iron, and may cost up to $10 million to cleanup.(RMN7/26/94)

#5619 40CFR Ch.1 (7-1-91 Edition) Subpart D – Record-keeping and Reporting 262.44 (a) A generator must keep a copy of each manifest signed in accordance with 262.23(a) for three years or until he receives a signed copy from the designated facility which received the waste.

15. 5663-5754
#5663-66 Asarco letter 3/17/82 Dean Knight to R.Thorvilson DHES to the effect that "Asarco's Troy Unit is a mining operation excluded from regulation by the Bevill Amendment." Clarification of Status form. X on "The following temporary exemptions of ARM 16.44.304 (and 40CFR 261.4) remove the need for hazardous waste management facility status for my business."

#5667-8 Asarco letter 8/12/80 Jack Bingham to EPA Region VIII. Notification of Hazardous Waste Facility, Troy Unit, Asarco, Inc.

#5742-49 Asarco letter to All Plant Managers dated 7/30/80 concerning Chemical Substance Inventory program initiation. #5744-49 are an example of all substances

/materials used by Wallace Office. *Troy mine would / should have one of these and we should ask for it. Lists all substances and suppliers..*

16. 5755-5867 Safety-Kleen Corp. service & delivery sheets 7/99 through 12/90.

17. 5868-6008
#5922 Attention Jack Tuholske: American Cyanamid Invoice (6/29/84) for 13 tons Aluminum Sulfate. Important for Rock Creek MPDES permit that dropped Aluminum monitoring criteria.

#5924 City Service Co. / Libby, MT. Invoice for bulk solvent @ 474 gallons.

#5944 Attention Jack Tuholske: Univar Co. Invoice (8/6/84) for 4000 lb Aluminum sulfate Gran. Same as 5922.

#5954 City Service Co. / Libby, MT. Invoice (10/9/84) for 4 barrels Unoba A2 grease. I believe this is one of the lithium greases used.

#5957 City Service Co. / Libby, MT. Invoice (10/5/84) 520 lbs. or gal. Solvent Rel.

#5969 City Service Co. / Libby, MT. Invoice (11/20/84) 300 lbs. or gal. bulk Solvent (Hyd).

#5993 City Service Co. / Libby, MT. Invoice (12/21/84) Gear lube 2,460 lbs.

#5995 Attention Jack Tuholske: Van Waters & Rogers / Univar. Invoice (12/21/84) 912 - 50 lb. bags of Aluminum Sulfate. Same as #5922

#6002 Attention Jack Tuholske: Van Waters & Rogers / Univar Invoice (10/31/84) 25-100 lb. bags of Aluminum Sulfate Gran. Same as #5922.

#6005 Nalco Chemical Co. Invoice (10/25/84) 7-55 gal. barrels Nalco 3DD758 Liquid D8D. ***Only Invoice found signed for by Lee McKinney.***

18. 6009-6129
#6048 Asarco memo concerning EPA inspection by Charles Frank Stagsdell of 5/14/81 Stan Stoker (electrical foreman) to Jack Bingham concerning EPA inspection of electrical equipment that may contain PCB's. *Interesting persecution complex letter for the times.*

#6116-8 Hazardous Waste Manifest 8/19/94 transport of PCB's from Troy mine, App. 260 gallons and 5 transformer carcasses.

#6124-29 Six forms of some sort indicating testing of PCB contaminated transformers. Notation at bottom of each: "Letter from Continental No PCB's 9-18-80. Tested 4/25/86 56-360 PPM Contaminated." *Note #6124-29 indicates 6 contaminated transformers and #6116-8 is invoice for removal of 5 carcasses.*

19. 6130-6362
#6130-38 Asarco PCB distribution list. #6138 (4) "Drained and decontaminated carcasses from PCB transformers and soil, rags and other debris (at any conc. PCB's) can be landfilled. *Does this include landfilled within a tailings impoundment?*

#6157 Asarco letter 6/20/95 D. Young – Mike Balboni (USFS) concerning 5 PCB transformers at Troy mine.

#6189 Bid from Continental Transformer Services Inc.(5/20/94) to remove PCB contaminated transformers. Retrofill / $23,370. Disposal / $18,065.00.

#6191 Transformer status & location sheet.

#6205-6 Asarco letter 6/9/94 New bids to remove PCB contaminated transformers. Half as expensive.

#6282 Low concentration PCB spill clean-up certification. *Clean-up done with Triclorethane.*

#6283 EPA Inspection report 7/25/90 on leaking transformers. Sheet indicates seven (7) leaking transformers. *See #6116-8 and #6124-9 for discrepancies.*

#6295 Manifest Number 510068. PCB debris drum content from Coeur, Galena and Troy operations.

#6297 Letter (6/6/91) from Ensco to Asarco about PCB debris pick-up and cost / 1-55 gal. bbl. $1200.

#6302 Asarco Letter 7/27/90 to EPA concerning low-concentration PCB oil stain on two transformer & clean-up.

20. #6363-6414 NA

21. 6415-6844 #6443-4 Industrial Hygiene & Toxicology Data Sheet. Trade name: Super Permalube Grease, important components: **Lithium thickener.**

#6445-6 Industrial Hygiene & Toxicology Data Sheet. Trade name: Amoco Lithium Multi-Purpose Grease, important components: **Lithium thickener.**

#6513-16 Copper concentrate: attention to Jim Meyer's symptoms.

#6544 J.T. Baker Chemical Co. / Barium nitrate / oxidizing agent. Material Safety Data Sheet, Attention: Summit Envirosolutions.

#6552-55 J.T. Baker Chemical Co. / Barium Chloride, Dihydrate. Material Safety Data

Sheet, Attention: Summit Envirosolutions.

#6640-43 J.T. Baker Chemical Co. / Sodium Cyanide, Material Safety Data Sheet.

#6672-74 Cyanamid / Material Safety Data sheet: Superfloc 355 Flocculant. Waste Disposal: "Disposal must be made in accordance with applicable government regulations."

22. 6853-7186 #6853 Material Safety Data Sheet. Product name: Chlorothene ® SM Solvent.

#6942 Material Safety Data Sheet. Product name: EutecTrode 2101. Ingredients: **Lithium Chloride 1-5%.**

#6960-1 Material Safety Data Sheet. Chemical name; Sodium Thiocyante. Trade name: Sodium Sulfocyante.

#7025-26 Fiske Brothers Refining Co. / Material Safety Data Sheet. Product name: Lubriplate Gear Shield. Formula: **Lithium soap**, mineral oil, and additives.

23. 7187-7717
#7244-45 Material Safety Data Sheet. Product name: Hi-Tri ® Solvent / Ingredient: **Trichloroethylene.**

#7247-8 Material Safety Data Sheet. Product name: Cool It. Formula: **1,1,1, Trichloroethane.**

#7330-33 Material Safety Data Sheet. Product name: **Sodium Hydroxide**. Waste disposal method: PPG recommends disposal of neutralized material in an approved hazardous waste management facility.

#7410-11 Transco NW. Inc. Product name: SC2000 / rubber adhesive. Formula: rubber compound kept liquid with **trichloroethylene.**

#7414 Shell Oil Co. Material Safety Data Sheet., Product name: Shell Alvanla ® Grease 2. Hazardous ingredients: **Lithium soaps.**

#7455-58 Thermacote Welco Co., Material Safety Data Sheet, Product name: Welco 1620 Anti-Spatter, Hazardous mixtures: *Specifically, **Trichlorothane III.**

#7459-61 Technichem Corp., Material Safety Data Sheet (MSDS), Product name: Heavy Duty Hot Tank Powder, Hazardous mixures: **Sodium Hydroxide 70-90%, Sodium Metasilicate 10-20%.**

#7464 Thatcher Chemical Company, Material Safety Data Sheet, Product: Aluminum Sulfate Solution. Attention: Jack Tuholske, RCM MPDES permit.

#7470-73 Tip-Top Stahlgruber, MSDS, Product name: SC-2000 Cement, **Chemical Characteristic: Trichlorethylene.**

#7485-87 Texaco Inc. MSDS, Product name: 01922 Molytex EP 2, **Chemical / Common Name: Lithium 12-hydroxystearate.**

#7491-93 Texaco Inc., MSDS, Product name: 921 Multifax EP1, **Components: Lithium Hydroxide CAS# (1310-65-2) 0.8%.**

#7494-97 Texaco Inc., MSDS, Product name: 995 Multifax EP2, **Components: Lithium hydroxide 4-10.99% CAS # (1310-65-2)**

#7498 Texaco Inc. **Dear Customer letter 2/10/87 to Asarco, P.O.B. 868, Troy, MT 59935** "Enclosed are Industrial Hygiene, Toxicology, and Material Safety Data Sheets for Texaco products you recently purchased."

#7515-17 Texaco Inc., MSDS, Product name: 01970 Crater 2X Fluid / Gear lubricant, Precautionary label: **Contains 1,1,1,-Trichloroethane.**

#7518-20 Texaco Inc., MSDS, Product name: 1970 Crater 2X Fluid / Asphaltic lubricant, **Composition: 1,1,1, Trichloroethane 18.5%.**

#7521-23 Texaco Inc. MSDS, Product name: 958 Marfax Multi-purpose 2 (grease), **Composition: Lithium Hydroxide 0.78%** CAS#(1310-65-2)

#7524-26 Texaco Inc. MSDS, Product name: 901 Multifax EP 0 (grease), **Composition: Lithium Hydroxide 0.6%** CAS#(1310-65-2)

#7561-63 Texaco Inc. MSDS, Product name: 00958 Marfax Multi Purpose 2 (grease), **Chemical / Common Name: Lithium 12-hydrosstearate 4-10.99%**

#7589-91 Texaco Inc. MSDS, Product name: 1939 Premiiium RB Grease, **Composition: Lithium 12-hydroxystearte 15-20%.**

#7668-71 Vulcan Chemicals MSDS, Product name**: Trichloroethylene 100%**

#7688-90 The Whitmore Manufactoring Co. MSDS, **Product name: Surtac Plus / black paste w/solvent odor, Trichlorwthylene, CAS (79-01-6)**

24. 7718-39 NA

25. 7740-7771
#7746 Used grease and oil pickup sheet 1/9/1991- 11/5/94. Other miscellaneous similar sheets. No data sheets prior to 1991.

26. 7772-7803 Water Pollution Prevention, Spill Prevention and Countermeasure Plan (SPCC) for Asarco Troy Unit.

#7773 Memorandum Brian Hansen (MFG) to Dave Young (Asarco) " I have reviewed SPCC plan..... *The plan indicates that gasoline, diesel fuel, oil, used oil, cleaning solvent and calcium hypochlorite are used on site. I was only able to find discussions on how the diesel fuel and used oil are handled and stored. It would be helpful to briefly discuss how the other substances are handled and stored. * The sections on Inspections and Records and Personnel, training and spill prevention procedures [corresponding to 40 CFR Part 112.7(e)(8)(i) and (e)(10)(iii), page 5 of the plan] should note that records are kept concerning the inspections and training."
It might be beneficial to ask for these documents (Inspections & Records) and maybe even Personnel!

27. 7804-7874 Reagent Consumption Use, Grinding Media and Power Use 1984-1993. Notes for Jack Tuholske: Aluminum Sulfate use begun in milling process in Dec. **1984.** During a period of 7 months in **1985** Aluminum Sulfate use averaged 9 ton per month. Also grind ball size & use varies considerably. ALL indications of some experimentation. July of **1986** work with Aluminum for water clarity completed. Still experimenting w/ milling process. Frother mix replacement.

Last three months of **1987** experimentation w/grinding medium (ball size).

1988, 89 & 90 Reagent Consumption Use, Grinding Media and Power Use **MISSING**???
See e-mail of 2/5/04 to Jim Kuipers, cc: Bechtold & Rossbach.

1991 Lot of play in the flocculant field.

1992 Not a lot to tell.

1993 Only 3 months of real operation.

28. 7875-7887 Flotation tailing report sheets. ????

29. 7888-7907 Distribution letter concerning Federal Rail Administration / DOT inquiries as to Asarco shipments of Hazardous Waste via rail, primarily heavy metals and contamination.

30. 7908-8636 Filler junk. NA

Recommendations for FURTHER DISCOVERY REQUEST and other questions.

A. See # 9. Should ask for "Requisition sheets" for all oils, grease and lubricants from 1981-93.

B. See #10. Purchase of Potassium Amyl Xanthate. Quantity use confirmed by Reagent Consumption Use sheets indicate at least 900+ / 55gal. barrels came into plant with this product alone. If there was a $20 barrel deposit as indicated then Asarco was ponying up $18,000 in deposit money per year on this reagent alone. This is enough deposit money to want to recover. There would have to be some methodology for tracking the return of all these barrels to recover the deposit. **DISCOVERY.**

C. See #11. Question; are the halogenated solvents described Trichloroethylene?

D. See #13 / **5307** Hazardous Waste logbook described in this document. Request copy through **DISCOVERY.**

E. See #13 /#5330-31 Field Investigation Report (R. Reinke / DHES) 8/22/90 discussing waste practices. Mine generates 2000 gal. stoddard product per year. **Lee McKinney explanation of waste management for assay lab.** Spent acids discharged to float machine. *This possibly corroborates some of Greg's testimony about lab waste reporting to tailings impoundment via tails thickener.*

#5341-43 Solvent consumption sheets. Great explanation: "Trichlorethane – Chlorethane sp. gr.=1.320, consumption: 440 gal. in 1987 = 37 gal. / mo.= 404 lb./mo. Disposal; evaporates; ? sludge goes into sewage treatment facility then to?"
See 11 above.

F. See #14 / **#5431 Part Two (waste description sheet) of 1993 haz-waste Report Form to MDHES. Other chemicals, Trichloroethylene, Toulene, Sodium Hydroxide. Trichloroethylene waste amount generated 155 lbs. (8 lbs. / gal.) and amount shipped off-site, 155 lbs. does not square with (Item 13, #5344-45 which indicates 450 gallons of Trichloroethylene usage annually**. *Explanation and reconciling needed!* **DISCOVERY.**

G. See #14 /#5470-84 Small Generator Annual Haz-waste Report Form to MDHES for 1991.
#5472 Waste description sheet: Waste Petroleum Naptha Combustible Liquid, 14796.
No other haz-waste reported, No Part Two waste description sheet for Trichloroethylene, Toulene, Sodium Hydroxide. Hard to believe use of such chemicals at mine would have changed so radically. Explanation and reconciling needed

#5485-93 Small Generator Annual Haz-waste Report Form to MDHES for 1990.
#5487 Waste description sheet. Waste Petroleum Naptha Combustible Liquid, 5209.
No other haz-waste reported, No Part Two waste description sheet for Trichloroethylene, Toulene, Sodium Hydroxide. Hard to believe use of such at mine would have changed so radically. Explanation and reconciling needed

DISCOVERY : We want to know if Trichloroethylene was purchased and used in these years. Relate to A & D above that might answer this question. If it was purchased and

used as in previous years then at least 155 gallons should show up as having gone to hazardous waste site as per F above.

H. See #15 / #5742-49 Asarco letter to All Plant Managers dated 7/30/80 concerning Chemical Substance Inventory program initiation. #5744-49 is an example of all substances /materials used by Wallace Office. *Troy mine would / should have one of these and we should ask for it. Lists all substances and suppliers.* **DISCOVERY**

I. See #18 / #6124-29 Six forms of some sort indicating testing of PCB contaminated transformers.
Notation at bottom of each: "Letter from Continental No PCB's 9-18-80. Tested 4/25/86 56-360 PPM Contaminated." *Note #6124-29 indicates 6 contaminated transformers and #6116-8 is invoice for removal of 5 carcasses. This could relate to unsolicited EPA brochure sent to CRG from EPA Region VIII, Denver.*

J. See #25 / **25**. 7740-7771
#7746 Used grease and oil pickup sheet 1/9/1991- 11/5/94. Other miscellaneous similar sheets. No data sheets prior to 1991.

Relate back to # 13 / #5328 Letter from DHES 10/1/90 to L. Erickson / Asarco four drums of stoddard solvent sent to Moore Oil of Libby that qualified as hazardous waste. Moore Oil not allowed to handle such material. *Possibility that Moore Oil of Libby was regularly picking up stuff they shouldn't have been.*

Appendix B
Mine Water Balance Analysis

50 West 14th Street, Suite 200
Helena, Montana 59601
tel: 406 441-1400
fax: 406 449-7725

Memorandum

To: *Emily Corsi, Herb Rolfes, DEQ*

From: *Bill Bucher, Kim Chase - CDM*

Date: *April 12, 2010*

Subject: *Mine Water Balance Analysis - Troy Mine*

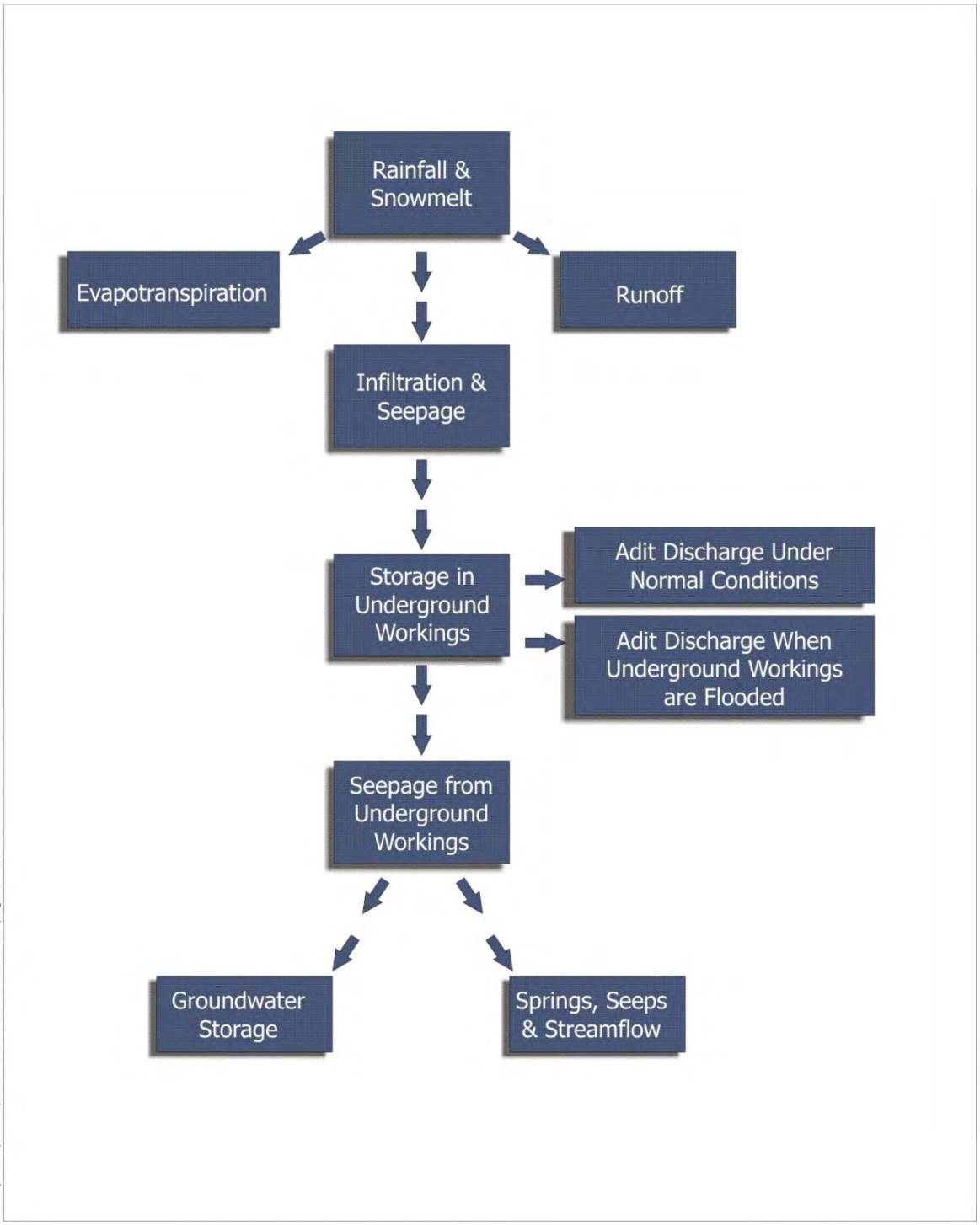
CDM has been retained by the Montana Department of Environmental Quality (DEQ) to develop a water balance model for the Troy Mine to predict expected discharge from the mine workings, if any, after mine closure. The purpose of this memorandum is to present the results of our analysis of existing data that we used to predict whether the Troy Mine will fill with water after pumping ceases to a level that will allow discharge of mine water to the surface. If the mine workings are predicted to discharge, how long it will take to do so and how much discharge may be expected will also be predicted. A review of the existing data and the conceptual water balance are available in a Technical Memorandum prepared by CDM dated January 16, 2009.

The Troy Mine is an underground copper and silver mine located south of the town of Troy in Lincoln County, MT. ASARCO began operating the mine in 1982 and halted production in 1993 due to low metals prices. The mine was sold to Revett Silver Company and production resumed under Genesis, a subsidiary of Revett, in 2005. In 2006, Genesis submitted a Revised Reclamation Plan, for which an Environmental Assessment (EA) must be completed. In support of the EA, this Memorandum assesses the possibility of mine flooding discharging to the surface.

Conceptual Water Balance Model

The conceptual water balance is shown in Figure 1 and is discussed in detail in the January 16, 2009 Technical Memorandum. The water that enters the mine all originates as rainfall or snowmelt above or near the underground workings. This precipitation, minus the portion lost to evapotranspiration, overland or subsurface runoff, enters the groundwater system adjacent to the mine workings and potentially seeps through the mine walls or enters fractures that connect to the mine. The water received by the underground workings may be held as storage or it may seep out through fractures or porous formations. If the underground workings are flooded, water may discharge from the service adit, the lowest

Figure 1. Conceptual Model of Mine Water Balance



potential connection to the surface. Under normal conditions, there is some discharge from the service adit due to water entering from the adit walls and back. It is only the water entering or leaving the mine workings that is of concern in this analysis of whether the or not the mine workings will flood to an elevation which will result in discharge from the mine workings via the service adit.

The conceptual model of mine flooding developed in this study is based on the following assumptions about groundwater in the vicinity of the mine:

- The geology of the rock around the mine workings is fractured metamorphic rock, which allows significant flow through the fractures.
- The aquifers adjacent to the mine workings are local, unconfined aquifers which have the potential to fluctuate rapidly in response to precipitation and runoff patterns as well as mine dewatering activities.
- If pumping ceases and water levels recover, there is a potential for water to discharge through the service adit at a known elevation (4225 ft.).

Figure 2 is a conceptual drawing of a flooded mine that will discharge through an adit. In this scenario, water levels have recovered to an elevation sufficiently high to permit overflow through a discharge point, in this case the service adit of the Troy Mine. Figure 3 shows an alternate scenario in which the recovered water level remains below the overflow point and the mine does not discharge. Determining which scenario occurs in the future after pumping has ceased depends on the recovered elevation of the local aquifer. This is essentially a groundwater analysis problem, which requires an understanding of the local geology and aquifers that we do not have. Therefore, the ability to analyze this problem completely is compromised, and we are limited to the storage data collected by the mine operators to interpret the potential behavior of the local systems under future conditions.

Methods

Because no quantitative information is available about the groundwater conditions surrounding the underground workings, it is not possible to directly calculate the mine water's effect on the surrounding water table. Additionally, there is no way to calculate the magnitude of flows into the underground workings or natural seepage out of the workings. However, it is possible to calculate the difference between inflow and outflow from the change in storage over a given time period. The basic method employed here is the analysis of mine inflow volumes as determined from the pumping rates and storage changes measured by the mine operators through the years. The inflow to the mine workings can be defined as the pumping rate plus the change in storage:

Figure 2. Conceptual Model of Mine Discharging through Adit

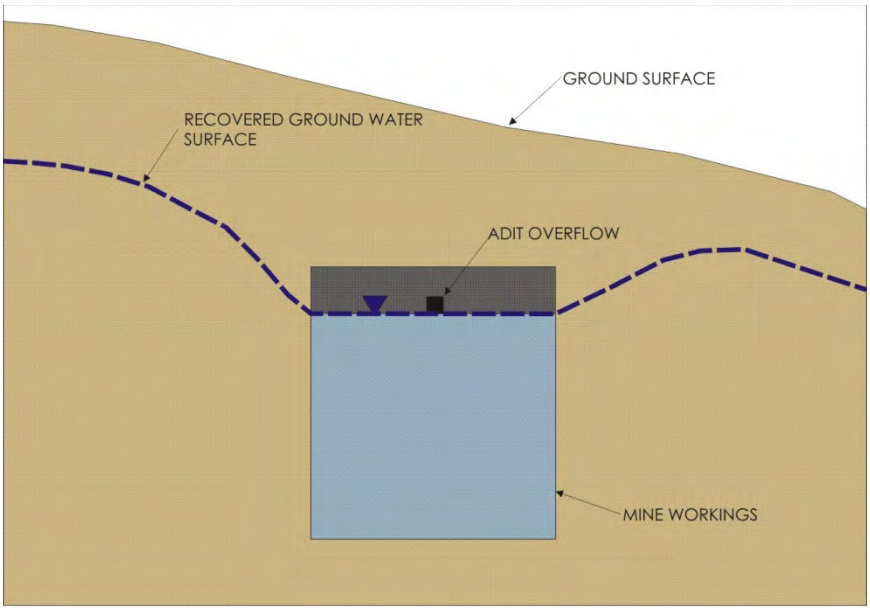
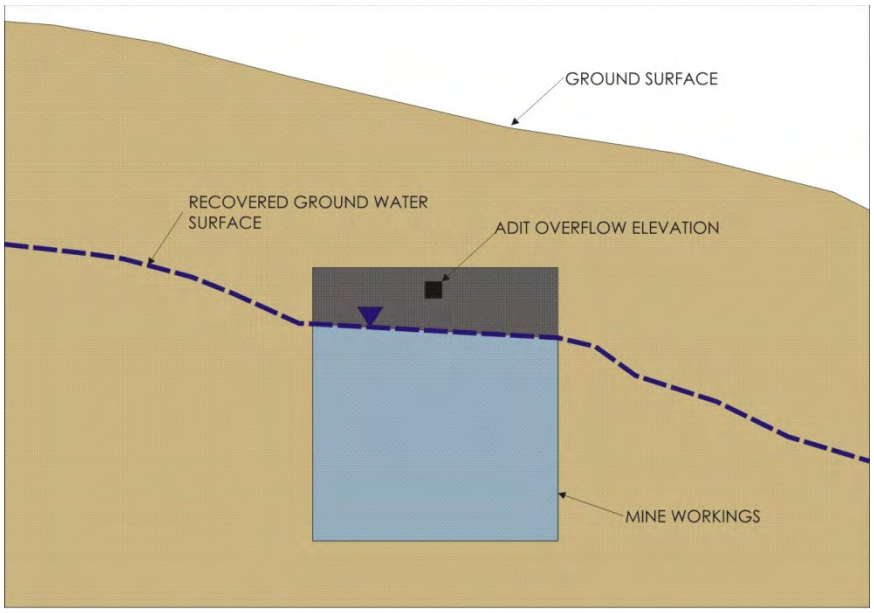


Figure 3. Conceptual Model of Mine without Discharge to Surface



$$I = Q_p + \Delta S$$

Where:

I is the mine inflow for the period
Q_p is the pumping rate for the period
ΔS is the change in mine storage for the period.

It is possible that portions of the mine discharge to the surrounding formations where the local water table is below the mine water elevation. This potential is highest when the mine pool is at a high elevation and the local aquifers are depressed after a dry period such as normally occurs in late summer. However, records indicate that this mine generally receives inflow in excess of any outflow, and in this analysis we will use the term mine inflow to mean the net difference between inflow and outflow from the mine workings.

Relationships for inflow were established based on the hypothesis that inflow to the underground workings would be dependent on rain and snowmelt amounts and on water levels in the underground workings. Rain and snowmelt, acting through the groundwater pathway, are believed to be the primary source of water input to the underground workings. When groundwater levels are higher, it follows that the head difference between water in the underground workings and the surrounding groundwater is greater and, therefore, inflow to the underground workings will be greater. Therefore, inflow is proposed to be a function of both recent rain and snowmelt and the elevation of the local groundwater surface:

$$I = f(R, H)$$

Where R is a rainfall and snowmelt and H is a measure of head difference between the mine pool and the local aquifer. The sum of rainfall plus snowmelt is a logical measure of water that has potential to enter the mine. To show that the inflow to the underground workings is related to rainfall and snowmelt, inflow was plotted for each year alongside rainfall and snowmelt.

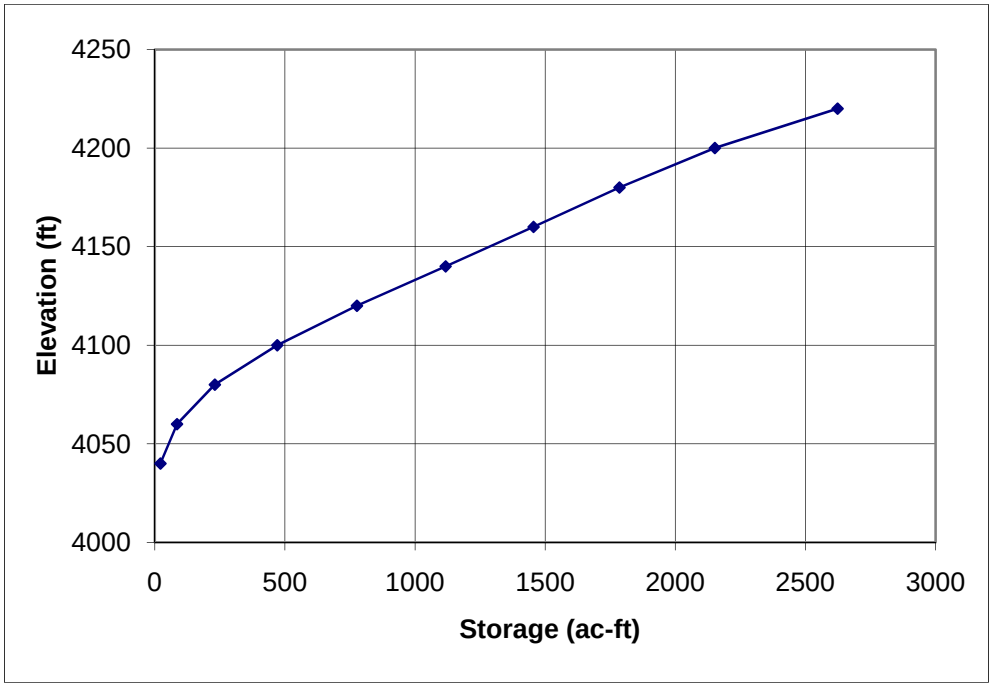
Rain and snowmelt was plotted against inflow over several different time-scales to determine the most appropriate time scale for analysis. This resulted in a method for predicting the inflow to the mine for any precipitation/runoff condition. For the annual time scale, an average value of total rain plus snowmelt was used as the input variable for the years 2004 through 2008 giving a set of four different inflows for these years. Then the actual value of inflow for each year was compared to the value predicted by the linear correlation. This predicted inflow was then plotted against the average water elevation in the underground workings during each year. A second linear correlation was then calculated for inflow as a function of water elevation and was used to predict the expected effect of water level on the change in storage.

With this information, it is possible to estimate the potential for surface discharge from the underground workings and the expected outflow. Further calculations can predict the time until discharge with an assumed initial mine pool elevation and typical precipitation conditions.

Analysis and Results

Our analysis of mine water levels relies on the elevation-storage curve developed by Genesis, Inc. (2004) which is shown in Figure 4 after conversion to acre-feet (ac-ft). This relationship is based on mine surveys of the extent of workings at sequential elevations in the mine with allowance for remaining pillars.

Figure 4. Water Elevation vs. Storage Relation for Troy Mine

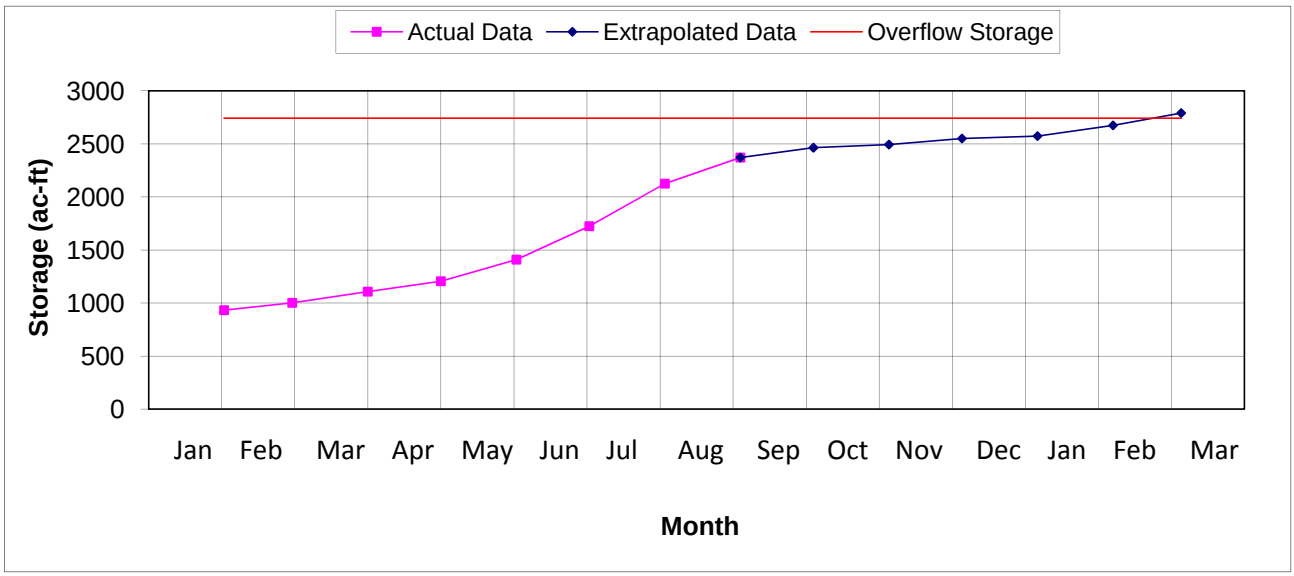


Potential for Mine Flooding

The discharge of mine water from a flooded mine appears to be a real possibility based on data collected in water year 2003 when mine pumping did not occur. Figure 5 plots cumulative mine water storage from January 2003 through August 2003 (end of month values). At the end of August 2003, the storage volume was 2371 ac-ft, which corresponds to an elevation of 4209 ft, the highest recorded water level in this portion of the mine. This level is just 16 feet short of the adit overflow elevation of 4225 ft. In September pumping resumed, the storage volume did not exceed 2371 ac-ft, and pumping continued at a higher rate into 2004, decreasing the storage volume. If the pumping volumes are added to the cumulative volume at the

end of August 2003, it is seen that the storage volume could have continued to increase, potentially exceeding the storage volume of 2,742 ac-ft (corresponding to a discharge elevation of 4225 feet) in February 2004. Thus, if pumping had not resumed, the mine may have started discharging in a relatively short period of time. On the other hand, it is expected that inflow rates decrease with higher water elevations. Therefore, it is also possible that the inflows would have decreased with increasing water elevation sufficiently that the mine would not have discharged. In the following analysis, an attempt is made to determine which of these scenarios is most likely based on analysis of available data.

Figure 5. Measured and Extrapolated Cumulative Mine Water Storage, 2003 – 2004.



Relationship between Inflow and Precipitation Events

As described in the methods section, the relationship for inflow was separated into a function dependent on rain and snowmelt history and a function dependent on water elevation. The first step was to develop the relationship between inflow and precipitation and runoff. This was initiated by examining the temporal sequence of rain and snowmelt at a local SNOTEL site with the inflow to the mine.

Daily precipitation and snow-water equivalent data were gathered from Natural Resources Conservation Service SNOwpack TELemetry (SNOTEL) site 932, Poorman Creek (Natural Resources Conservation Service, 2008). The SNOTEL site is located approximately 14.7 miles to the southeast of Troy Mine. It is located at an elevation of 5100 feet, near the middle of the range of surface elevations directly overlying the mine (4600 feet to 5580 feet). Data for accu-

mulated precipitation are available for water years 1999 to 2008 and snow-water equivalent data are available from water year 1969 to 2008. Because of its relative proximity to the mine and its similar elevation, the Poorman Creek SNOTEL site should adequately represent precipitation conditions in the mine area.

The analysis was conducted on monthly, seasonal and annual time scales with special attention paid to lag between surface events and the inflow. The graphs located in Appendix A (Rain+Snow, Storage vs Time) show that the monthly change in storage within the underground workings follows the amount of rainfall and snowmelt very well. However, the lag time between the peak of rainfall plus snowmelt to the peak change in storage is inconsistent. The amount of time that the change in storage peak follows the rainfall plus snowmelt peak varies from zero to two months. In attempting to correlate rainfall and snowmelt with change in storage plus pumped volume during periods of pumping, several time scales were used. The correlation on a monthly basis was weak, with an r-squared of 0.3. When the change in storage was lagged one month behind the rainfall and snowmelt, the correlation weakened even further. The data was then reorganized by season: winter being January, February, March; spring being April, May, June and so on. This improved the correlation to an r-squared of 0.61. On an annual basis, the r-squared improved to 0.73. After removing 2007 from the data, the correlation improved further to an r-squared of 0.87. Because of the poorer correlations for the shorter time scales, the annual time scale was adopted for this analysis.

Figure 6 shows the relationship between mine inflow and rain plus snowmelt on an annual basis for water years 2004 through 2006 and 2008. The data for 2007 is excluded from this analysis because it is suspect for reasons explained later in this memorandum.

Based on the period of record from 1999 to 2008, the average annual rain plus snowmelt for the Poorman Creek SNOTEL site was 79.5 inches. Using the correlation relation established above, this amount of precipitation predicts an average annual inflow into the mine of 1418 ac-ft. To eliminate the effects of rainfall and snowmelt from the inflow relation, predicted inflows were calculated using the relationship in Figure 6 and then subtracted from the actual inflows measured in the corresponding years. These residual amounts were then added to the average annual inflow of 1418 ac-ft resulting in a set of adjusted inflows that are independent of rainfall and precipitation effects to the extent that the data allow. Table 1 summarizes this calculation.

Figure 6. Correlation between Mine Inflow and Rain plus Snowmelt for Water Years 2004 – 2006 and 2008

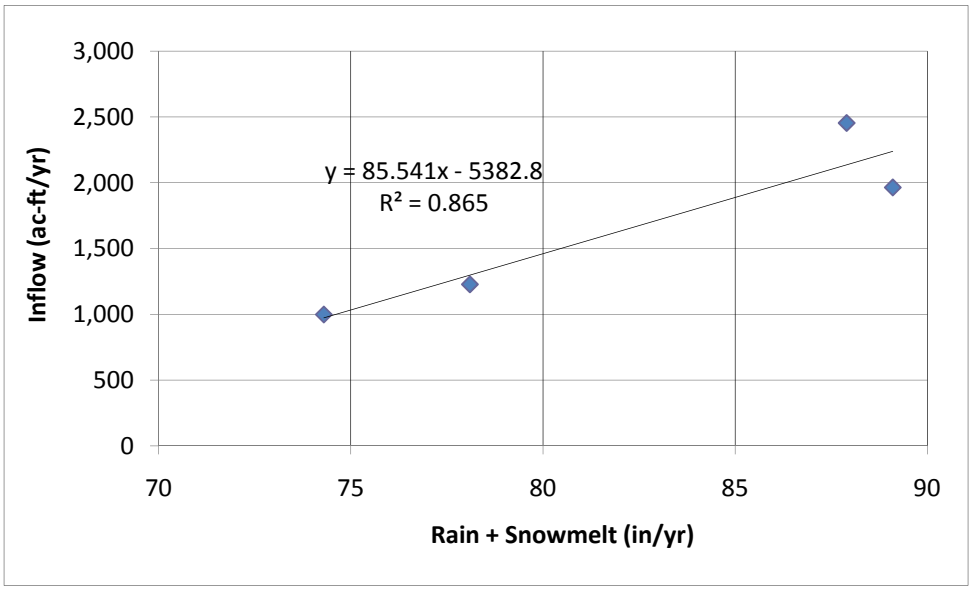


Table 1. Variables and Results of Adjusted Inflow Calculation.

Year	Average Elev (ft)	Measured Inflow (ac-ft)	Rain+snow (in/yr)	Predicted Inflow (ac-ft)	Residual (ac-ft)	Adjusted Inflow (ac-ft)	Q (cfs)
2008	4082.8	2454	87.9	2130	324.2	1736.4	2.4
2006	4169.9	1228	78.1	1291	-63.5	1348.8	1.9
2005	4189.8	999	74.3	966	32.6	1444.9	2.0
2004	4189.9	1965	89.1	2233	-267.5	1144.7	1.6

Relationship between Inflow and Water Elevation

Cumulative mine inflows for the years that the pool elevation was being controlled by pumping are plotted in Figure 7. These curves show that mine flow is generally relatively small and consistent through the fall and winter months and increases greatly, but by varying amounts, in the spring before tapering to lower rates in the summer. As shown in Figure 8, which shows storage levels in the mine throughout this period, stored water was rather high in 2004 through 2006, averaging 1854 ac-ft. In 2007, the water level was drawn down and remained relatively low through 2008. Figure 7 shows clearly the effects of maintaining a low storage level in 2008: the annual inflow for this year was the highest in the pumping period although annual rain plus snowmelt was higher in 2004.

Figure 7 also shows that mine inflow was negative during the winter in 2007. This suggests that water was flowing out of the mine for this period by means other than pumping. Inspection of Figure 8 shows that the mine was being rapidly drawn down through this period. That water would not be flowing into the mine during a period of rapid drawdown is physically difficult to explain and it is suspected that either the storage data or the pumping rates are in error during this period. Therefore, data from water year 2007 have not been used in this analysis.

With a relation between rainfall plus snowmelt and inflow established on an annual basis, the residual information can be used to develop information on the relation between water elevation and inflow. Conceptually the mine workings can be thought of as a large diameter well

Figure 7. Cumulative Inflow for Water Years 2004 through 2008

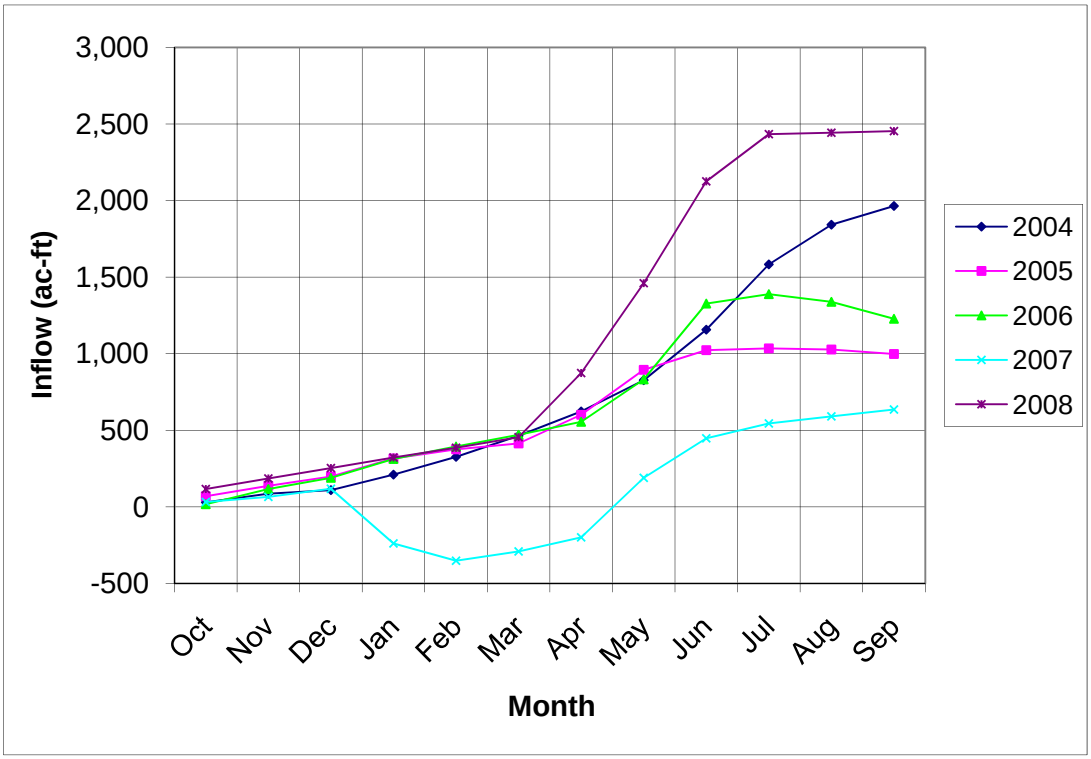
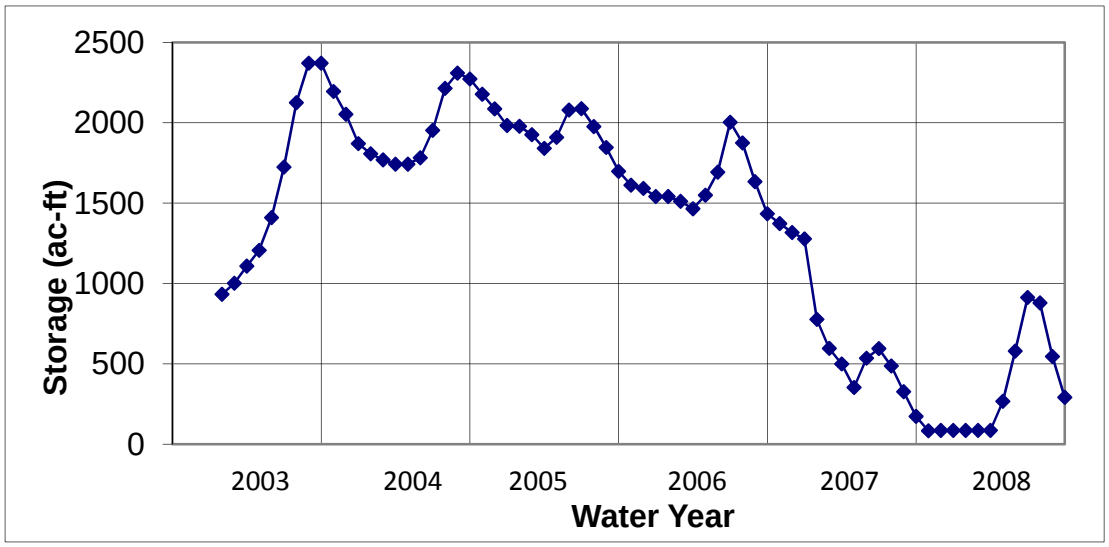


Figure 8. Mine Water Storage 2003 through 2008.



located within an unconfined aquifer. Because the time period for pumping in this analysis is a year, which is relatively long in most pumping applications, the relation of inflow and water elevation should approximate a Theis curve (Freeze and Cherry, 1979). The equation for the Theis curve is:

$$h_0 - h = \frac{Q}{4\pi T} W(u)$$

where $W(u)$ is the well function

$$u = \frac{r^2 s_y}{4Tt}$$

h_0 is the initial height of the water table

h is the height of the water table at distance r and time t

Q is the flow into the well

r is the radial distance from the well

S_y is the specific yield for an unconfined aquifer

T is the transmissivity of the aquifer

t is time since initiation of pumping

This linear equation relates water elevation (h) and inflow (Q). Plotting water elevation versus inflow for the four years of data presented in Table 1 and fitting a linear regression line through the points results in the graph shown in Figure 9. The r-squared for this correlation is 0.75. Extrapolating the line to the point where $h = h_0$ results in a predicted initial value (or recovered value) for h_0 of 4413 ft., well above the adit overflow elevation of 4225 ft. This suggests the water level in the mine will rise to the adit discharge level when pumping ceases.

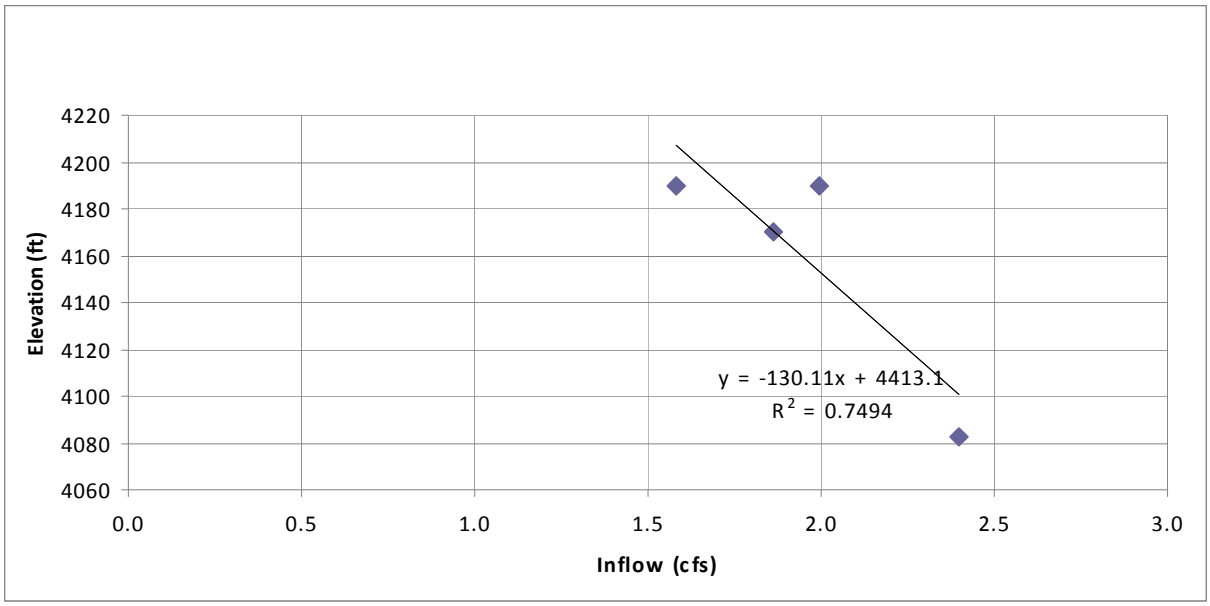
As a check on the validity of the Theis equation in this application, it is shown that a consistent set of aquifer parameters can be derived from the slope of the linear regression (negative 130). If we assume that the typical radius at the edge of the mine workings is related to the area of workings at elevation 4220 ft, the radius for computational purposes is about 800 ft. We can also use a specific yield of 0.05 for fractured crystalline rock (the range is typically zero to 0.10, Freeze and Cherry, 1979), we can calculate from the Theis equation that the formation transmissivity is about 4×10^{-4} ft^2/s. If we assume that the thickness of the affected aquifer is about 400 ft., this corresponds to a hydraulic conductivity of about 3×10^{-5} cm/s, which is mid-range in the expected hydraulic conductivities of fractured metamorphic rocks (Freeze and Cherry, 1979). Thus, a reasonable set of hydraulic parameters appears to be consistent with the slope calculated from the data. Note that this is not an attempt to derive actual hydraulic parameters; this calculation is merely a check that it is physically probable that the calculated slope can occur.

Timing and Quantity of Overflow

The relations derived in the previous sections can be used to estimate the time frame in which the mine workings will fill to the overflow point as well as the potential discharge volume. The average precipitation/runoff condition of 79.5 inches per year is assumed and the water elevation versus inflow relation is applied to calculate when the mine will fill to the overflow point. Then the average inflow at that elevation is used to calculate the average annual discharge from the adit due to the mine workings overflow. An additional assumption is that the inflow is distributed through the year approximately as it was in 2006, a year with close to average rain plus snowmelt.

If the mine starts completely pumped down to elevation 4020 in October and then the pumps are shut down, the calculations indicate that the mine will fill under average rain plus snowmelt conditions sometime in June of the following water year, 21 months later. Thereafter, the average rate of discharge to the service adit is anticipated to be about 1.5 cfs or 1,050 ac-ft per

Figure 9. Relation of Water Elevation to Adjusted Mine Inflow.



year. It is possible that the discharge will cease in August and September because of the lowered local water table in these months.

Annual and Seasonal Variations in Adit Discharge

Given the great variations from year to year and within any year in inflow to the mine, it is expected that discharges from the overflowing adit will vary both annually and seasonally. Given, the limited available data, estimates of natural variation in mine discharge rates cannot be made precisely and cannot accurately assess discharge rates during years in which precipitation is substantially higher or lower than during the years for which mine outflow data are available. The additional data necessary to refine this analysis can only be collected during unusually high or low precipitation years, and it cannot reasonably be expected that such opportunities will occur during the time frame in which this environmental analysis must be completed. Other methods of mine discharge estimation would require that data (ground water elevations, spring locations and flow rates, etc) have been collected prior to mining. Such data do not exist and cannot be obtained.

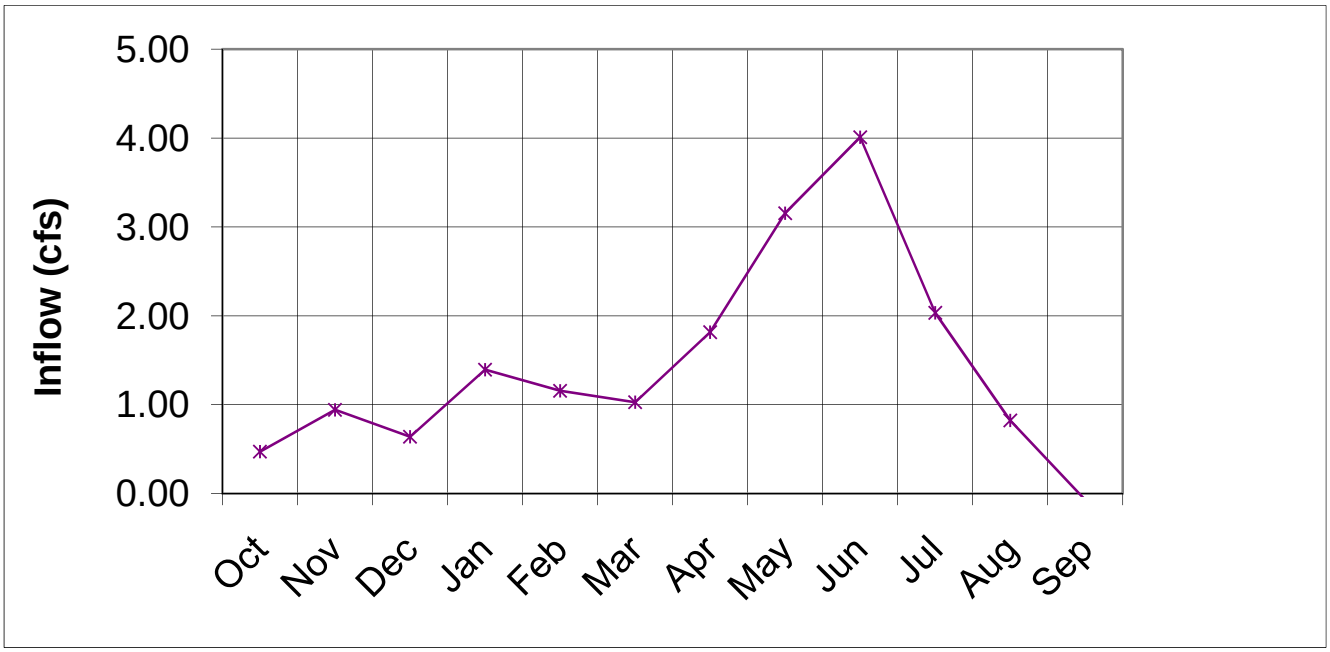
The relationship of water elevation to mine inflow (with no mine discharge) was determined based on four years of storage records. Within these years, 2004 was the wettest year (89.1 inches rain plus snowmelt) and 2005 was the driest (74.3 inches of rain plus snowmelt).

Comparing the calculated annual inflow for these years compared to the mean annual inflow shows that inflows were 39% higher than average in 2004 and 30% lower than average in 2005. If these ratios are assumed to apply to the inflow that would occur at the discharge elevation, the range of annual discharges varies from 1.0 to 2.0 cfs.

These two years, however, are not extreme precipitation years at the Poorman Creek SNOTEL site. In 2002 rain plus snow was about 104.1 inches and 2001 had 45.4 inches at this site, much greater and lesser amounts than were observed in 2004 and 2005. If we attempt to convert these more extreme amounts to inflows using the relationship derived for years 2004 through 2006 plus 2008, considerable extrapolation of the relation is required. In fact, the inflow predicted for 2001 is negative, indicating the inapplicability of this relation during drier years. Without storage-elevation data for more extreme years, it is not possible to predict with any certainty the behavior of adit discharge in extreme precipitation years. However, using the maximum rain plus snow value in 2002 (104.1 inches) from the ten-year period of record at Poorman Creek, an estimated annual adit discharge of 3.6 cfs is calculated. For lack of better data, this figure may approximate a 10-year return interval annual discharge.

Determining seasonal variations in predicted adit discharge is also problematic. As discussed previously, the attempts to develop robust, predictive models of monthly or seasonal flow were not successful. However, an estimation of the seasonal variation in predicted discharge for average conditions can be developed from the high storage level records of 2004 to 2006. Using the mean monthly values for these three years, and proportioning them by the ratio of the predicted annual average flow (1.45 cfs) to the annual flows for this period (1.93 cfs), the monthly flows presented in Figure 10 were calculated. The peak monthly flow is 4.0 cfs in June and the minimum is zero in September, when no discharge is expected. Inspection of the mine inflow data for individual months from 2004 to 2006 and correcting to average annual discharge from the mine adit indicates that a maximum discharge of 6.25 cfs could occur at the adit. In this 36 month period of record, four months would have had no discharge (always the August-September period). However, 2006, when the peak monthly discharge is predicted, was not an extremely high precipitation year so larger discharges than 6.25 cfs are possible.

Figure 10. Average expected monthly mine discharges based on 2004 to 2006 mine inflow data.



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Appendix C
Mine Water Management Analysis

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Technical Memorandum

To: *Emily Corsi, Herb Rolfes - DEQ*
Bobbie Lacklen, John McKay - KNF

From: *Bill Bucher, Kim Chase - CDM*

Date: *December 3, 2010*

Subject: *Mine Water Management Analysis - Troy Mine*

CDM has been retained by the Montana Department of Environmental Quality (DEQ) to analyze proposed mine water management alternatives for the Troy Mine. The purpose of this memorandum is to present the results of analysis of water management alternatives to be considered in the Draft Environmental Assessment (EA) for closure of the Troy Mine. This memorandum only addresses the physical management of water; water chemistry issues are being addressed separately.

The Troy Mine is an underground copper and silver mine located south of the town of Troy in Lincoln County, MT. ASARCO began operating the mine in 1982 and halted production in 1993 due to low metals prices. The mine was sold to Revett Silver Company and production resumed under Genesis, a subsidiary of Revett, in 2005. In 2006, Genesis submitted a Revised Reclamation Plan in support of this EA. This memorandum analyzes water management alternatives presented in the EA.

It has previously been shown in the *Mine Water Balance Analysis – Troy Mine* Technical Memorandum (CDM, 2010) that the Troy Mine is expected to discharge mine water after closure. The three closure alternatives to be evaluated in the draft EA consider different water management scenarios:

- Alternative 1 is the original closure proposal from the 1978 reclamation Plan. It would close the adits with non-hydraulic plugs, which would allow the mine water to discharge from the portals. Mine water would then infiltrate to the groundwater system. The glacial till near the mill site probably is not sufficiently permeable to allow infiltration of the expected quantity of water, and there is likely a substantial risk that saturation of this material could trigger landslides and slumping of material into the creek, causing further pollution. In addition there would be a direct discharge to Stanley Creek from the adit that

would not meet State water quality standards and would not be authorized. Therefore, this alternative is not being considered further in this water management analysis.

- Alternative 2 is the revised reclamation plan of March 2006 proposed by Genesis. In this alternative, the conveyor and service adits would be closed with non-hydraulic plugs, and the mine water would be carried by the existing tailings and reclaim water lines to the decant ponds. At the ponds, the water would infiltrate and evaporate, and metals would be adequately attenuated by the underlying soils to preserve ground and surface water quality in the area.

- Alternative 3 is the agency mitigated alternative. In this alternative, the both the Service and Conveyor adits would be closed with partial backfill only and the mine water would be captured inside the entrances and transported to the decant ponds for treatment and disposal. The existing tailings lines would be removed and replaced with a new, buried line with at least 6.9 cubic feet per second (cfs) capacity. If there is insufficient capacity in the new transport line or a leak or other upset, part or all of the flow would be diverted automatically to the reclaim water line that is presently in place. Sensors installed in the line would detect these conditions and Supervisory Control and Data Acquisition (SCADA) instrumentation would automatically open and close appropriate valves and alert maintenance personnel. The decant ponds would be bermed to prevent the entry of storm water. They will be constructed about 10 feet deep and lined with gravel to prevent the growth of aquatic vegetation.

The analysis of water management for a discharging mine in Alternatives 2 and 3 is the main focus of this memorandum.

Management of Mine Discharge

Mine water discharging from the service and conveyor adits at Troy Mine will be transported through a system of pipelines to the existing decant ponds in the tailings pond area under Alternatives 2 and 3. The locations of these facilities are shown in Figure 1. The question to be answered through a water balance analysis is whether the decant ponds will eventually fill and overtop or if infiltration and evaporation are sufficient to maintain the pond level below this elevation. The following information is needed to develop a water balance for the decant ponds at the tailings impoundment:

- Discharge from the mine adits

- Pond Area

- Pond volume and stage-volume relationship

- Evaporation and precipitation information near the pond

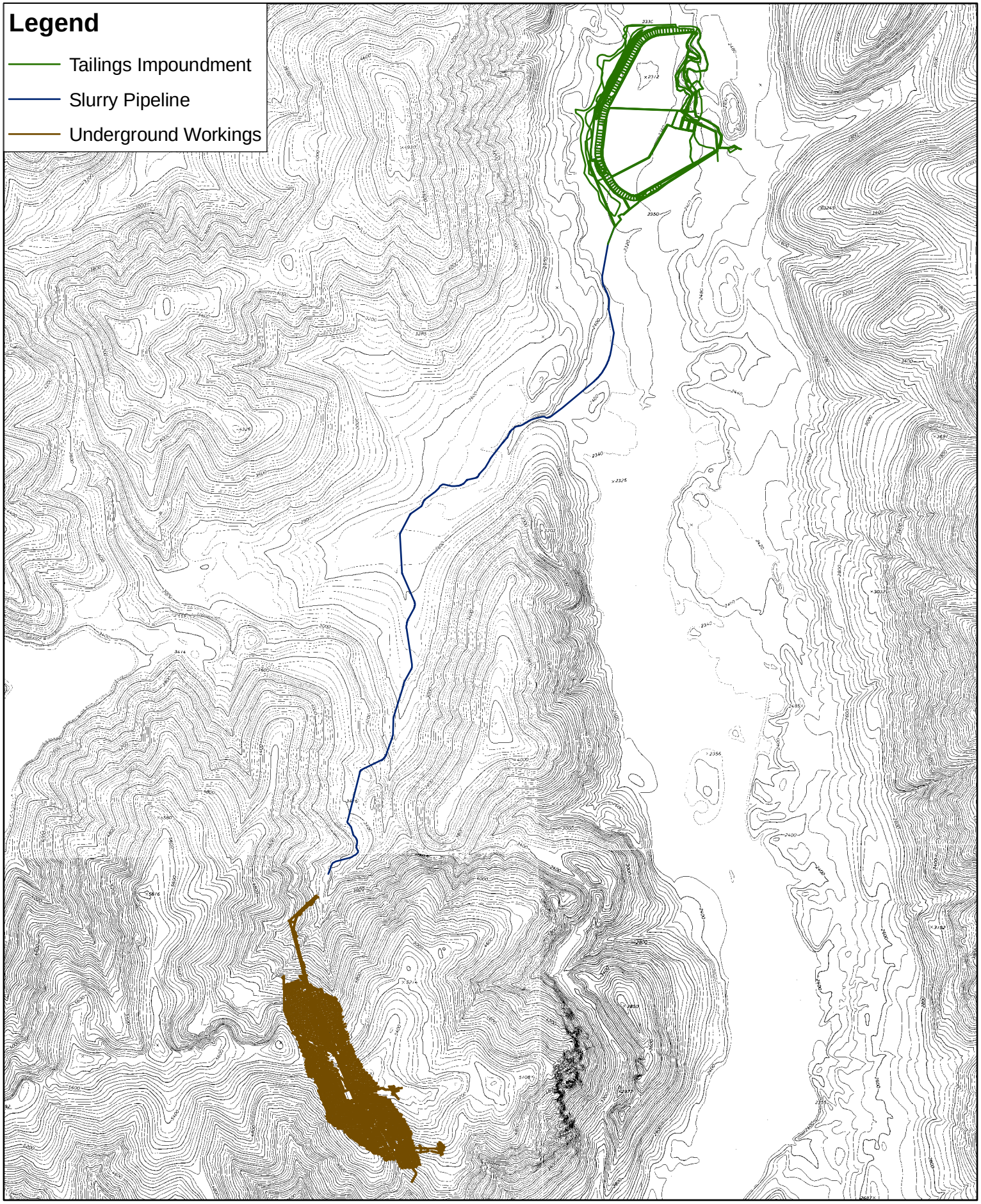

Figure 1: Location of Underground Workings, Pipeline, and Tailings Impoundment

0 0.2 0.4 0.8 1.2 Miles

CDM

N

- Infiltration rate below the pond

For a detailed water balance analysis, a ten-year period with monthly time steps was selected to provide sufficient time to allow a general balance of inputs and outputs and to capture extreme conditions that would correspond roughly to a ten-year recurrence interval. The selected time period was the period of record for the Poorman Creek SNOTEL site, where the available record runs from 1999 through 2008. The Poorman Creek period of record is important to this analysis because the estimated mine discharges are tied to precipitation records at Poorman Creek in the mine water balance memorandum (CDM 2010). Monthly values for the mine discharge and climatic data were developed for the period 1999 -2009 as input to the pond water balance model.

Mine Discharge Data

In the *Mine Water Balance Analysis – Troy Mine* Technical Memorandum, CDM developed an annual relationship between rain plus snowmelt and mine discharge. This relationship demonstrated that the mine would generally discharge water after closure and quantified the annual amount of discharge. Although no robust predictive model of monthly discharge could be developed, evaluation of mine inflows on a monthly basis during a period of high mine water level resulted in an approximate distribution of expected mine discharge through a typical year. To produce the monthly data set, the predictive model was used to calculate estimated annual mine discharge based on precipitation records at the Poorman Creek SNOTEL. The average monthly distribution of mine discharge was then estimated by adding the typical distribution to the difference between the annual distribution for a particular year and the average annual discharge:

$$Q_{Myrx} = Q_{Ayrx} - Q_{Aave} + Q_{Mave}$$

Where: Q_{Myrx} is the calculated monthly discharge for year x

Q_{Ayrx} is the predicted annual flow for year x

Q_{Aave} is the predicted average annual flow

Q_{Mave} is the typical monthly discharge.

Table 1 shows the calculation of the predicted annual discharge based on precipitation at the Poorman Creek SNOTEL site and Table 2 shows the estimated monthly mine discharges for the period of record 1999-2008. The equation used to calculate the monthly discharges occasionally results in negative discharges; these discharges are set to zero.

Table 1. Predicted Annual Inflow and Discharge (Q_{Ayrx}) Based on Inflow Analysis Relations

Year	Rain+ Snowmelt (in)	Predicted Inflow (ac-ft)	Predicted Inflow (cfs)	Adjusted Inflow (cfs)*	Estimated Discharge (cfs)
1999	76.0	1118	1.54	1.54	1.14
2000	84.4	1837	2.54	2.54	1.87
2001	45.4	-1499	-2.07	0.76	0.56
2002	104.1	3522	4.86	4.86	3.59
2003	69.4	554	0.76	0.76	0.56
2004	89.1	2239	3.09	3.09	2.28
2005	74.3	973	1.34	1.34	0.99
2006	78.1	1298	1.79	1.79	1.32
2007	79.0	1375	1.90	1.90	1.40
2008	87.9	2136	2.95	2.95	2.18

*Because the inflow prediction equation results in a negative mine inflow for 2001, the mine inflow is conservatively set to the next lowest inflow (2003).

Table 2. Estimated Monthly Discharges at Mine Adit Elevation 4225 ft.

	Estimated Monthly Discharge (cfs)									
Month	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Oct	0.17	0.90	0.00	2.62	0.00	1.31	0.02	0.35	0.43	1.21
Nov	0.64	1.37	0.06	3.09	0.06	1.78	0.49	0.82	0.90	1.68
Dec	0.33	1.07	0.00	2.79	0.00	1.48	0.19	0.52	0.60	1.37
Jan	1.09	1.82	0.51	3.54	0.51	2.23	0.94	1.27	1.35	2.13
Feb	0.85	1.58	0.28	3.30	0.28	1.99	0.70	1.03	1.11	1.89
Mar	0.72	1.46	0.15	3.17	0.15	1.87	0.58	0.91	0.99	1.76
Apr	1.51	2.24	0.94	3.96	0.94	2.65	1.36	1.69	1.77	2.55
May	2.85	3.58	2.27	5.30	2.27	3.99	2.70	3.03	3.11	3.89
Jun	3.70	4.44	3.13	6.16	3.13	4.85	3.56	3.89	3.97	4.74
Jul	1.73	2.46	1.15	4.18	1.15	2.87	1.58	1.91	1.99	2.77
Aug	0.52	1.25	0.00	2.97	0.00	1.66	0.37	0.70	0.78	1.56
Sep	0.00	0.36	0.00	2.07	0.00	0.77	0.00	0.00	0.00	0.66

The estimated monthly discharges presented in Table 2 do not account for the water that originates in that portion of the service adit below the high point of 4,225 ft. or a corresponding high point in the conveyor adit. These adit discharges have been measured semi-annually by the mine operator from July 2005 to February 2008 using weirs. The flows vary relatively little with the average February flow of the two adits being 0.67 cfs and the average July flow being 0.74 cfs. The 0.67 cfs flow was applied to the months of August through March, and the

0.74 cfs flow was applied to the months of April through July, resulting in the total estimated mine discharges shown in Table 3.

Table 3. Estimated Monthly Total Mine Discharges (QM_{yrx})

	Estimated Total Mine Discharge (cfs)									
Month	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Oct	0.84	1.57	0.67	3.29	0.67	1.98	0.69	1.02	1.10	1.88
Nov	1.31	2.04	0.73	3.76	0.73	2.45	1.16	1.49	1.57	2.35
Dec	1.00	1.74	0.67	3.46	0.67	2.15	0.86	1.19	1.27	2.04
Jan	1.76	2.49	1.18	4.21	1.18	2.90	1.61	1.94	2.02	2.80
Feb	1.52	2.25	0.95	3.97	0.95	2.66	1.37	1.70	1.78	2.56
Mar	1.39	2.13	0.82	3.84	0.82	2.54	1.25	1.58	1.66	2.43
Apr	2.25	2.98	1.68	4.70	1.68	3.39	2.10	2.43	2.51	3.29
May	3.59	4.32	3.01	6.04	3.01	4.73	3.44	3.77	3.85	4.63
Jun	4.44	5.18	3.87	6.90	3.87	5.59	4.30	4.63	4.71	5.48
Jul	2.47	3.20	1.89	4.92	1.89	3.61	2.32	2.65	2.73	3.51
Aug	1.19	1.92	0.67	3.64	0.67	2.33	1.04	1.37	1.45	2.23
Sep	0.67	1.03	0.67	2.74	0.67	1.44	0.67	0.67	0.67	1.33

Climatic Data at the Tailings Pond

Precipitation data were taken from the Troy, MT weather station 248390 (Western Regional Climate Center 2009). This station is located 9.5 miles north of the tailings facility at an elevation of 1929 ft. It has 48 years of record. The elevation of the tailings ponds is about 2,400 feet, somewhat higher than Troy, so increased precipitation might be expected at this site. However, without local information, the Troy weather station data cannot be reliably adjusted to the site.

Five years of pan evaporation data, 1963-1967, are available from the tailings facility (Genesis, Inc. 2008). To estimate the evaporation amounts for the period 1999-2008, the record was extended using data from Station 4328 at Hungry Horse Dam near Columbia Falls, MT. This station is located at an elevation of 3,160 feet. Fifty-eight years of pan evaporation data, 1948 to 2007, are available from the National Climatic Data Center. The data from the tailings facility were compared to the evaporation values at Hungry Horse Dam and a correction factor was created. Before using the corrected data, a coefficient of 0.75 was applied to the data to adjust for the increased energy and therefore increased evaporation experienced in an evaporation pan as opposed to a lake or pond (Haan et al, 1994).

Average annual precipitation at the Troy, MT weather station is 24.5 inches for the period 1960-2009. November and December are the wettest months and July and August are the driest. Average annual adjusted evaporation is 15.7 inches. The greatest evaporation is generally experienced in August.

In most years, precipitation will exceed evaporation. Therefore, if the area of disposal ponds is increased, any accelerated loss of water due to evaporation will more than be compensated for by increased precipitation, and larger pond areas would not equate to greater disposal of water.

Estimation of Infiltration Rate

There are several sources of information on infiltration rates in the vicinity of the tailings ponds including estimates of seepage from the ponds as well as measurements of the hydraulic conductivity of the underlying materials in the vicinity of the ponds. Seepage was estimated in the Operating Plan (Asarco, 1976) to range between 292 and 803 gallons per minute (gpm), whereas the Draft Environmental Impact Statement (USFS-DSL, 1978) estimated 1,170 gpm. The Tailing Impoundment Design and Operation report (Pfahl, 1989) estimated seepage at 845 gpm based on a simplified water balance. Unfortunately, insufficient information is provided to determine the area over which seepage calculations occurred. Without this information, it is not possible to calculate infiltration on a unit area basis. In Alternatives 2 and 3, the current decant pond would be used to dispose of the mine discharge. This may be a reasonable solution if the bottom of the decant pond is not sealed by slimes. Alternatively, a new pond could be excavated directly in native materials and used to dispose of the discharge water. An estimate of infiltration rate based on hydraulic properties of the native materials is appropriate in the analysis of long-term water disposal options.

The Interim Report of Findings Hydrologic and Hydrogeologic Assessment prepared by Summit et al (1996) offers the most comprehensive data for the materials underlying the tailings pond area. This report includes logs from ten test borings, seven monitoring wells and seven sandpoints in the vicinity of the tailings ponds. Data from a hydraulic conductivity test and other information related to infiltration rates are presented. The Summit report measured a hydraulic conductivity of 8.4 feet per day using a well in the middle of the tailings pond and one just below the pond berm. The boring logs from these wells and other wells in the area indicated the unit measured was primarily fine sand. This hydraulic conductivity value is within the expected range for sandy materials.

In November of 1995, ASARCO personnel decreased the flow rate to the decant pond for seven days. During this time, Summit reported a 4.5 foot drop in water levels in the decant pond. The report does not state the amount that the flow rate was decreased or whether flow ceased altogether, so it is not possible to calculate an exact infiltration rate from this information. However, a 4.5 foot drop in water level over the area of the decant pond for a seven-day period equates to a rate of infiltration of 0.64 feet per day and provides a potential pond infiltration rate.

Further data on the infiltration rate at the decant ponds was obtained in 2001 during a tracer test conducted by Hydrometrics (2001). During a period of low mine water discharge, all discharge to the decant ponds was suspended and a 24-day salt tracer test was conducted.

During this period, the ponds dropped at a typical rate of about 0.4 feet per day, somewhat lower than the rate determined in the 1995 study. The infiltration rates used in our analyses vary from 8.4 feet per day for good infiltration conditions to a minimum of 0.4 feet per day.

Water Balance at the Tailings Pond

Precipitation on the surface of the tailings and mine water delivered to the decant ponds are the major input values for a water balance calculation at the tailings facility. The primary outputs are seepage and evaporation from the decant ponds. The general equation used to determine the change (Δ) in storage of water at the decant ponds or tailings impoundment is as follows:

$$\Delta Storage = Precipitation + Mine\ Discharge - (Evaporation + Seepage)$$

Because information on the size of the proposed disposal facilities is not included in the proposed Alternatives, the procedure followed in this analysis was to set the size of the proposed disposal facility based on the other inputs to the model. For simplicity, it was assumed that an infiltration pond of a certain area had a capacity of 10 feet of water and vertical sides. This approximate design would need to be revised based on site conditions and other factors during implementation of the pond disposal alternative. In the model input, the pond area was varied to determine at what size the pond would overflow at some time under the 10-year climatic record.

An initial model run was undertaken with the assumption that the hydraulic conductivity of the underlying materials at the site was 8.4 feet/day, a value derived from aquifer tests by Summit et al (1996). A review of the well logs in the vicinity of the east edge of the tailings pond indicates that ground water would be located about 50 feet below the pond bottom. This information was inserted into Darcy's equation to translate the hydraulic conductivity into an infiltration rate:

$$v = k\,i$$

where v = the Darcy velocity
k = hydraulic conductivity (ft/day) and
i = the gradient.

To calculate the gradient, the following terms are defined:

h_A = the height of the pond bottom above the aquifer in feet, and
h_W = the depth of water in the pond in feet.

For vertical flow, the gradient, i, is the total head ($h_A + h_w$) divided by the length of the media through which it passes (h_A) or, for 50 foot separation from the aquifer:

$$i = (h_A + h_w)/ h_A$$

$$i = (50 + h_w)/50$$

Referring to the spreadsheet model "Water Management" and work sheet "1.6-acre Pond" on the attached compact disc, for a pond with a maximum depth of 10 feet, the infiltration rate will vary from 8.4 to 10.1 ft/ft^2 – day. Because of the depth to the aquifer is large, the amount of water in a pond with a maximum 10-foot depth does not have a great effect on the magnitude of the infiltration rate. Running the model with various-sized ponds and the precipitation rates for the period of record shows that a 1.6-acre pond that is 10 feet deep would not overtop. Note that the model indicates the pond only fills with water during the wettest portion of 2002, which was the wettest year in the period of record. In part, this is because the infiltration rate modeled (at least 403 acre-feet for a 30-day month) is sufficiently high to accommodate the mine discharge rate, which only averaged 292 acre-feet. Neither precipitation nor evaporation exceed one acre-foot per month, and are almost inconsequential in this calculation. Only when mine inflows exceed those of June 2002 does the model predict the 1.6-acre pond would fill.

It is likely that the high infiltration rate used in the preceding calculation will not be realistic, at least in the long term, due to siltation or vegetation accumulating in the pond. Although pond maintenance should minimize these effects, it is still probable that some decrease in performance will be experienced over time. Therefore, a spreadsheet calculation was also developed to size a pond for the minimum infiltration rate of 0.4 ft per day reported in 2001 by Hydrometrics. Referring to the spreadsheet model "Water Management" and worksheet "23-acre Pond" on the attached compact disc, at this lower infiltration rate, a 23-acre pond is required to prevent overtopping a 10-foot deep pond. For this pond configuration, the model indicates the pond would hold water during early summer in four of the wet years, 2000, 2002, 2004 and 2008. Although the effects of precipitation and evaporation are somewhat more important with a larger surface area pond, they are still generally less than 10 acre-feet per month with minor effects on the calculation.

Implementation

The calculations presented in the previous section suggest that disposal of water through use of a pond is feasible given the transmissive quality of the underlying soils. Even a 23-acre pond would be quite feasible to construct, although it would have significant maintenance requirements. Because the existing 4-acre decant pond system has successfully infiltrated excess mine water during operations, it is expected that this same facility can continue to handle mine discharge water after mine closure. Normally these ponds infiltrate about 2,500 gpm (5.6 cfs) and have infiltrated 3,000 gpm (6.7 cfs), which is nearly the maximum design flow assumed in this memorandum (6.9 cfs) (personal communication, Doug Parker, Hydrometrics, June 16, 2010). If the existing ponds are maintained with a depth of about 10 feet, are gravel lined to increase infiltration, and vegetation growth is controlled, the infiltration rate

should be maintained. The infiltration ponds would need a berm constructed around them to prevent storm water from flowing into them.

Summary

This memorandum presents an analysis of the expected feasibility of mine water disposal in the vicinity of the tailings ponds. Based on previous work, the mine will discharge an average of 2.1 cfs from its adits after pumping ceases and water reaches the overflow elevation of the adits. Flows are expected to range from 0.67 cfs to 6.90 cfs with the largest discharges generally expected in the months of May and June in relatively wet years.

A spreadsheet water balance model was developed for the water disposal pond and used to evaluate 10 years of discharge and climatic data including precipitation, evaporation, and infiltration. The infiltration rates modeled were based on an aquifer test performed at the tailings pond and an observation of infiltration rates at the decant pond. It is not known how representative these data are of the soil conditions in the area. A range of pond sizes, depths, and infiltration rates was modeled using actual discharge plus precipitation rates. The various pond designs were sufficient to contain all expected inflows during the 10-year evaluation period. An important conclusion of this analysis is that the pond size is almost entirely dependent on the magnitude of the mine water discharge and infiltration rate of the subsurface, and relatively unaffected by precipitation and evaporation.

Water disposal ponds sized from 1.6 to 23 acres are feasible to build and maintain. The current decant ponds, which are about 4 acres in size fall within the modeled range of sizes. These ponds have successfully infiltrated the mine discharge for the period of operation of the mine and, with proper maintenance, should continue to infiltrate the discharges expected post closure. To prevent plugging of the ponds and ensure they are not overwhelmed with storm water runoff, berms should be constructed around the ponds to exclude entry of storm water runoff from the surrounding area.

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Appendix D
Troy Mine Metals Attenuation Study-
Secondary Processes

Department of Environmental Quality

Troy Mine
Copper Attenuation Study – Secondary Processes

July 8, 2010

Final

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Section 6 References

Attachment 1 Analytical Reports
Attachment 2 Photographs

Section 1
Introduction

The fate of the copper, antimony, lead, uranium, arsenic, cadmium, and other metals within the waters discharged to the decant pond is of great interest, as one of the alternatives is to discharge the mine water to the decant pond and to allow natural attenuation mechanisms to remove the metals from solution. Currently (during active operation of the mine), Genesis is using the decant ponds to settle out suspended sediment from the tailings slurry which is piped from the mill. The decant water is then pumped to the mill circuit via a return line. The system is currently semi-closed in that some, but not all of the water is recirculated. As the decant ponds are not lined, some of the decant pond water seeps through the bottom of the pond into the underlying aquifer.

In 2001 Hydrometrics conducted a tracer study in which sodium chloride (salt) was added to the decant ponds (Hydrometrics, 2001). The migration of the salt into the underlying and downgradient groundwater was then monitored by measuring the conductivity within the existing wells. The report concluded that while the deep wells and decant ponds appear to be hydraulically connected, the response time is long, suggesting that the decant water is transported predominantly within shallow sand and gravels above the zone of the then existing wells. Shallow monitoring wells were installed as part of the study.

While the decant pond water appeared to be traveling downgradient of the ponds within the shallow alluvial system, the copper concentrations in the shallow wells were either below the laboratory reporting limit or were significantly lower than in the decant pond water, suggesting that the copper was being removed via some geochemical process. In 2004, a study was conducted in order to determine the fate and transport of copper beneath the decant ponds (Land and Water, 2004). The soil beneath the decant ponds was analyzed for total copper as well as electron microprobe and sequential extraction analyses. The results indicated that copper was attenuated within the upper foot of soil via the precipitation of secondary copper phases (carbonates, silicates, and oxides) as well as adsorption onto organic matter.

Because it is not certain whether the attenuation mechanism(s) occurring within the sediments below the decant pond would have a finite duration or would perpetually precipitate copper within or immediately beneath the pond, the agencies determined that testing should be conducted to evaluate secondary attenuation processes which may occur if copper migrates beyond the decant pond and mixes with downgradient groundwater. The investigation was expanded to include other metals in addition to copper.

The evaluation consisted of two parts;

1) Initial geochemical modeling using analyses of the groundwater downgradient of the decant ponds, decant pond water, and mine water to determine if iron hydroxide is predicted to precipitate. Mixing of the decant pond water with the groundwater simulates the current situation during active mining, where mill water would mix with groundwater. In order to simulate a second, post closure scenario, mine water was mixed with groundwater.

2) Jar testing to determine the fraction of metals removed during precipitation of iron hydroxide.

Section 2
Modeling Methodology

A geochemical model, PHREEQC (Parkhurst and Appelo, 1999), was used to predict the geochemical reactions that will occur in response to mixing mine water (decant water) with the native groundwater downgradient of the toe ponds. PHREEQC is a thermodynamic equilibrium program designed to model chemical speciation in aqueous solutions, determine the saturation states of solutions with minerals and gases, and predict the results of various reactions, such as dissolution of minerals and oxidation.

The modeling shows which phases or minerals are predicted to become supersaturated (if any) as a result of mixing of the waters. Minerals that are supersaturated would eventually precipitate (assuming the mineral forms at low temperature) as equilibrium is established.

2.1 Water Analyses Internal Consistency Evaluation

The analyses were checked for internal consistency using both charge balance and mass balance relationships. Any solution containing a mixture of positively and negatively charged ions must have an overall charge balance of zero (the sum of the negative ions must equal the sum of the positive ions). If an analysis reported by a lab does not have a calculated charge balance near zero, then it indicates either that one or more errors have occurred in the analysis and/or that ions are present that were not analyzed for.

By evaluating both the mass balance and charge balance, conclusions can be drawn about the accuracy and completeness of the analyses. The possible mass balance and charge balance combinations and the corresponding interpretations are shown in **Table 2-1.**

The charge balance was calculated from the lab analyses as follows:

$$(\Sigma(\text{Cations x charge}) - \Sigma(\text{Anions x charge}))/ (\Sigma(\text{Cations x charge}) + \Sigma(\text{Anions x charge})) \times 100\% \quad (2\text{-}2)$$

Where "cations" refers to the molar concentration of positively-charged ions (moles/L) and "anions" to the molar concentration of negatively-charged ions.

Mass balance is the comparison of the total mass of constituents in solution measured by an analysis called "total dissolved solids" (TDS-Measured) compared to a summation of all the constituents measured in each individual analysis (TDS-Calculated). TDS is determined by evaporating a measured volume of the solution to dryness and weighing the residual salts. Again, if the measured TDS is different from the calculated TDS, either some parameter is missing or there is an error in the analysis.

The mass balance was calculated using the following relationship:

TDS-Calculated /TDS-Measured (2-3)

TDS was calculated by summing the concentrations of all species in mg/L. Adjustments were made in cases where the species that would be formed upon evaporation were in a different form than that provided by the laboratory. For instance, silicon reported as "Si" (atomic mass = 28.09 g/mole) was converted to "SiO_2" (atomic mass = 60.09 g/mole) using the factor 2.14 (60.09g/mole / 28.09 g/mole = 2.14). In addition, the bicarbonate concentration was multiplied by a factor of 0.49 to account for loss of carbon dioxide gas during evaporation.

Table 2-1 – Interpretation of Charge and Mass Balance Results

TDS-Calculated/ TDS-Measured	Charge Balance	Interpretation[1]
>1	Positive	Cations are over-reported
>1	Negative	Anions are over-reported
<1	Negative	Cations are under-reported and/or one or more important cations were not analyzed
<1	Positive	Anions are under-reported and/or one or more important anions were not analyzed

1. Note that the interpretation represents the least complex explanation. In some cases, multiple problems with an analysis may have caused the inconsistencies.

The acceptability criteria for the internal consistency checks are reported in **Table 2-2**.

Table 2-2 Chemical Analysis Acceptability Criteria

Test	Criteria
Charge Balance	+-10%
Calculated TDS/Measured TDS	0.9-1.1

The wells used to represent the downgradient groundwater were selected by looking at the chemistry, particularly the iron content within the water (see Section 3). A summary of the waters used in the modeling is provided in **Table 2-3**

Table 2-3 – Summary of Water Samples Used for PHREEQC Geochemical Modeling – EPA Column Experiment.

Sample ID	Date Sampled	Notes
Decant 1	5/14/09	Decant pond
MW-01-15	5/13/09 6/08/09[1]	Well along southern edge of the decant pond. Screened at a depth of approximately 40 feet below ground surface (bgs).
MW 95-4[2]	5/12/09	Well located just north of the southernmost toe pond (in between ponds). Screened at a depth of approximately 15 feet bgs.
MW 95-5[2]	5/12/09	Located downgradient of the toe ponds and screened at a depth of approximately 10 feet bgs.

1. Resampled for dissolved copper due to a suspected laboratory error.
2. Completed at or near the groundwater table within a sand and gravel zone.

The internal consistency checks of the data along with the chemical data used in the modeling are shown in **Table 2-4.**

Table 2-4 – Summary of analytical data Used in the PHREEQC Modeling (mg/L dissolved unless noted otherwise)

Parameter	Decant 1	MW-01-15	MW 95-4	MW 95-5
Date Sampled	5/14/09	6/08/09	5/12/09	5/12/09
Temperature (°C)	9.5	14.1	8	8.8
pH-Lab	7.6	7.5	6.5	5.9
pH-Field	7.45	7.3	7.3	6.04
Total Alkalinity (as $CaCO_3$)	82	85	77	31
Chloride	4	4	1	<1
Sulfate (as SO_4)	33	41	111	3
Sulfide	0.04	<0.04	0.22	<0.04
Ammonia (as N)	6.0	3.64	3.72	<0.05
Nitrite + Nitrate (as N)	17.6	14.5	0.02	0.09
Phosphorous (as P)	0.134	0.025	0.014	0.016
Arsenic	0.002	<0.001	0.002	<0.001
Antimony	0.046	0.029	<0.003	<0.003
Barium	0.097	0.107	0.114	0.016
Cadmium	0.00089	0.00136	0.00093	0.00089
Calcium	17	23	29	6
Copper	0.028	0.009[2]	<0.001	0.002
Iron	0.06	<0.05	7.84	0.18
Lead	0.0026	<0.0005	<0.0005	<0.0005
Magnesium	4	5	8	1
Manganese	0.554	0.467	2.43	0.457
Potassium	27	23	17	5
Silica	8.5	11.4	46.4	60.8
Sodium	31	32	13	5
Uranium	0.0029	0.0018	<0.0003	<0.0003
Conductivity (µmhos/cm)	427	405	445	82
TDS Measured	305	247	292	97
TDS Calculated	259	259	286	100
Charge Balance (%)[1]	-0.44	1.59	-1.93	2.71
TDS-C/TDS-M	0.85	1.05	0.98	1.03

1. Calculated using PHREEQC.

2. Re-sampled due to an apparent lab error.

The results indicate that all of the waters meet the chemical analysis acceptability criteria with the exception of Decant 1, which has a mass balance which is out of range. As the charge balance is very good, the error could simply be an over-reporting of the TDS analysis, which would have no impact on the modeling. There may also be a neutral species that was not included within the analysis, but this would have minimal impact on the modeling

2.2 PHREEQC Thermodynamic Database

The PHREEQC database is provided as a starting point and often new phases need to be added to address specific modeling requirements. The thermodynamic database used by PHREEQC was supplemented to include several additional iron phases. The phases that were added and the thermodynamic data used are shown in **Table 2-5**.

Table 2-5 - Summary of Thermodynamic Data Added to the PHREEQC Database

Phase	Reaction	Log Ksp	ΔHr° (kcal)
Troilite	Fe^{+2} (aq) + S^{-2} (aq) → FeS (troilite)	19.1	-10.9
Pyrite	Fe^{+2} (aq) + S^{0} (aq) + S^{-2} (aq) → FeS_2 (pyrite)	29.3	-27.6
Marcasite	Fe^{+2} (aq) + S^{0} (aq) + S^{-2} (aq) → FeS_2 (marcasite)	28.6	-26.6
Mackinawite	Fe^{+2} (aq) + S^{-2} (aq) → FeS (mackinawite)	17.6	-8.5
Mackinawite (alkaline)[1]	Fe^{+2} (aq) + HS^{-} (aq) → FeS (mackinawite) + H^{+}	-3.5	-
Greigite	Fe^{+2} (aq) + 2 Fe^{+3} (aq) + 4 S^{2-} (aq) → Fe_3S_4 (greigite)	90.4	-57.4
Magnetite	$3Fe^{+2} + 4H_2O \rightarrow Fe_3O_4 + 8H^{+} + 2e^{-}$	-45.8	-
Lepidocrocite	$Fe^{+2} + 2H_2O \rightarrow$ γ-FeOOH + $3H^{+} + e^{-}$	-16.7	-

1. "alkaline" refers to the solubility of the mackinawite phase which forms at pH>7 (Rickard, 2006)

More common phases, such as hematite were already included in the PHREEQC database and are not included in **Table 2-5**. Pyrite was in the PHREEQC database, but only the solubility constant (log Ksp) was provided. The log Ksp was recalculated, along with the enthalpy (**ΔHr°**) to make sure the data were consistent.

2.3 Oxidation-Reduction Potential (ORP)

The oxidation-reduction potential (ORP) of the solution (also referred to as "Eh") is one of the most important parameters for geochemical modeling, but is also one of the most difficult to accurately measure.

Eh was calculated several ways for potential use in the modeling, including the following:

- From the platinum electrode measurements collected in the field
- From the sulfate/sulfide redox couple
- From the nitrite/ammonia redox couple

ORP Calculation Methods

Oxidation reduction potential (ORP) is used by the PHREEQC model to determine the relative proportions of the parameters that have more than one oxidation state in solution. For example iron can exist in solution as ferric iron (Fe^{+3}) or as ferrous iron (Fe^{+2}). The ORP can be directly measured using a platinum electrode, which has several problems, including interferences by sediment, certain ions, or dissolved organic matter. Lindberg and Runnels (1984) recommend evaluating the redox couples within a solution, such as sulfate/sulfide, ferrous iron/ferric iron, or nitrate/nitrite to determine the ORP and if the system is in redox equilibrium. Often, the Eh measured by the platinum electrode is a mixed potential resulting from multiple redox couples. The Eh can be calculated for each redox couple and compared. The system can be considered in redox equilibrium only when the Eh determined from each couple is the same. A summary of Eh values calculated using various methods along with dissolved oxygen (DO) values for comparison is presented in **Table 2-6**. The ferric/ferrous couple was not used due to the very low aqueous concentrations of ferric iron at low Eh and near-neutral pH. Obtaining ferric iron by difference (subtracting ferrous iron from total iron) could not be performed due to the low concentration of dissolved ferric iron in these systems (dissolved ferrous and total iron are essentially identical) and the error in the analytical techniques. Dissolved oxygen (DO) concentrations are listed in the table for comparison.

Table 2-6 Summary of Eh Values Calculated Using Different Methods

Parameter	Decant 1	MW-01-15	MW 95-4	MW 95-5		
$Eh_{Pt\ Electrode}$ (mV)	397	351	272	397		
$Eh_{SO4-2/S-2}$ (mV)	-200	>198[2]	-183	>-110[2]		
$Eh_{NO2-/NH4+}$ (mV)[1]	347	349	336	>452[3]		
DO (mg/L)	8.90	4.35	0.18	1.77		

1. The assumption was made that nitrate+nitrite = nitrite

2. Using the detection limit of 0.04 mg/L for sulfide, so the Eh can be considered a minimum.

3. Using the detection limit of 0.05 mg/L for ammonia, so the Eh can be considered a minimum

Eh Pt electrode = The Eh as determined using the platinum electrode

$Eh_{SO4-2/S-2}$ = The Eh calculated from the sulfate/sulfide couple

$Eh_{NO2-/NH4+}$ = The Eh calculated from the nitrite/ammonia couple

A comparison of the Eh values indicates that in general, the waters are not in redox equilibrium. For instance, well MW 95-4 contains both significant sulfide (a reduced form) and nitrite or nitrate (an oxidized form), which would not occur together under equilibrium conditions. The decant water contains significant concentrations of both ammonia and oxygen. Given enough time, the ammonia will be oxidized by the DO, producing nitrite and/or nitrate and water.

Section 3
Geochemical Modeling Results

3.1 Mineral Saturation States

The PHREEQC model uses a term called the saturation index (SI) to quantify the degree of saturation of a mineral. SI is defined as follows:

$$SI = Log\ (IAP/Ksp) \qquad (3\text{-}1)$$

Where IAP is the ion activity product and Ksp is the solubility product constant for the phase in question. For phases at saturation, IAP=Ksp and SI = 0. A negative SI indicates that the phase is unsaturated (IAP<Ksp) while a positive SI (IAP>Ksp) indicates the phase is supersaturated. In practice, a range of 0±0.5 SI units is considered saturated due to uncertainties in analytical and thermodynamic data (Hem, 1970). In the present study, a value of 0±1.0 SI units was used to allow for additional uncertainties in the redox measurements and Eh calculations.

The mineral saturation states for the unmixed waters are provided in **Table 3-1**.

Table 3-1 – Summary of Saturation Indices (SIs) Determined Using PHREEQC

Phase	MW 95-4	MW 95-5	MW-01-15	Decant 1
Barite ($BaSO_4$)	0.85	-1.30	0.35	0.33
Poorly Ordered Mackinawite (FeS)	0.68	-2.93	-2.94	-3.21
Alkaline Mackinawite (FeS)	0.68	-	-3.13	-3.26
Amorphous $Fe(OH)_3$	-	0.90	**1.76**[1]	**2.48**[2]
Siderite ($FeCO_3$)	0.62	-2.51	-3.01	-3.35
Vivianite ($Fe_3(PO_4)_2$ $8H_2O$)	-0.31	-8.94	-10.96	-10.32
Rhodochrosite ($MnCO_3$)	0.42	-1.78	-0.13	0.01
Amorphous Silica (SiO_2)	-0.25	-0.14	-0.92	-1.00

1.Supersaturation likely due to using half the reporting limit for the iron concentration (0.025 mg/L)

2.Supersaturation likely due to uncertainties in the reported iron concentration (0.06 mg/L) so close to the reporting limit of 0.05 mg/L

Bold indicates supersaturated phases

Shaded cells represent phases at equilibrium (SI=0±1 SI unit)

Minerals that are at saturation (SI = 0 ± 1) are in equilibrium and will not precipitate or dissolve unless the geochemical conditions are changed. Supersaturated solutions (SI >1) are predicted to precipitate, while undersaturated phases (SI<1) are predicted to dissolve (if present).

In addition to the minerals shown above, other minerals which were not included in the thermodynamic database are possible. For example, there is field evidence for the presence of the mineral delafossite ($CuFeO_2$), based on the work conducted by Land and Water (2004).

Ferrous Iron Minerals

Ferrous iron minerals have the capacity to coprecipitate copper. The high pH mackinawite phase investigated by Rickard (2006) which has been named "alkaline mackinawite" for the purposes of this report was only included for sites which had pH values greater than 7 (MW 95-4, MW-01-15, and Decant 1).

Well MW 95-4 is at saturation with respect to the iron monosulfide mackinawite, as well as siderite, and vivianite, all of which are ferrous iron (Fe^{+2}) minerals. The other waters, being more oxidized are undersaturated with respect to the ferrous iron minerals.

Amorphous Silica

Amorphous silica is at saturation for all of the waters analyzed. However, silica does not typically incorporate copper into precipitates except as inclusions of other phases, such as iron oxyhydroxides or sulfides.

Barite

Barite is at saturation in all of the waters except for well MW 95-5. Barite does not typically coprecipitate metals such as copper.

Rhodochrosite

Rhodocrosite is at saturation in all of the waters except for MW 95-5. Rhodochrosite likely does not incorporate copper into the crystal structure of the mineral to a great extent as divalent copper and divalent manganese have significantly different ionic radii (71 picometers [pm] for divalent copper vs 80 pm for divalent manganese). However, as the ionic radii are within 30% of each other limited substitution of copper for manganese in the mineral structure may be possible according to "Goldschmidt's Rules."

Amorphous $Fe(OH)_3$

Amorphous $Fe(OH)_3$ is calculated to be at saturation in well MW 95-5 and is supersaturated for well MW-01-15 and Decant 1. The supersaturation of MW-01-15 is likely due to the use of half the reporting limit for the iron concentration. For Decant 1, the iron concentration may be in error, as the value reported is close to the reporting limit, where instrument "noise" is usually significant. Instrument noise is the fluctuation in laboratory results as the limitations of the analytical method are approached. In th case, the error is minimal, as supersaturation or saturation of amorphous $Fe(OH)_3$ are both indications that the mineral is present in the system already or will precipitate given enough time.

Another explanation for the supersaturation of amorphous $Fe(OH)_3$ is that fine particulate iron is being included in the dissolved analysis. Studies have shown that very fine grained particulate matter (less than 0.45 microns in diameter) can pass through the filters. During processing (digestion) of the sample the fine particles dissolve and are included as part of the dissolved fraction of iron.

Comparison of Historic Iron Concentrations

As the presence of iron in the groundwater is important for the removal mechanism being investigated, a review of the historic iron concentrations within the groundwater was conducted. In May 2009, well MW 95-5, had surprisingly low iron compared to the March 2001 analysis where a concentration of 36 mg/L was measured. **Figure 1** shows that both wells MW 95-4 and MW 95-5 have had large variations in dissolved iron concentrations since 1995. The decrease in iron concentration in MW-95-5 from 36 mg/L to 0.08 mg/L in April 2003 and 0.18 mg/L in May 2009 was likely due to oxidation of the iron by decant water, infiltration, or dust control irrigation. It appears that the downgradient groundwater at times is influenced by oxygenated water of unknown origin that may be seasonal in nature or the result of changes in decant water influx (i.e. Mine Flooding study from September 2002 through February 2004) or the water balance of the groundwater system.

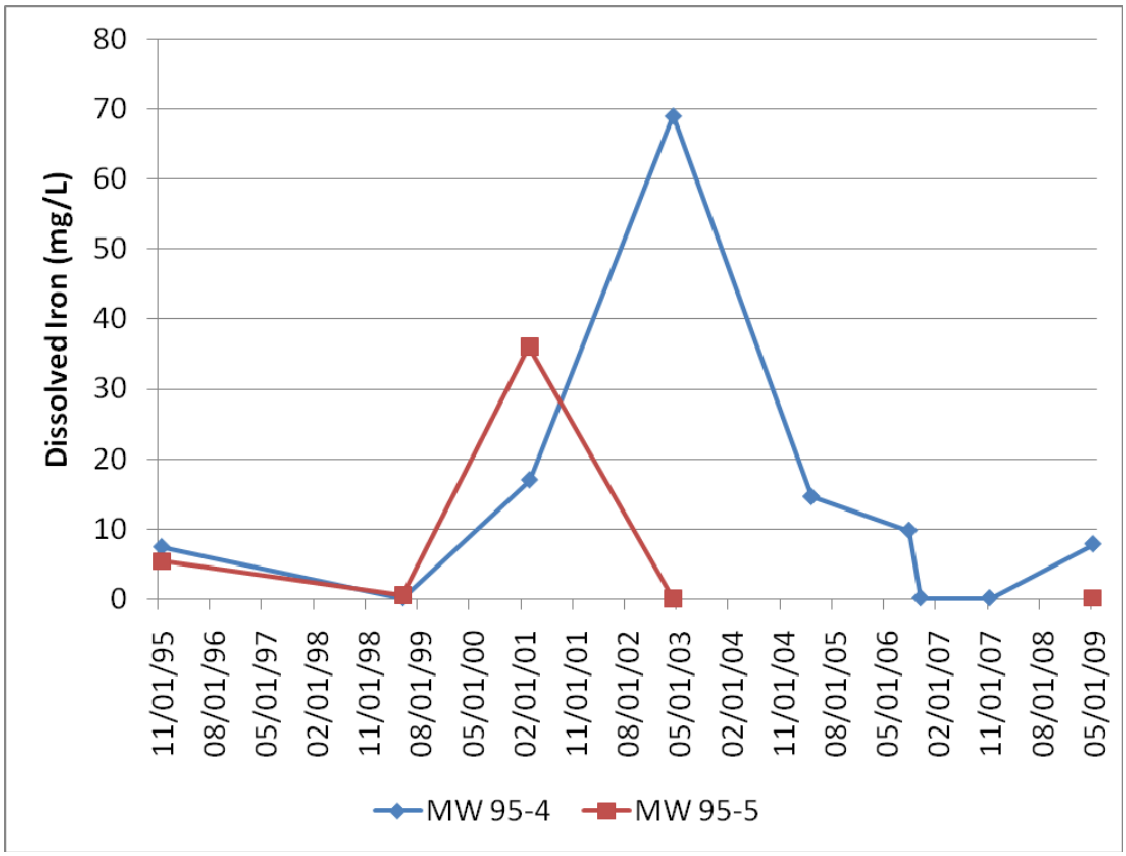

Figure 1 – Variations in dissolved iron concentrations with time for wells MW 95-4 and MW 95-5.

Iron concentrations within wells MW-1, MW-2, and MW-3 have also varied significantly, as shown in **Figure 2**. The inconsistency in the iron concentrations within the downgradient groundwaters may indicate that the secondary removal process is more effective at some times than others due possibly to seasonal processes.

3.2 Mixing Scenarios

Mixing scenarios were modeled using the waters from well MW-01-15 and well MW 95-4 in equal proportions. The decant water was not modeled, as it has the same measured Eh value and an even higher DO concentration than MW-01-15. The mixing ratio was set at 50% for each water as this is the optimal degree of mixing where both iron and DO concentrations are high. At lower fractions of MW 95-4 the iron concentration becomes lower, while at greater fractions the DO (and Eh) becomes lower. The water from well MW-01-15 is beneath the decant ponds and is the water that will eventually travel downgradient to mix with the natural groundwater.

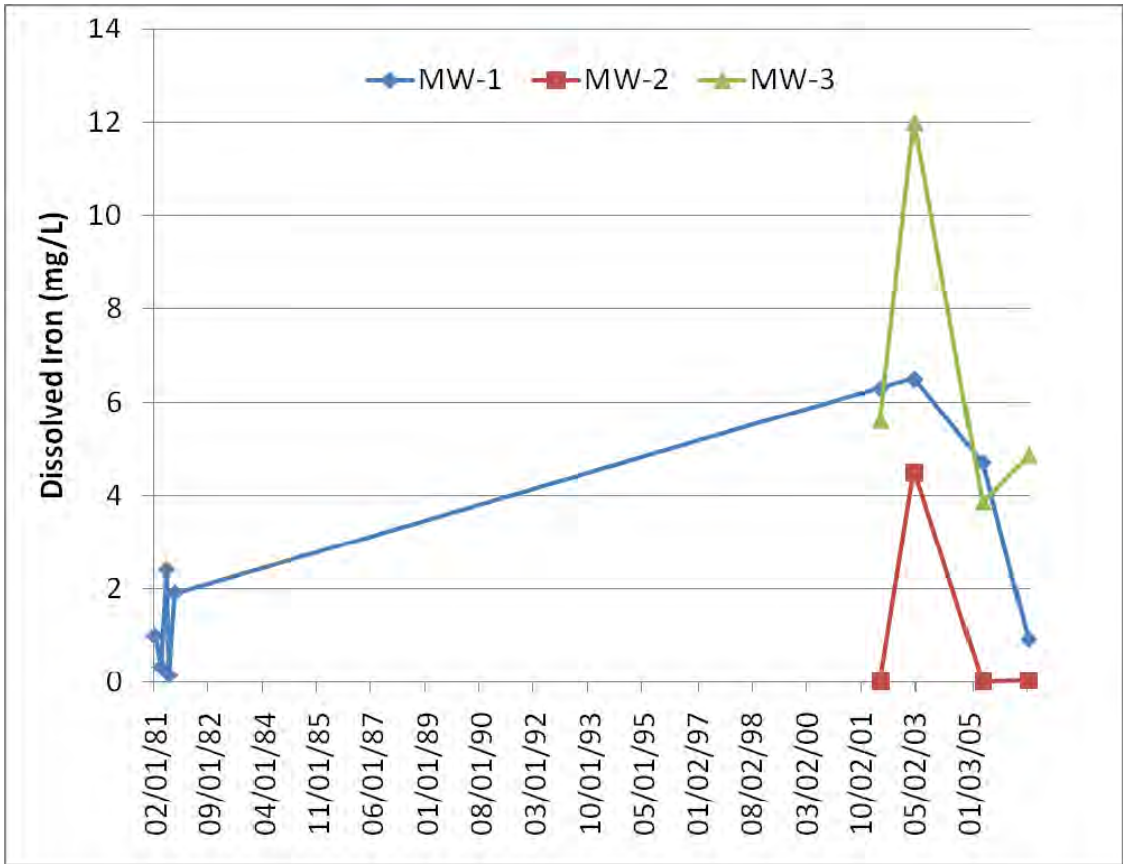

Figure 2 – Variations in dissolved iron concentrations with time for wells MW-1, MW-2 and MW-3

The results of the mixing modeling using three different assumptions to set the Eh of the mixture is shown in **Table 3-2**.

Table 3-2 – Summary of the 50:50 Mixing Simulation Results Using PHREEQC

Scenario	Iron Precipitated as $Fe(OH)_3$	Percent of Iron Precipitated
MW 95-4 and MW-01-15, Assume all of the DO in the mixture reacts with the iron	3.90 mg/L	100%
MW 95-4 and MW-01-15, Assume that the Eh attained by the mixture is the same as for well MW 95-5 (397 mV)	3.90 mg/L	100%
MW 95-4 and MW-01-15, Assume that the final Eh is the average of the two waters mixed (83 mV)	3.87 mg/L	98.3%

The Eh of the mixture had to be set within PHREEQC, as the model does not accurately predict the final Eh of the mixture. The three scenarios were as follows:

- Assume all of the DO in the mixture reacts with the iron – The DO provided by the decant water is allowed to react with any ferrous iron present in MW 95-4. While this makes sense from an equilibrium standpoint, oxygen does not usually attain equilibrium within surface waters.

- Assume that the Eh attained by the mixture is the same as for well MW 95-5 (397 mV) – As it is likely that well MW 95-5 has already undergone mixing, the use of the "final" Eh of a real site water is reasonable. As the mine or decant water is similar to an oxygenated infiltration water in terms of the redox properties, this is a reasonable assumption.

- Assume that the final Eh is the average of the two waters – While this scenario is the least likely of the three, it was included in order to show the result of a lower final Eh. In reality, the Eh of mixed waters is rarely linear as this method implies.

The results show that the mixing of the decant-influenced water (MW-01-15) and the natural groundwater (MW 95-4) results in the precipitation of $Fe(OH)_3$. Should copper from the decant or mine water ever reach the area of MW 95-4, the precipitation of the amorphous ferric hydroxide would likely result in coprecipitation of copper as follows:

$$2x\ Fe^{+3} + 3\text{-}3x\ Cu^{+2} + 6\ OH^{-} \rightarrow Fe_{2x}Cu_{3\text{-}3x}(OH)_6\ (s) \qquad (3\text{-}2)$$

Where "x" is the fraction of iron in the precipitated phase (Other divalent [charge of +2] metals would be removed in a similar fashion). However, the value of x is difficult to predict and determination of the relative fractions of iron and copper in the coprecipitate requires bench-scale testing.

Section 4
Bench-Scale Tests

4.1 Sample Collection

To determine the relative fractions of iron and copper in the coprecipitate, samples were collected for bench-scale testing. Three locations were selected at the Troy Mine site for sampling. To represent post-mining water quality, water was collected underground in the mine behind the Seven East dam. This water was chosen as an appropriate closure mine water surrogate because it was collected in an area of little recent blasting activity evidenced by its relatively low ammonia content (from explosives residues). Mine water would be discharged at closure to the decant pond, which was selected as the second sampling location. The third sample was ground water collected from location MW 95-4, at the farthest downgradient edge of the tailings impoundment.

On December 16, 2009, after meeting with mine personnel and reviewing safety procedures, sampling personnel mobilized to well MW95-4 for sampling. A static water level was collected and then MW 95-4 was purged of approximately 5 well volumes using a disposable bailer. Field water quality readings were collected throughout the purging using a portable water quality meter. After purging the well, a sample was analyzed using field test equipment to check for ferrous iron concentrations in the well water. Results showed approximately 5 mg/L of ferrous iron; this was above the minimum requirement of 2 mg/L, so analytical and jar test samples were collected. Samples collected for laboratory analysis were immediately preserved in the field. The preserved samples would be laboratory analyzed to determine the initial concentrations of metals. An additional volume was collected for jar testing in unpreserved jugs.

The decant pond was sampled next. Due to the cold temperatures and icy conditions, access to the pond was limited to the pump dock. A hole was chipped through the ice to gain access to the pond water. Field readings were collected and then analytical and jar test samples were collected, as before.

Mine water was then collected next from behind the underground dam. Field readings, analytical samples, and jar test samples were collected, similar to the previous locations.

Field notes and photographs were collected during the sampling process, and are attached.

4.2 Jar Test Procedures

Once the sampling was completed, jar tests were performed using the unpreserved samples. A control plus mixtures were selected for testing, as follows:

- Control - 1000 mL MW 95-4 water
- Jar 1 - 250 mL of MW 95-4 water with 750 mL decant water (25% A+ 75% B)
- Jar 2 - 500 mL of MW 95-4 water with 500 mL decant water (50% A+ 50% B)
- Jar 3 - 750 mL of MW 95-4 water with 250 mL decant water (75% A+ 25% B)
- Jar 4 - 250 mL of MW 95-4 water with 750 mL mine water (25% A+ 75% C)
- Jar 5 - 500 mL of MW 95-4 water with 500 mL mine water (50% A+ 50% C)
- Jar 6 - 750 mL of MW 95-4 water with 250 mL mine water (75% A+ 25% C)
- Jar 7 - 500 mL of MW 95-4 water with 500 mL mine water + 20mL 25% hydrogen peroxide [H_2O_2] (75% A+ 25% C + H_2O_2)

The appropriate volumes of each water sampled were added and mixed in each test jar, and then the jars were allowed to react for duration of 20 days (from December 16, 2009 to January 5, 2010).

The mixed samples were allowed to react at room temperature within the uncovered sample jars. After the reaction period, a portion of each test jar was filtered, preserved, and submitted to the lab. Field parameters were again collected from the test jars. The remaining volume from each jar was labeled and archived.

All test jars were photographed prior to and after filtration.

4.3 Results

The results of the jar testing are summarized in **Table 4-1,** while the full analytical reports are provided as Attachment 1.

Table 4-1 - Summary of Jar Test Results

Sample	Description	Antimony (mg/L)	Arsenic (mg/L)	Cadmium (mg/L)	Copper (mg/L)	Iron (mg/L)	Manganese (mg/L)	Uranium (mg/L)	Lead (mg/L)
MW95-4	Field Sample	<0.001	<0.003	<0.00008	0.006	15.5	5.34	0.0005	<0.0005
Decant Pond	Field Sample	0.068	<0.003	<0.00008	0.032	<0.05	0.862	0.0033	0.0008
Mine Water	Field Sample	0.015	<0.003	<0.00008	0.114	<0.05	0.105	0.0011	0.0010
Jar 1	25% MW95-4 75% Decant	0.046	<0.001	0.0001	0.007	0.008	2.17	0.0017	<0.0005
Jar 2	50% MW95-4 50% Decant	0.026	<0.001	0.0001	0.005	0.009	3.49	0.0003	<0.0005
Jar 3	75% MW95-4 25% Decant	0.010	<0.001	0.0002	0.003	0.008	4.86	0.0004	<0.0005
Jar 4	25% MW95-4 75% Mine	0.010	<0.001	<0.0001	0.012	<0.005	1.52	0.0007	<0.0005
Jar 5	50% MW95-4 50% Mine	0.006	<0.001	0.0001	0.005	0.007	2.74	0.0004	<0.0005
Jar 6	75% MW95-4 25% Mine	0.002	<0.001	0.0002	0.003	<0.005	4.47	<0.0003	<0.0005
Jar 7	50% MW95-4 50% Mine w/ H_2O_2	0.007	<0.001	<0.0001	0.002	0.005	2.79	<0.0003	<0.0005
Control	100% MW95-4	<0.001	<0.001	0.0002	0.002	0.009	6.03	<0.0003	<0.0005

The differences in the reporting limit for arsenic were due to the fact that the three initial samples were analyzed using the standard reporting limit used by the laboratory. For all subsequent samples low level arsenic analyses were requested. However, the higher initial reporting limit was not a problem, as all subsequent analyses, including the control were below the low level reporting limit.

Reductions in concentrations of iron, copper, and to a lesser extent, antimony and uranium were observed as a result of mixing mine or decant water with the natural groundwater. Arsenic (as discussed above) and cadmium were below the analytical reporting limit in all three source waters. However, cadmium was detected in several of the mixed samples. As it is impossible to have a concentration in a mixture greater than either of the two component waters, it suggests a laboratory error, which is to be expected at levels so close to the reporting limit.

Due to the effect of dilution when two waters are mixed, the percent removals were calculated from the concentrations that would have resulted as a result of mixing alone (without coprecipitation or adsorption). The results are shown in **Table 4-2**.

Table 4-2 - Metal Removal Efficiency (Factoring in Dilution)

Sample	Antimony - Dilution (mg/L)	Percent Antimony Removal	Copper - Dilution (mg/L)	Percent Copper Removal	Iron - Dilution (mg/L)	Percent Iron Removal	Manganese - Dilution (mg/L)	Percent Manganese Removal	Uranium - Dilution (mg/L)	Percent Uranium Removal
Jar 1	0.051	10.5%	0.0255	72.5%	3.9	99.8%	2.0	-9.5%	0.0026	34.6%
Jar 2	0.035	25.2%	0.019	73.7%	7.8	99.9%	3.1	-12.5%	0.0019	84.2%
Jar 3	0.018	44.8%	0.0125	76.0%	11.6	99.9%	4.2	-15.2%	0.0012	66.7%
Jar 4	0.012	14.0%	0.087	86.2%	3.9	99.9%	1.4	-7.5%	0.0010	26.3%
Jar 5	0.008	27.3%	0.06	91.7%	7.8	99.9%	2.7	-0.6%	0.0008	50.0%
Jar 6	0.005	59.0%	0.033	90.9%	11.6	100.0%	4.0	-10.9%	0.0007	76.9%
Jar 7	0.008	15.2%	0.06	96.7%	7.8	99.9%	2.7	-2.5%	0.0	81.3%
Control	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Greater than 99% of the iron was removed during the 20 day duration of the jar tests, indicating that sufficient time was given to oxidize the ferrous iron to ferric iron and result in precipitation. The red-brown color of the jar tests indicated that iron oxyhydroxides had precipitated (see Attachment 2 for photographs). However, the manganese did not oxidize, even in the sample to which hydrogen peroxide was added (jar 7).

In general, copper was coprecipitated with the iron to a greater extent than antimony or uranium. However, the water of concern for the post-closure scenario would be mine water which had a significantly lower antimony (0.015 mg/L for the mine water vs. 0.068 for the current decant water) and uranium (0.0033 mg/L vs. 0.0011 mg/L) concentrations. An estimated 73-76% of the copper was removed from the decant/groundwater mixtures, with the removal efficiency increasing with increasing fractions of groundwater.

A similar trend was observed for the mine water/groundwater mixtures, although the efficiency was higher, ranging from 92-98% removal. Greater removal efficiencies may be expected at mixtures containing groundwater fractions higher than 75%. This higher groundwater fraction would be expected at the leading edge of any decant water plume containing copper that could hypothetically migrate from the tailings ponds in the future.

Section 5
Conclusions

The results of the modeling and bench-scale testing show that should the initial removal mechanisms documented by Land and Water (2004) to occur beneath the decant ponds become less effective over time, there are additional existing

geochemical mechanisms capable of removing at least 73-98% of the copper, 11-59% of the antimony, and 35-84% of the uranium from groundwater.

Section 6
References

Hem, 1970. *Study and Interpretation of the Chemical Characteristics of Natural Water*. 2nd ed. U.S. Geological Survey Water-Supply Paper 1473.

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Attachment 1
Analytical Reports

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
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ANALYTICAL SUMMARY REPORT

January 28, 2010

Paul Kukay
Genesis Inc.
7000 Asarco Rd
Troy, MT 59935

Workorder No.: H10010040

Project Name: Troy Mine Jar Testing

Energy Laboratories Inc received the following 8 samples for Genesis Inc. on 1/5/2010 for analysis.

Sample ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
H10010040-001	Control - 010410	01/04/10 14:56	01/05/10	Aqueous	Metals by ICP/ICPMS, Dissolved
H10010040-002	Jar1 - 010410	01/04/10 15:02	01/05/10	Aqueous	Same As Above
H10010040-003	Jar2 - 010410	01/04/10 15:10	01/05/10	Aqueous	Same As Above
H10010040-004	Jar3 - 010410	01/04/10 15:16	01/05/10	Aqueous	Same As Above
H10010040-005	Jar4 - 010410	01/04/10 15:25	01/05/10	Aqueous	Same As Above
H10010040-006	Jar5 - 010410	01/04/10 15:30	01/05/10	Aqueous	Same As Above
H10010040-007	Jar6 - 010410	01/04/10 15:35	01/05/10	Aqueous	Same As Above
H10010040-008	Jar7 - 010410	01/04/10 15:40	01/05/10	Aqueous	Same As Above

BRANCH LABORATORY LOCATIONS
eli-b - Energy Laboratories, Inc. - Billings, MT, EPA # MT00005
eli-c - Energy Laboratories, Inc. - Casper, WY, EPA# WY00002
eli-g - Energy Laboratories, Inc. - Gillette, WY, EPA# WY00006
eli-h - Energy Laboratories, Inc. - Helena, MT, EPA# MT00945
eli-r - Energy Laboratories, Inc. - Rapid City, SD, EPA# SD00012
eli-t - Energy Laboratories, Inc. - College Station, TX, EPA# TX01520

SUBCONTRACTING ANALYSIS
Subcontracting of sample analyses to an outside laboratory may be required. If so, ENERGY LABORATORIES, INC. will utilize its branch laboratories or qualified contract laboratories for this service. Any such laboratories are indicated within the Laboratory Analytical Report.

SAMPLE TEMPERATURE COMPLIANCE: 4°C (±2°C)
Temperature of samples received may not be considered properly preserved by accepted standards. Samples that are hand delivered immediately after collection shall be considered acceptable if there is evidence that the chilling process has begun.

ELI appreciates the opportunity to provide you with this analytical service. For additional information, including certifications, and analytical services visit our web page www.energylab.com.

Report Approved By:_____

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc.
Project: Troy Mine Jar Testing
Lab ID: H10010040-001
Client Sample ID Control - 010410

Report Date: 01/28/10
Collection Date: 01/04/10 14:56
DateReceived: 01/05/10
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, DISSOLVED							
Antimony	ND	mg/L		0.001		E200.8	01/08/10 23:35 / dck
Arsenic	ND	mg/L		0.001		E200.8	01/08/10 23:35 / dck
Cadmium	0.0002	mg/L		0.0001		E200.8	01/08/10 23:35 / dck
Copper	0.002	mg/L		0.001		E200.8	01/08/10 23:35 / dck
Iron	0.009	mg/L		0.005		E200.8	01/12/10 01:28 / dck
Manganese	6.03	mg/L		0.005		E200.8	01/09/10 20:32 / dck

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc.
Project: Troy Mine Jar Testing
Lab ID: H10010040-002
Client Sample ID Jar1 - 010410

Report Date: 01/28/10
Collection Date: 01/04/10 15:02
DateReceived: 01/05/10
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, DISSOLVED							
Antimony	0.046	mg/L		0.001		E200.8	01/08/10 23:42 / dck
Arsenic	ND	mg/L		0.001		E200.8	01/08/10 23:42 / dck
Cadmium	0.0001	mg/L		0.0001		E200.8	01/08/10 23:42 / dck
Copper	0.007	mg/L		0.001		E200.8	01/08/10 23:42 / dck
Iron	0.008	mg/L		0.005		E200.8	01/12/10 01:48 / dck
Manganese	2.17	mg/L		0.005		E200.8	01/08/10 23:42 / dck

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc.
Project: Troy Mine Jar Testing
Lab ID: H10010040-003
Client Sample ID Jar2 - 010410

Report Date: 01/28/10
Collection Date: 01/04/10 15:10
DateReceived: 01/05/10
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, DISSOLVED							
Antimony	0.026	mg/L		0.001		E200.8	01/08/10 23:48 / dck
Arsenic	ND	mg/L		0.001		E200.8	01/08/10 23:48 / dck
Cadmium	0.0001	mg/L		0.0001		E200.8	01/08/10 23:48 / dck
Copper	0.005	mg/L		0.001		E200.8	01/08/10 23:48 / dck
Iron	0.009	mg/L		0.005		E200.8	01/12/10 02:36 / dck
Manganese	3.49	mg/L		0.005		E200.8	01/08/10 23:48 / dck

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc.
Project: Troy Mine Jar Testing
Lab ID: H10010040-004
Client Sample ID Jar3 - 010410

Report Date: 01/28/10
Collection Date: 01/04/10 15:16
DateReceived: 01/05/10
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, DISSOLVED							
Antimony	0.010	mg/L		0.001		E200.8	01/09/10 00:43 / dck
Arsenic	ND	mg/L		0.001		E200.8	01/09/10 00:43 / dck
Cadmium	0.0002	mg/L		0.0001		E200.8	01/09/10 00:43 / dck
Copper	0.003	mg/L		0.001		E200.8	01/09/10 00:43 / dck
Iron	0.008	mg/L		0.005		E200.8	01/09/10 00:43 / dck
Manganese	4.86	mg/L		0.005		E200.8	01/09/10 21:39 / dck

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc.
Project: Troy Mine Jar Testing
Lab ID: H10010040-005
Client Sample ID Jar4 - 010410

Report Date: 01/28/10
Collection Date: 01/04/10 15:25
DateReceived: 01/05/10
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, DISSOLVED							
Antimony	0.010	mg/L		0.001		E200.8	01/09/10 00:50 / dck
Arsenic	ND	mg/L		0.001		E200.8	01/09/10 00:50 / dck
Cadmium	ND	mg/L		0.0001		E200.8	01/09/10 00:50 / dck
Copper	0.012	mg/L		0.001		E200.8	01/09/10 00:50 / dck
Iron	ND	mg/L		0.005		E200.8	01/09/10 00:50 / dck
Manganese	1.52	mg/L		0.005		E200.8	01/09/10 00:50 / dck

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc.
Project: Troy Mine Jar Testing
Lab ID: H10010040-006
Client Sample ID Jar5 - 010410

Report Date: 01/28/10
Collection Date: 01/04/10 15:30
DateReceived: 01/05/10
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, DISSOLVED							
Antimony	0.006	mg/L		0.001		E200.8	01/09/10 00:56 / dck
Arsenic	ND	mg/L		0.001		E200.8	01/09/10 00:56 / dck
Cadmium	0.0001	mg/L		0.0001		E200.8	01/09/10 00:56 / dck
Copper	0.005	mg/L		0.001		E200.8	01/09/10 00:56 / dck
Iron	0.007	mg/L		0.005		E200.8	01/09/10 00:56 / dck
Manganese	2.74	mg/L		0.005		E200.8	01/09/10 00:56 / dck

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc.
Project: Troy Mine Jar Testing
Lab ID: H10010040-007
Client Sample ID Jar6 - 010410

Report Date: 01/28/10
Collection Date: 01/04/10 15:35
DateReceived: 01/05/10
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, DISSOLVED							
Antimony	0.002	mg/L		0.001		E200.8	01/09/10 01:03 / dck
Arsenic	ND	mg/L		0.001		E200.8	01/09/10 01:03 / dck
Cadmium	0.0002	mg/L		0.0001		E200.8	01/09/10 01:03 / dck
Copper	0.003	mg/L		0.001		E200.8	01/09/10 01:03 / dck
Iron	ND	mg/L		0.005		E200.8	01/09/10 01:03 / dck
Manganese	4.47	mg/L		0.005		E200.8	01/09/10 01:03 / dck

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc.
Project: Troy Mine Jar Testing
Lab ID: H10010040-008
Client Sample ID Jar7 - 010410

Report Date: 01/28/10
Collection Date: 01/04/10 15:40
DateReceived: 01/05/10
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, DISSOLVED							
Antimony	0.007	mg/L		0.001		E200.8	01/09/10 01:10 / dck
Arsenic	ND	mg/L		0.001		E200.8	01/09/10 01:10 / dck
Cadmium	ND	mg/L		0.0001		E200.8	01/09/10 01:10 / dck
Copper	0.002	mg/L		0.001		E200.8	01/09/10 01:10 / dck
Iron	0.005	mg/L		0.005		E200.8	01/09/10 01:10 / dck
Manganese	2.79	mg/L		0.005		E200.8	01/09/10 01:10 / dck

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

QA/QC Summary Report

Client: Genesis Inc.
Project: Troy Mine Jar Testing

Report Date: 01/28/10
Work Order: H10010040

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8								Analytical Run: ICPMS204-B_100108A		
Sample ID: QCS-090602A,090609	6	Initial Calibration Verification Standard								01/08/10 13:32
Antimony		0.0499	mg/L	0.050	100	90	110			
Arsenic		0.0497	mg/L	0.0050	99	90	110			
Cadmium		0.0258	mg/L	0.0010	103	90	110			
Copper		0.0507	mg/L	0.010	101	90	110			
Iron		0.261	mg/L	0.030	102	90	110			
Manganese		0.247	mg/L	0.010	99	90	110			
Sample ID: ICSA-090423A	6	Interference Check Sample A								01/08/10 13:39
Antimony		0.000189	mg/L	0.050						
Arsenic		0.000151	mg/L	0.0050						
Cadmium		0.000421	mg/L	0.0010						
Copper		0.00118	mg/L	0.010						
Iron		99.6	mg/L	0.030	100	70	130			
Manganese		0.00223	mg/L	0.010						
Sample ID: ICSAB-090423A,09010	6	Interference Check Sample AB								01/08/10 13:46
Antimony		0.000153	mg/L	0.050		0	0			
Arsenic		0.0105	mg/L	0.0050	105	70	130			
Cadmium		0.0101	mg/L	0.0010	101	70	130			
Copper		0.0208	mg/L	0.010	104	70	130			
Iron		96.9	mg/L	0.030	97	70	130			
Manganese		0.0220	mg/L	0.010	110	70	130			
Sample ID: QCS-090602A,090609	6	Initial Calibration Verification Standard								01/08/10 22:07
Antimony		0.0498	mg/L	0.050	100	90	110			
Arsenic		0.0498	mg/L	0.0050	100	90	110			
Cadmium		0.0263	mg/L	0.0010	105	90	110			
Copper		0.0503	mg/L	0.010	101	90	110			
Iron		0.264	mg/L	0.030	104	90	110			
Manganese		0.251	mg/L	0.010	101	90	110			
Sample ID: ICSA-090423A	6	Interference Check Sample A								01/08/10 22:14
Antimony		0.000180	mg/L	0.050						
Arsenic		0.000103	mg/L	0.0050						
Cadmium		0.000326	mg/L	0.0010						
Copper		0.00123	mg/L	0.010						
Iron		98.6	mg/L	0.030	99	70	130			
Manganese		0.00219	mg/L	0.010						
Sample ID: ICSAB-090423A,09010	6	Interference Check Sample AB								01/08/10 22:20
Antimony		0.000156	mg/L	0.050		0	0			
Arsenic		0.0104	mg/L	0.0050	104	70	130			
Cadmium		0.0101	mg/L	0.0010	101	70	130			
Copper		0.0207	mg/L	0.010	104	70	130			
Iron		96.3	mg/L	0.030	96	70	130			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

QA/QC Summary Report

Client: Genesis Inc. **Report Date:** 01/28/10
Project: Troy Mine Jar Testing **Work Order:** H10010040

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8								Analytical Run: ICPMS204-B_100108A		
Sample ID: ICSAB-090423A,09010	6	Interference Check Sample AB								01/08/10 22:20
Manganese		0.0210	mg/L	0.010	105	70	130			
Sample ID: QCS-090602A,090609	6	Initial Calibration Verification Standard								01/09/10 05:14
Antimony		0.0493	mg/L	0.050	99	90	110			
Arsenic		0.0494	mg/L	0.0050	99	90	110			
Cadmium		0.0259	mg/L	0.0010	104	90	110			
Copper		0.0504	mg/L	0.010	101	90	110			
Iron		0.254	mg/L	0.030	99	90	110			
Manganese		0.256	mg/L	0.010	103	90	110			
Sample ID: ICSA-090423A	6	Interference Check Sample A								01/09/10 05:21
Antimony		0.000209	mg/L	0.050						
Arsenic		0.000148	mg/L	0.0050						
Cadmium		0.000313	mg/L	0.0010						
Copper		0.00130	mg/L	0.010						
Iron		97.9	mg/L	0.030	98	70	130			
Manganese		0.00207	mg/L	0.010						
Sample ID: ICSAB-090423A,09010	6	Interference Check Sample AB								01/09/10 05:27
Antimony		0.000150	mg/L	0.050		0	0			
Arsenic		0.0102	mg/L	0.0050	102	70	130			
Cadmium		0.00988	mg/L	0.0010	99	70	130			
Copper		0.0208	mg/L	0.010	104	70	130			
Iron		98.9	mg/L	0.030	99	70	130			
Manganese		0.0217	mg/L	0.010	108	70	130			
Method: E200.8										Batch: R59545
Sample ID: LRB	6	Method Blank				Run: ICPMS204-B_100108A				01/08/10 14:46
Antimony		ND	mg/L	3E-05						
Arsenic		ND	mg/L	2E-05						
Cadmium		ND	mg/L	1E-05						
Copper		ND	mg/L	3E-05						
Iron		ND	mg/L	6E-05						
Manganese		3E-05	mg/L	2E-05						
Sample ID: LFB	6	Laboratory Fortified Blank				Run: ICPMS204-B_100108A				01/08/10 14:53
Antimony		0.0511	mg/L	0.050	102	85	115			
Arsenic		0.0497	mg/L	0.0050	99	85	115			
Cadmium		0.0495	mg/L	0.0010	99	85	115			
Copper		0.0485	mg/L	0.010	97	85	115			
Iron		4.91	mg/L	0.030	98	85	115			
Manganese		0.0497	mg/L	0.010	99	85	115			
Sample ID: H10010040-003AMS	6	Sample Matrix Spike				Run: ICPMS204-B_100108A				01/08/10 23:55
Antimony		0.0751	mg/L	0.0050	98	70	130			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

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Toll Free 877.472.0711 * 406.442.0711 * FAX 406.442.0712 * helena@enerylab.com

QA/QC Summary Report

Client: Genesis Inc.
Project: Troy Mine Jar Testing

Report Date: 01/28/10
Work Order: H10010040

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8										Batch: R59545
Sample ID: H10010040-003AMS	6	Sample Matrix Spike				Run: ICPMS204-B_100108A				01/08/10 23:55
Arsenic		0.0505	mg/L	0.0050	100	70	130			
Cadmium		0.0484	mg/L	0.0010	97	70	130			
Copper		0.0525	mg/L	0.010	95	70	130			
Iron		4.81	mg/L	0.030	96	70	130			
Manganese		3.40	mg/L	0.010		70	130			A
Sample ID: H10010041-001CMS	6	Sample Matrix Spike				Run: ICPMS204-B_100108A				01/09/10 01:57
Antimony		0.0507	mg/L	0.0050	101	70	130			
Arsenic		0.0501	mg/L	0.0050	100	70	130			
Cadmium		0.0498	mg/L	0.0010	96	70	130			
Copper		0.0467	mg/L	0.010	93	70	130			
Iron		4.84	mg/L	0.030	97	70	130			
Manganese		17.2	mg/L	0.010		70	130			A
Sample ID: H10010041-001CMSD	6	Sample Matrix Spike Duplicate				Run: ICPMS204-B_100108A				01/09/10 02:04
Antimony		0.0498	mg/L	0.0050	100	70	130	1.7	20	
Arsenic		0.0505	mg/L	0.0050	100	70	130	0.6	20	
Cadmium		0.0495	mg/L	0.0010	95	70	130	0.6	20	
Copper		0.0472	mg/L	0.010	94	70	130	1.1	20	
Iron		4.89	mg/L	0.030	98	70	130	1.1	20	
Manganese		17.3	mg/L	0.010		70	130	0.6	20	A

Qualifiers:

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ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.

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QA/QC Summary Report

Client: Genesis Inc.
Project: Troy Mine Jar Testing

Report Date: 01/28/10
Work Order: H10010040

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8								Analytical Run: ICPMS204-B_100109B		
Sample ID: QCS-090602A,090609		Initial Calibration Verification Standard							01/09/10 18:57	
Manganese		0.248	mg/L	0.010	99	90	110			
Sample ID: ICSA-090423A		Interference Check Sample A							01/09/10 19:03	
Manganese		0.00225	mg/L	0.010						
Sample ID: ICSAB-090423A,09010		Interference Check Sample AB							01/09/10 19:10	
Manganese		0.0224	mg/L	0.010	112	70	130			
Sample ID: QCS-090602A,090609		Initial Calibration Verification Standard							01/10/10 00:14	
Manganese		0.251	mg/L	0.010	101	90	110			
Method: E200.8										Batch: R59556
Sample ID: LRB		Method Blank				Run: ICPMS204-B_100109B			01/09/10 20:11	
Manganese		4E-05	mg/L	2E-05						
Sample ID: LFB		Laboratory Fortified Blank				Run: ICPMS204-B_100109B			01/09/10 20:18	
Manganese		0.0510	mg/L	0.010	102	85	115			
Sample ID: H10010040-001AMS		Sample Matrix Spike				Run: ICPMS204-B_100109B			01/09/10 20:39	
Manganese		5.96	mg/L	0.010		70	130			A
Sample ID: H10010040-001AMSD		Sample Matrix Spike Duplicate				Run: ICPMS204-B_100109B			01/09/10 20:45	
Manganese		5.96	mg/L	0.010		70	130	0	20	A
Sample ID: H10010041-001CMS		Sample Matrix Spike				Run: ICPMS204-B_100109B			01/09/10 21:53	
Manganese		16.1	mg/L	0.010		70	130			A
Sample ID: H10010041-001CMSD		Sample Matrix Spike Duplicate				Run: ICPMS204-B_100109B			01/09/10 21:59	
Manganese		14.2	mg/L	0.010		70	130	13	20	A

Qualifiers:

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QA/QC Summary Report

Client: Genesis Inc.
Project: Troy Mine Jar Testing

Report Date: 01/28/10
Work Order: H10010040

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8								Analytical Run: ICPMS204-B_100111A		
Sample ID: QCS-090602A,090609		Initial Calibration Verification Standard								01/11/10 17:17
Iron		0.260	mg/L	0.030	102	90	110			
Sample ID: ICSA-090423A		Interference Check Sample A								01/11/10 17:24
Iron		101	mg/L	0.030	101	70	130			
Sample ID: ICSAB-090423A,09010		Interference Check Sample AB								01/11/10 17:30
Iron		101	mg/L	0.030	101	70	130			
Sample ID: QCS-090602A,090609		Initial Calibration Verification Standard								01/12/10 05:25
Iron		0.255	mg/L	0.030	100	90	110			
Sample ID: ICSA-090423A		Interference Check Sample A								01/12/10 05:32
Iron		101	mg/L	0.030	101	70	130			
Sample ID: ICSAB-090423A,09010		Interference Check Sample AB								01/12/10 05:38
Iron		99.9	mg/L	0.030	100	70	130			
Method: E200.8										Batch: R59601
Sample ID: LRB		Method Blank				Run: ICPMS204-B_100111A				01/12/10 01:01
Iron		0.0004	mg/L	6E-05						
Sample ID: LFB		Laboratory Fortified Blank				Run: ICPMS204-B_100111A				01/12/10 01:08
Iron		4.85	mg/L	0.030	97	85	115			
Sample ID: H10010040-003AMS		Sample Matrix Spike				Run: ICPMS204-B_100111A				01/12/10 02:43
Iron		4.86	mg/L	0.030	97	70	130			
Sample ID: H10010040-003AMSD		Sample Matrix Spike Duplicate				Run: ICPMS204-B_100111A				01/12/10 02:50
Iron		4.85	mg/L	0.030	97	70	130	0.1	20	

Qualifiers:

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Workorder Receipt Checklist

Genesis Inc Troy Mine

H10010040

Login completed by: Tracy L. Lorash

Date and Time Received: 1/5/2010 1:26 PM

Reviewed by: BL2000\wjohnson

Received by: TLL

Reviewed Date: 1/27/2010 12:39:03 PM

Carrier name: Hand Del

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shipping container/cooler?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed w hen relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees w ith sample labels?	Yes ☐	No ☑	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received w ithin holding time?	Yes ☑	No ☐	
Container/Temp Blank temperature:	4.4°C On Ice		
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☑
Water - pH acceptable upon receipt?	Yes ☑	No ☐	Not Applicable ☐

Contact and Corrective Action Comments:

Jar 3 has 010409 as part of sample ID and as the date. Contacted Dustin and it is supposed to read 010410. Tl

ENERGY LABORATORIES

Chain of Custody and Analytical Request Record

PLEASE PRINT- Provide as much information as possible.

Company Name: CAMP DRESSER MCKEE / CDM	Project Name, PWS, Permit, Etc.: TROY MINE JAR TESTING	Sample Origin State: MT	EPA/State Compliance: Yes ☐ No ☒
Report Mail Address: 50 W 14TH ST, #200 HELENA, MT 59601	Contact Name: DUSTIN KLEMPEL Phone/Fax: (406) 441-1405	Email: KLEMPEL DT@CDM.COM	Sampler: (Please Print) DUSTIN T KLEMPEL
Invoice Address: P.O. BOX 1660 TROY, MT 59935	Invoice Contact & Phone: PAUL KUKAY (406) 295-5882 x221	Purchase Order: —	Quote/Bottle Order: —

Special Report/Formats – ELI must be notified prior to sample submittal for the following:

- ☐ DW
- ☐ GSA
- ☐ POTW/WWTP
- ☐ State: _____
- ☐ Other: _____
- ☐ A2LA
- ☐ EDD/EDT (Electronic Data) Format: _____
- ☐ LEVEL IV
- ☐ NELAC

Contact ELI prior to **RUSH** sample submittal for charges and scheduling – See Instruction Page

Comments: ALL SAMPLES FIELD FILTERED & PRESERVED BY SAMPLER

Shipped by: Hand del.
Cooler ID(s): —
Receipt Temp: 4.4 °C
On Ice: (Yes) No
Custody Seal (Y) N
Bottles/Coolers B (C)
Intact (Y) N
Signature Match (Y) N

ANALYSIS REQUESTED

	SAMPLE IDENTIFICATION (Name, Location, Interval, etc.)	Collection Date	Collection Time	MATRIX (Number of Containers; Sample Type: A W S V B O; Air Water Soils/Solids Vegetation Bioassay Other)	LOW LEVEL DISSOLVED METALS*	SEE ATTACHED	Normal Turnaround (TAT)	RUSH	LABORATORY USE ONLY
1	CONTROL-010410	01/04/10	1456	L	X				H10010040
2	JAR1-010410		15:02		X				
3	JAR2-010410		15:10		X				
4	JAR3-010410		15:16		X				
5	JAR4-010410		15:25		X				
6	JAR5-010410		15:30		X				
7	JAR6-010410		15:35		X				
8	JAR7-010410		15:40		X				
9									
10									

*LOW LEVEL DISSOLVED METALS = COPPER, ANTIMONY, IRON, MANGANESE, CADMIUM, ARSENIC

Custody Record MUST be Signed

Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
DUSTIN KLEMPEL	01/05/09 13:26	[signature]			
Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
			Received by Laboratory: Tracy Larsen	Date/Time: 1/5/10 13:26	Signature: [signature]

Sample Disposal: Return to Client: _____ Lab Disposal: _____

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report. Visit our web site at www.energylab.com for additional information, downloadable fee schedule, forms, and links.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc.
Project: Troy Mine
Lab ID: H09120170-001
Client Sample ID MW 95-4

Report Date: 01/07/10
Collection Date: 12/16/09 10:20
DateReceived: 12/17/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL PROPERTIES							
pH	6.4	s.u.		0.1		A4500-H B	12/17/09 17:50 / hm
Conductivity	801	umhos/cm		1		A2510 B	12/17/09 17:47 / hm
Solids, Total Dissolved TDS @ 180 C	561	mg/L		10		A2540 C	12/18/09 09:09 / JG
INORGANICS							
Alkalinity, Total as CaCO3	80	mg/L		1		A2320 B	12/17/09 20:25 / hm
Bicarbonate as HCO3	97	mg/L		1		A2320 B	12/17/09 20:25 / hm
Carbonate as CO3	ND	mg/L		1		A2320 B	12/17/09 20:25 / hm
Chloride	1	mg/L		1		E300.0	12/17/09 22:13 / hm
Sulfate	320	mg/L		1		E300.0	12/17/09 22:13 / hm
Sodium Adsorption Ratio (SAR)	0.63	unitless		0.01		Calculation	01/07/10 10:10 / wjj
Fluoride	ND	mg/L		0.1	4	A4500-F C	12/18/09 13:31 / JG
Sulfide	ND	mg/L		0.04		A4500 S-D	12/21/09 11:30 / eli-b
Hardness as CaCO3	232	mg/L		1		A2340 B	12/24/09 10:32 / sld
AGGREGATE ORGANICS							
Organic Carbon, Total (TOC)	3.2	mg/L		0.5		A5310 C	12/21/09 15:40 / eli-ca
NUTRIENTS							
Nitrogen, Ammonia as N	5.7	mg/L	D	0.5		E350.1	12/21/09 16:24 / stp
Nitrogen, Nitrate+Nitrite as N	ND	mg/L		0.01		E353.2	12/18/09 14:55 / stp
Phosphorus, Orthophosphate as P	ND	mg/L		0.001		E365.1	12/18/09 17:01 / stp
METALS, DISSOLVED							
Aluminum	ND	mg/L		0.03		E200.8	12/17/09 19:00 / dck
Antimony	ND	mg/L		0.003		E200.8	12/17/09 19:00 / dck
Arsenic	ND	mg/L		0.003		E200.8	12/17/09 19:00 / dck
Barium	0.255	mg/L		0.005		E200.8	12/17/09 19:00 / dck
Beryllium	ND	mg/L		0.001		E200.8	12/17/09 19:00 / dck
Cadmium	ND	mg/L		0.00008		E200.8	12/17/09 19:00 / dck
Calcium	62	mg/L		1		E200.7	12/17/09 15:30 / sld
Chromium	ND	mg/L		0.001		E200.8	12/17/09 19:00 / dck
Copper	0.006	mg/L		0.001		E200.8	12/17/09 19:00 / dck
Iron	15.5	mg/L		0.05		E200.7	12/17/09 15:30 / sld
Lead	ND	mg/L		0.0005		E200.8	12/17/09 19:00 / dck
Magnesium	19	mg/L		1		E200.7	12/17/09 15:30 / sld
Manganese	5.34	mg/L		0.005		E200.8	12/18/09 13:06 / dck
Mercury	ND	mg/L		0.00001		E200.8	12/17/09 19:00 / dck
Nickel	ND	mg/L		0.01		E200.8	12/17/09 19:00 / dck
Potassium	25	mg/L		1		E200.7	12/17/09 15:30 / sld
Selenium	ND	mg/L		0.001		E200.8	12/17/09 19:00 / dck
Silica	43.1	mg/L		0.2		E200.8	12/18/09 13:06 / dck

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc.
Project: Troy Mine
Lab ID: H09120170-001
Client Sample ID MW 95-4

Report Date: 01/07/10
Collection Date: 12/16/09 10:20
DateReceived: 12/17/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, DISSOLVED							
Silver	ND	mg/L		0.0005		E200.8	12/17/09 19:00 / dck
Sodium	22	mg/L		1		E200.7	12/23/09 10:25 / sld
Thallium	ND	mg/L		0.0002		E200.8	12/17/09 19:00 / dck
Uranium	0.0005	mg/L		0.0003		E200.8	12/17/09 19:00 / dck
Zinc	0.01	mg/L		0.01		E200.8	12/17/09 19:00 / dck
METALS, TOTAL							
Iron	17.4	mg/L		0.03		E200.7	12/22/09 12:41 / sld

Report Definitions:
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MCL - Maximum contaminant level.
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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc.
Project: Troy Mine
Lab ID: H09120170-002
Client Sample ID Decant Pond

Report Date: 01/07/10
Collection Date: 12/16/09 11:10
DateReceived: 12/17/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL PROPERTIES							
pH	8.1	s.u.		0.1		A4500-H B	12/17/09 17:51 / hm
Conductivity	685	umhos/cm		1		A2510 B	12/17/09 17:49 / hm
Solids, Total Dissolved TDS @ 180 C	436	mg/L		10		A2540 C	12/18/09 09:09 / JG
INORGANICS							
Alkalinity, Total as CaCO3	100	mg/L		1		A2320 B	12/17/09 20:31 / hm
Bicarbonate as HCO3	120	mg/L		1		A2320 B	12/17/09 20:31 / hm
Carbonate as CO3	ND	mg/L		1		A2320 B	12/17/09 20:31 / hm
Chloride	6	mg/L		1		E300.0	12/17/09 22:29 / hm
Sulfate	68	mg/L		1		E300.0	12/17/09 22:29 / hm
Sodium Adsorption Ratio (SAR)	2.55	unitless		0.01		Calculation	01/07/10 10:10 / wjj
Fluoride	0.3	mg/L		0.1	4	A4500-F C	12/18/09 13:31 / JG
Sulfide	ND	mg/L		0.04		A4500 S-D	12/21/09 11:30 / eli-b
Hardness as CaCO3	78	mg/L		1		A2340 B	12/18/09 12:19 / abb
AGGREGATE ORGANICS							
Organic Carbon, Total (TOC)	1.2	mg/L		0.5		A5310 C	12/21/09 15:51 / eli-ca
NUTRIENTS							
Nitrogen, Ammonia as N	11.2	mg/L	D	0.5		E350.1	12/21/09 16:26 / stp
Nitrogen, Nitrate+Nitrite as N	37.6	mg/L	D	0.5		E353.2	12/18/09 15:01 / stp
Phosphorus, Orthophosphate as P	0.070	mg/L		0.001		E365.1	12/18/09 17:02 / stp
METALS, DISSOLVED							
Aluminum	ND	mg/L		0.03		E200.8	12/17/09 19:07 / dck
Antimony	0.068	mg/L		0.003		E200.8	12/17/09 19:07 / dck
Arsenic	ND	mg/L		0.003		E200.8	12/17/09 19:07 / dck
Barium	0.091	mg/L		0.005		E200.8	12/17/09 19:07 / dck
Beryllium	ND	mg/L		0.001		E200.8	12/17/09 19:07 / dck
Cadmium	ND	mg/L		0.00008		E200.8	12/17/09 19:07 / dck
Calcium	22	mg/L		1		E200.7	12/17/09 15:39 / sld
Chromium	ND	mg/L		0.001		E200.8	12/17/09 19:07 / dck
Copper	0.032	mg/L		0.001		E200.8	12/17/09 19:07 / dck
Iron	ND	mg/L		0.05		E200.7	12/17/09 15:39 / sld
Lead	0.0008	mg/L		0.0005		E200.8	12/17/09 19:07 / dck
Magnesium	6	mg/L		1		E200.7	12/17/09 15:39 / sld
Manganese	0.862	mg/L		0.005		E200.8	12/17/09 19:07 / dck
Mercury	ND	mg/L		0.00001		E200.8	12/17/09 19:07 / dck
Nickel	ND	mg/L		0.01		E200.8	12/17/09 19:07 / dck
Potassium	32	mg/L		1		E200.7	12/17/09 15:39 / sld
Selenium	ND	mg/L		0.001		E200.8	12/17/09 19:07 / dck
Silica	9.7	mg/L		0.2		E200.8	12/17/09 19:07 / dck

Report Definitions:
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D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc.
Project: Troy Mine
Lab ID: H09120170-002
Client Sample ID Decant Pond

Report Date: 01/07/10
Collection Date: 12/16/09 11:10
DateReceived: 12/17/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, DISSOLVED							
Silver	ND	mg/L		0.0005		E200.8	12/17/09 19:07 / dck
Sodium	52	mg/L		1		E200.7	12/17/09 15:39 / sld
Thallium	ND	mg/L		0.0002		E200.8	12/17/09 19:07 / dck
Uranium	0.0033	mg/L		0.0003		E200.8	12/17/09 19:07 / dck
Zinc	ND	mg/L		0.01		E200.8	12/17/09 19:07 / dck
METALS, TOTAL							
Iron	0.45	mg/L		0.03		E200.7	12/22/09 12:44 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc.
Project: Troy Mine
Lab ID: H09120170-003
Client Sample ID Mine Water

Report Date: 01/07/10
Collection Date: 12/16/09 13:10
DateReceived: 12/17/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL PROPERTIES							
pH	7.5	s.u.		0.1		A4500-H B	12/17/09 17:52 / hm
Conductivity	288	umhos/cm		1		A2510 B	12/17/09 17:50 / hm
Solids, Total Dissolved TDS @ 180 C	184	mg/L		10		A2540 C	12/18/09 09:10 / JG
INORGANICS							
Alkalinity, Total as CaCO3	70	mg/L		1		A2320 B	12/17/09 20:52 / hm
Bicarbonate as HCO3	85	mg/L		1		A2320 B	12/17/09 20:52 / hm
Carbonate as CO3	ND	mg/L		1		A2320 B	12/17/09 20:52 / hm
Chloride	ND	mg/L		1		E300.0	12/17/09 22:46 / hm
Sulfate	42	mg/L		1		E300.0	12/17/09 22:46 / hm
Sodium Adsorption Ratio (SAR)	0.11	unitless		0.01		Calculation	01/07/10 10:10 / wjj
Fluoride	ND	mg/L		0.1	4	A4500-F C	12/18/09 13:31 / JG
Sulfide	ND	mg/L		0.04		A4500 S-D	12/21/09 11:30 / eli-b
Hardness as CaCO3	114	mg/L		1		A2340 B	12/24/09 10:32 / sld
AGGREGATE ORGANICS							
Organic Carbon, Total (TOC)	ND	mg/L		0.5		A5310 C	12/21/09 16:00 / eli-ca
NUTRIENTS							
Nitrogen, Ammonia as N	0.39	mg/L		0.05		E350.1	12/21/09 16:00 / stp
Nitrogen, Nitrate+Nitrite as N	7.4	mg/L	D	0.1		E353.2	12/18/09 15:03 / stp
Phosphorus, Orthophosphate as P	0.003	mg/L		0.001		E365.1	12/18/09 17:03 / stp
METALS, DISSOLVED							
Aluminum	ND	mg/L		0.03		E200.8	12/17/09 19:14 / dck
Antimony	0.015	mg/L		0.003		E200.8	12/17/09 19:14 / dck
Arsenic	ND	mg/L		0.003		E200.8	12/17/09 19:14 / dck
Barium	0.047	mg/L		0.005		E200.8	12/17/09 19:14 / dck
Beryllium	ND	mg/L		0.001		E200.8	12/17/09 19:14 / dck
Cadmium	ND	mg/L		0.00008		E200.8	12/17/09 19:14 / dck
Calcium	30	mg/L		1		E200.7	12/17/09 15:42 / sld
Chromium	ND	mg/L		0.001		E200.8	12/17/09 19:14 / dck
Copper	0.114	mg/L		0.001		E200.8	12/17/09 19:14 / dck
Iron	ND	mg/L		0.05		E200.7	12/17/09 15:42 / sld
Lead	0.0010	mg/L		0.0005		E200.8	12/17/09 19:14 / dck
Magnesium	10	mg/L		1		E200.7	12/17/09 15:42 / sld
Manganese	0.105	mg/L		0.005		E200.8	12/17/09 19:14 / dck
Mercury	ND	mg/L		0.00001		E200.8	12/17/09 19:14 / dck
Nickel	ND	mg/L		0.01		E200.8	12/17/09 19:14 / dck
Potassium	ND	mg/L		1		E200.7	12/17/09 15:42 / sld
Selenium	ND	mg/L		0.001		E200.8	12/17/09 19:14 / dck
Silica	5.8	mg/L		0.2		E200.8	12/17/09 19:14 / dck

Report Definitions:
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D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc.
Project: Troy Mine
Lab ID: H09120170-003
Client Sample ID Mine Water

Report Date: 01/07/10
Collection Date: 12/16/09 13:10
DateReceived: 12/17/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, DISSOLVED							
Silver	ND	mg/L		0.0005		E200.8	12/17/09 19:14 / dck
Sodium	3	mg/L		1		E200.7	12/23/09 10:28 / sld
Thallium	ND	mg/L		0.0002		E200.8	12/17/09 19:14 / dck
Uranium	0.0011	mg/L		0.0003		E200.8	12/17/09 19:14 / dck
Zinc	0.02	mg/L		0.01		E200.8	12/17/09 19:14 / dck
METALS, TOTAL							
Iron	ND	mg/L		0.03		E200.7	12/22/09 12:47 / sld

Report Definitions:
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QA/QC Summary Report

Client: Genesis Inc.
Project: Troy Mine

Report Date: 01/07/10
Work Order: H09120170

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: A2510 B									Analytical Run: COND_091217A	
Sample ID: ICV1_091217A		Initial Calibration Verification Standard							12/17/09 17:45	
Conductivity		716	umhos/cm	1.0	**100**	90	110			
Method: A2510 B									Batch: 091217A-COND-PROBE-W	
Sample ID: LCS1_091217A		Laboratory Control Sample				Run: COND_091217A			12/17/09 17:46	
Conductivity		1400	umhos/cm	1.0	**99**	90	110			
Sample ID: H09120186-001ADUP		Sample Duplicate				Run: COND_091217A			12/17/09 17:54	
Conductivity		520	umhos/cm	1.0				**0.1**	10	
Method: A2540 C									Batch: 7607	
Sample ID: MB-7607		Method Blank				Run: ACCU-124 (14410200)_091218			12/18/09 09:13	
Solids, Total Dissolved TDS @ 180 C		6	mg/L	1						
Sample ID: LCS-7607		Laboratory Control Sample				Run: ACCU-124 (14410200)_091218			12/18/09 09:07	
Solids, Total Dissolved TDS @ 180 C		1010	mg/L	10	**100**	90	110			
Sample ID: H09120186-002AMS		Sample Matrix Spike				Run: ACCU-124 (14410200)_091218			12/18/09 09:10	
Solids, Total Dissolved TDS @ 180 C		2140	mg/L	10	**99**	80	120			
Sample ID: H09120186-002AMSD		Sample Matrix Spike Duplicate				Run: ACCU-124 (14410200)_091218			12/18/09 09:11	
Solids, Total Dissolved TDS @ 180 C		2140	mg/L	10	**99**	80	120	**0**	10	
Method: A4500-H B									Batch: 091217A-PH-W	
Sample ID: LCS1_091217A		Laboratory Control Sample				Run: PH2_091217A			12/17/09 17:44	
pH		7.06	s.u.	0.10	**101**	99	101			
Method: A2320 B									Batch: R59017	
Sample ID: MBLK		Method Blank				Run: MAN-TECH_091217A			12/17/09 17:18	
Alkalinity, Total as CaCO3		ND	mg/L	0.9						
Sample ID: LCS		Laboratory Control Sample				Run: MAN-TECH_091217A			12/17/09 17:25	
Alkalinity, Total as CaCO3		570	mg/L	4.0	**95**	90	110			
Sample ID: H09120170-002A MS		Sample Matrix Spike				Run: MAN-TECH_091217A			12/17/09 20:38	
Alkalinity, Total as CaCO3		730	mg/L	4.0	**104**	90	110			
Sample ID: H09120170-002A MSD		Sample Matrix Spike Duplicate				Run: MAN-TECH_091217A			12/17/09 20:46	
Alkalinity, Total as CaCO3		710	mg/L	4.0	**102**	90	110	**1.6**	20	

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QA/QC Summary Report

Client: Genesis Inc.
Project: Troy Mine

Report Date: 01/07/10
Work Order: H09120170

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: A4500 S-D									Analytical Run: SUB-B140740	
Sample ID: ICV1_091221A		Initial Calibration Verification Standard							12/21/09 11:30	
Sulfide		0.216	mg/L	0.040	106	90	110			
Method: A4500 S-D									Batch: B_091221A-SULFIDE-MB-W	
Sample ID: B09121305-002BMS		Sample Matrix Spike				Run: SUB-B140740			12/21/09 11:30	
Sulfide		9.14	mg/L	1.0	90	70	130			
Sample ID: B09121305-002BMSD		Sample Matrix Spike Duplicate				Run: SUB-B140740			12/21/09 11:30	
Sulfide		8.99	mg/L	1.0	89	70	130	1.6	30	
Sample ID: MBLK1_091221A		Method Blank				Run: SUB-B140740			12/21/09 11:30	
Sulfide		ND	mg/L	0.02						
Sample ID: LFB1_091221A		Laboratory Fortified Blank				Run: SUB-B140740			12/21/09 11:30	
Sulfide		0.220	mg/L	0.040	109	70	130			
Method: A4500-F C									Analytical Run: PH_091218A	
Sample ID: ICV1_091218A		Initial Calibration Verification Standard							12/18/09 13:31	
Fluoride		0.746	mg/L	0.10	99	90	110			
Method: A4500-F C									Batch: 091218A-F-ISE-W	
Sample ID: MBLK1_091218A		Method Blank				Run: PH_091218A			12/18/09 13:31	
Fluoride		ND	mg/L	0.03						
Sample ID: LFB1_091218A		Laboratory Fortified Blank				Run: PH_091218A			12/18/09 13:31	
Fluoride		0.477	mg/L	0.10	95	90	110			
Sample ID: LCS1_091218A		Laboratory Control Sample				Run: PH_091218A			12/18/09 13:31	
Fluoride		0.746	mg/L	0.10	96	90	110			
Sample ID: H09120170-001ADUP		Sample Duplicate				Run: PH_091218A			12/18/09 13:31	
Fluoride		0.0398	mg/L	0.10					20	
Sample ID: H09120170-002AMS		Sample Matrix Spike				Run: PH_091218A			12/18/09 13:31	
Fluoride		0.753	mg/L	0.10	96	85	115			
Sample ID: H09120170-002AMSD		Sample Matrix Spike Duplicate				Run: PH_091218A			12/18/09 13:31	
Fluoride		0.745	mg/L	0.10	94	85	115	1.1	20	

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QA/QC Summary Report

Client: Genesis Inc.
Project: Troy Mine

Report Date: 01/07/10
Work Order: H09120170

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E300.0									Analytical Run: IC101-H_091218A	
Sample ID: CCV	2	Continuing Calibration Verification Standard							12/17/09 20:34	
Chloride		23	mg/L	1.0	92	90	110			
Sulfate		50	mg/L	1.0	101	90	110			
Sample ID: ICV	2	Initial Calibration Verification Standard							12/17/09 20:51	
Chloride		2.4	mg/L	1.0	97	90	110			
Sulfate		9.4	mg/L	1.0	94	90	110			
Method: E300.0									Batch: R59015	
Sample ID: LFB	2	Laboratory Fortified Blank				Run: IC101-H_091218A			12/17/09 21:07	
Chloride		24	mg/L	1.0	98	90	110			
Sulfate		53	mg/L	1.0	106	90	110			
Sample ID: MBLK	2	Method Blank				Run: IC101-H_091218A			12/17/09 21:24	
Chloride		ND	mg/L	0.05						
Sulfate		ND	mg/L	0.1						
Sample ID: H09120175-001A MS	2	Sample Matrix Spike				Run: IC101-H_091218A			12/17/09 23:19	
Chloride		26	mg/L	1.0	96	90	110			
Sulfate		61	mg/L	1.0	106	90	110			
Sample ID: H09120175-001A MSD	2	Sample Matrix Spike Duplicate				Run: IC101-H_091218A			12/17/09 23:35	
Chloride		26	mg/L	1.0	96	90	110	0.2	20	
Sulfate		60	mg/L	1.0	105	90	110	1.1	20	
Method: A5310 C									Analytical Run: SUB-C127879	
Sample ID: ICV-5085		Initial Calibration Verification Standard							12/21/09 09:15	
Organic Carbon, Total (TOC)		10.4	mg/L	0.50	104	90	110			
Method: A5310 C									Batch: C_R127879	
Sample ID: MBLK		Method Blank				Run: SUB-C127879			12/21/09 09:40	
Organic Carbon, Total (TOC)		0.06	mg/L	0.04						
Sample ID: LCS-5085		Laboratory Control Sample				Run: SUB-C127879			12/21/09 14:59	
Organic Carbon, Total (TOC)		10.3	mg/L	0.50	103	90	110			
Sample ID: H09120170-003E		Sample Matrix Spike				Run: SUB-C127879			12/21/09 17:21	
Organic Carbon, Total (TOC)		5.14	mg/L	0.50	99	85	115			
Sample ID: H09120170-003E		Sample Matrix Spike Duplicate				Run: SUB-C127879			12/21/09 17:31	
Organic Carbon, Total (TOC)		5.36	mg/L	0.50	103	85	115	4.1	10	

Qualifiers:

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QA/QC Summary Report

Client: Genesis Inc.
Project: Troy Mine

Report Date: 01/07/10
Work Order: H09120170

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E350.1								Analytical Run: NUTRIENTS_091221A		
Sample ID: ICV-1		Initial Calibration Verification Standard							12/21/09 15:16	
Nitrogen, Ammonia as N		1.01	mg/L	0.10	101	90	110			
Sample ID: ICB		Initial Calibration Blank, Instrument Blank							12/21/09 15:24	
Nitrogen, Ammonia as N		-0.0100	mg/L	0.10		0	0			
Sample ID: CCV-19		Continuing Calibration Verification Standard							12/21/09 15:52	
Nitrogen, Ammonia as N		0.530	mg/L	0.10	106	90	110			
Sample ID: CCV-32		Continuing Calibration Verification Standard							12/21/09 16:18	
Nitrogen, Ammonia as N		0.530	mg/L	0.10	106	90	110			
Method: E350.1								Batch: A2009-12-21_5_NH3_01		
Sample ID: LCS-2		Laboratory Control Sample				Run: NUTRIENTS_091221A			12/21/09 15:18	
Nitrogen, Ammonia as N		8.19	mg/L	0.19	103	90	110			
Sample ID: LFB-3		Laboratory Fortified Blank				Run: NUTRIENTS_091221A			12/21/09 15:20	
Nitrogen, Ammonia as N		1.00	mg/L	0.10	100	90	110			
Sample ID: MBLK-6		Method Blank				Run: NUTRIENTS_091221A			12/21/09 15:26	
Nitrogen, Ammonia as N		ND	mg/L	0.02						
Sample ID: H09120170-003CMS		Sample Matrix Spike				Run: NUTRIENTS_091221A			12/21/09 16:02	
Nitrogen, Ammonia as N		1.43	mg/L	0.10	104	90	110			
Sample ID: H09120170-003CMSD		Sample Matrix Spike Duplicate				Run: NUTRIENTS_091221A			12/21/09 16:04	
Nitrogen, Ammonia as N		1.40	mg/L	0.10	101	90	110	2.1	20	
Sample ID: H09120168-001BDUP		Sample Duplicate				Run: NUTRIENTS_091221A			12/21/09 16:22	
Nitrogen, Ammonia as N		5.19	mg/L	0.47				0	20	

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QA/QC Summary Report

Client: Genesis Inc.
Project: Troy Mine

Report Date: 01/07/10
Work Order: H09120170

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E353.2									Analytical Run: NUTRIENTS_091218A	
Sample ID: ICV-1		Initial Calibration Verification Standard								12/18/09 14:33
Nitrogen, Nitrate+Nitrite as N		1.01	mg/L	0.050	**101**	90	110			
Sample ID: CCV-4		Continuing Calibration Verification Standard								12/18/09 14:39
Nitrogen, Nitrate+Nitrite as N		0.520	mg/L	0.050	**104**	90	110			
Sample ID: ICB		Initial Calibration Blank, Instrument Blank								12/18/09 14:43
Nitrogen, Nitrate+Nitrite as N		-0.0100	mg/L	0.050		0	0			
Method: E353.2									Batch: A2009-12-18_5_NO3_01	
Sample ID: LCS-2		Laboratory Control Sample				Run: NUTRIENTS_091218A				12/18/09 14:35
Nitrogen, Nitrate+Nitrite as N		18.9	mg/L	0.095	**103**	90	110			
Sample ID: LFB-3		Laboratory Fortified Blank				Run: NUTRIENTS_091218A				12/18/09 14:37
Nitrogen, Nitrate+Nitrite as N		1.03	mg/L	0.050	**103**	90	110			
Sample ID: MBLK-7		Method Blank				Run: NUTRIENTS_091218A				12/18/09 14:45
Nitrogen, Nitrate+Nitrite as N		ND	mg/L	0.010						
Sample ID: H09120170-001CMS		Sample Matrix Spike				Run: NUTRIENTS_091218A				12/18/09 14:57
Nitrogen, Nitrate+Nitrite as N		0.970	mg/L	0.050	**97**	90	110			
Sample ID: H09120170-001CMSD		Sample Matrix Spike Duplicate				Run: NUTRIENTS_091218A				12/18/09 14:59
Nitrogen, Nitrate+Nitrite as N		0.970	mg/L	0.050	**97**	90	110	**0**	20	

Qualifiers:

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ND - Not detected at the reporting limit.

QA/QC Summary Report

Client: Genesis Inc.
Project: Troy Mine

Report Date: 01/07/10
Work Order: H09120170

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E365.1									Analytical Run: FIA202-HE_091218B	
Sample ID: ICV		Initial Calibration Verification Standard								12/18/09 16:54
Phosphorus, Orthophosphate as P		0.249	mg/L	0.010	**100**	90	110			
Sample ID: CCV		Continuing Calibration Verification Standard								12/18/09 16:57
Phosphorus, Orthophosphate as P		0.252	mg/L	0.010	**101**	90	110			
Sample ID: ICB		Initial Calibration Blank, Instrument Blank								12/18/09 16:59
Phosphorus, Orthophosphate as P		0.00103	mg/L	0.010		0	0			
Method: E365.1										Batch: R59073
Sample ID: LCS		Laboratory Control Sample				Run: FIA202-HE_091218B				12/18/09 16:55
Phosphorus, Orthophosphate as P		3.11	mg/L	0.010	**101**	90	110			
Sample ID: LFB		Laboratory Fortified Blank				Run: FIA202-HE_091218B				12/18/09 16:56
Phosphorus, Orthophosphate as P		0.206	mg/L	0.010	**103**	90	110			
Sample ID: MBLK		Method Blank				Run: FIA202-HE_091218B				12/18/09 17:00
Phosphorus, Orthophosphate as P		ND	mg/L	0.001						
Sample ID: H09120170-003AMS		Sample Matrix Spike				Run: FIA202-HE_091218B				12/18/09 17:04
Phosphorus, Orthophosphate as P		0.196	mg/L	0.010	**97**	90	110			
Sample ID: H09120170-003AMSD		Sample Matrix Spike Duplicate				Run: FIA202-HE_091218B				12/18/09 17:05
Phosphorus, Orthophosphate as P		0.196	mg/L	0.010	**97**	90	110	**0.1**	20	
Sample ID: H09120198-002ADUP		Sample Duplicate				Run: FIA202-HE_091218B				12/18/09 17:08
Phosphorus, Orthophosphate as P		0.0306	mg/L	0.010				**4.6**	20	
Method: E200.7										Batch: 7638
Sample ID: MB-7638		Method Blank				Run: ICP1-HE_091222A				12/22/09 12:35
Iron		ND	mg/L	0.008						
Sample ID: LCS-7638		Laboratory Control Sample				Run: ICP1-HE_091222A				12/22/09 12:38
Iron		2.46	mg/L	0.030	**98**	85	115			
Sample ID: H09120185-001AMS5		Sample Matrix Spike				Run: ICP1-HE_091222A				12/22/09 12:59
Iron		2.36	mg/L	0.030	**93**	70	130			
Sample ID: H09120185-001AMSD5		Sample Matrix Spike Duplicate				Run: ICP1-HE_091222A				12/22/09 13:02
Iron		2.57	mg/L	0.030	**101**	70	130	**8.4**	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

QA/QC Summary Report

Client: Genesis Inc.
Project: Troy Mine

Report Date: 01/07/10
Work Order: H09120170

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7									Analytical Run: ICP1-HE_091217B	
Sample ID: ICV	5	Initial Calibration Verification Standard								12/17/09 14:22
Calcium		41.9	mg/L	1.0	**105**	95	105			
Iron		4.12	mg/L	0.030	**103**	95	105			
Magnesium		41.8	mg/L	1.0	**104**	95	105			
Potassium		38.6	mg/L	1.0	**97**	95	105			
Sodium		40.5	mg/L	1.0	**101**	95	105			
Sample ID: CCV-1	5	Continuing Calibration Verification Standard								12/17/09 14:30
Calcium		26.0	mg/L	1.0	**104**	95	105			
Iron		2.59	mg/L	0.030	**103**	95	105			
Magnesium		25.4	mg/L	1.0	**101**	95	105			
Potassium		24.3	mg/L	1.0	**97**	95	105			
Sodium		25.6	mg/L	1.0	**102**	95	105			
Sample ID: ICSA	5	Interference Check Sample A								12/17/09 14:44
Calcium		556	mg/L	1.0	**111**	80	120			
Iron		199	mg/L	0.030	**99**	80	120			
Magnesium		572	mg/L	1.0	**114**	80	120			
Potassium		0.0146	mg/L	1.0		0	0			
Sodium		0.0725	mg/L	1.0		0	0			
Sample ID: ICSAB	5	Interference Check Sample AB								12/17/09 14:47
Calcium		478	mg/L	1.0	**96**	80	120			
Iron		186	mg/L	0.030	**93**	80	120			
Magnesium		528	mg/L	1.0	**106**	80	120			
Potassium		20.3	mg/L	1.0	**102**	80	120			
Sodium		21.9	mg/L	1.0	**109**	80	120			
Sample ID: CCV	5	Continuing Calibration Verification Standard								12/17/09 14:51
Calcium		27.1	mg/L	1.0	**108**	90	110			
Iron		2.70	mg/L	0.030	**108**	90	110			
Magnesium		26.3	mg/L	1.0	**105**	90	110			
Potassium		24.2	mg/L	1.0	**97**	90	110			
Sodium		25.1	mg/L	1.0	**100**	90	110			
Sample ID: CCV	5	Continuing Calibration Verification Standard								12/17/09 15:33
Calcium		22.7	mg/L	1.0	**91**	90	110			
Iron		2.39	mg/L	0.030	**95**	90	110			
Magnesium		22.9	mg/L	1.0	**92**	90	110			
Potassium		24.0	mg/L	1.0	**96**	90	110			
Sodium		25.3	mg/L	1.0	**101**	90	110			
Sample ID: ICSA	5	Interference Check Sample A								12/17/09 15:54
Calcium		474	mg/L	1.0	**95**	80	120			
Iron		180	mg/L	0.030	**90**	80	120			
Magnesium		513	mg/L	1.0	**103**	80	120			

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QA/QC Summary Report

Client: Genesis Inc.
Project: Troy Mine

Report Date: 01/07/10
Work Order: H09120170

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7									Analytical Run: ICP1-HE_091217B	
Sample ID: ICSA	5	Interference Check Sample A							12/17/09 15:54	
Potassium		-0.0107	mg/L	1.0		0	0			
Sodium		0.0732	mg/L	1.0		0	0			
Sample ID: ICSAB	5	Interference Check Sample AB							12/17/09 15:57	
Calcium		464	mg/L	1.0	93	80	120			
Iron		194	mg/L	0.030	97	80	120			
Magnesium		487	mg/L	1.0	97	80	120			
Potassium		19.9	mg/L	1.0	99	80	120			
Sodium		20.3	mg/L	1.0	101	80	120			
Method: E200.7									Batch: R59005	
Sample ID: MBLK	5	Method Blank				Run: ICP1-HE_091217B			12/17/09 15:02	
Calcium		ND	mg/L	0.1						
Iron		0.002	mg/L	0.002						
Magnesium		0.06	mg/L	0.02						
Potassium		ND	mg/L	0.04						
Sodium		ND	mg/L	0.1						
Sample ID: LFB	5	Laboratory Fortified Blank				Run: ICP1-HE_091217B			12/17/09 15:05	
Calcium		8.98	mg/L	1.0	90	85	115			
Iron		0.916	mg/L	0.030	91	85	115			
Magnesium		9.14	mg/L	1.0	91	85	115			
Potassium		9.76	mg/L	1.0	98	85	115			
Sodium		9.16	mg/L	1.0	92	85	115			
Sample ID: LCS	5	Laboratory Control Sample				Run: ICP1-HE_091217B			12/17/09 15:08	
Calcium		20.2	mg/L	1.0	101	90	110			
Iron		2.04	mg/L	0.030	102	90	110			
Magnesium		20.5	mg/L	1.0	102	90	110			
Potassium		19.7	mg/L	1.0	99	90	110			
Sodium		21.1	mg/L	1.0	106	90	110			
Sample ID: H09120169-001BMS2	5	Sample Matrix Spike				Run: ICP1-HE_091217B			12/17/09 15:24	
Calcium		43.8	mg/L	1.0	97	70	130			
Iron		1.91	mg/L	0.030	96	70	130			
Magnesium		66.2	mg/L	1.0	97	70	130			
Potassium		20.0	mg/L	1.0	95	70	130			
Sodium		44.4	mg/L	1.0	103	70	130			
Sample ID: H09120169-001BMSD2	5	Sample Matrix Spike Duplicate				Run: ICP1-HE_091217B			12/17/09 15:27	
Calcium		44.7	mg/L	1.0	101	70	130	1.9	20	
Iron		1.93	mg/L	0.030	96	70	130	0.8	20	
Magnesium		64.4	mg/L	1.0	88	70	130	2.7	20	
Potassium		20.1	mg/L	1.0	95	70	130	0.7	20	
Sodium		42.3	mg/L	1.0	93	70	130	4.7	20	

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QA/QC Summary Report

Client: Genesis Inc.
Project: Troy Mine

Report Date: 01/07/10
Work Order: H09120170

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7									Analytical Run: ICP1-HE_091222A	
Sample ID: ICV		Initial Calibration Verification Standard								12/22/09 10:31
Iron		3.88	mg/L	0.030	97	95	105			
Sample ID: CCV-1		Continuing Calibration Verification Standard								12/22/09 10:39
Iron		2.53	mg/L	0.030	101	95	105			
Sample ID: ICSA		Interference Check Sample A								12/22/09 10:49
Iron		196	mg/L	0.030	98	80	120			
Sample ID: ICSAB		Interference Check Sample AB								12/22/09 10:52
Iron		181	mg/L	0.030	91	80	120			
Sample ID: CCV		Continuing Calibration Verification Standard								12/22/09 12:16
Iron		2.44	mg/L	0.030	98	90	110			
Sample ID: ICSA		Interference Check Sample A								12/22/09 13:58
Iron		180	mg/L	0.030	90	80	120			
Sample ID: ICSAB		Interference Check Sample AB								12/22/09 14:01
Iron		180	mg/L	0.030	90	80	120			
Method: E200.7										Batch: R59144
Sample ID: MBLK		Method Blank				Run: ICP1-HE_091222A				12/22/09 11:09
Iron		0.005	mg/L	0.002						
Sample ID: LFB		Laboratory Fortified Blank				Run: ICP1-HE_091222A				12/22/09 11:12
Iron		1.00	mg/L	0.030	100	85	115			
Sample ID: LCS		Laboratory Control Sample				Run: ICP1-HE_091222A				12/22/09 11:15
Iron		1.96	mg/L	0.030	98	90	110			
Sample ID: H09120198-006EMS2		Sample Matrix Spike				Run: ICP1-HE_091222A				12/22/09 12:22
Iron		1.92	mg/L	0.030	96	70	130			
Sample ID: H09120198-006EMSD2		Sample Matrix Spike Duplicate				Run: ICP1-HE_091222A				12/22/09 12:26
Iron		1.91	mg/L	0.030	95	70	130	0.7	20	

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QA/QC Summary Report

Client: Genesis Inc.
Project: Troy Mine

Report Date: 01/07/10
Work Order: H09120170

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7									Analytical Run: ICP1-HE_091223A	
Sample ID: ICV		Initial Calibration Verification Standard								12/23/09 09:30
Sodium		41.0	mg/L	1.0	**103**	95	105			
Sample ID: CCV-1		Continuing Calibration Verification Standard								12/23/09 09:38
Sodium		25.6	mg/L	1.0	**102**	95	105			
Sample ID: ICSA		Interference Check Sample A								12/23/09 09:52
Sodium		0.0690	mg/L	1.0		0	0			
Sample ID: ICSAB		Interference Check Sample AB								12/23/09 09:55
Sodium		21.8	mg/L	1.0	**109**	80	120			
Sample ID: CCV		Continuing Calibration Verification Standard								12/23/09 09:59
Sodium		26.1	mg/L	1.0	**104**	90	110			
Sample ID: ICSA		Interference Check Sample A								12/23/09 12:37
Sodium		0.0589	mg/L	1.0		0	0			
Sample ID: ICSAB		Interference Check Sample AB								12/23/09 12:40
Sodium		21.8	mg/L	1.0	**109**	80	120			
Sample ID: ICSA		Interference Check Sample A								12/23/09 13:57
Sodium		0.0611	mg/L	1.0		0	0			
Sample ID: ICSAB		Interference Check Sample AB								12/23/09 14:01
Sodium		21.3	mg/L	1.0	**107**	80	120			
Sample ID: ICSA		Interference Check Sample A								12/23/09 20:02
Sodium		0.0665	mg/L	1.0		0	0			
Sample ID: ICSAB		Interference Check Sample AB								12/23/09 20:06
Sodium		20.3	mg/L	1.0	**102**	80	120			
Method: E200.7									Batch: R59176	
Sample ID: MBLK		Method Blank				Run: ICP1-HE_091223A				12/23/09 10:06
Sodium		ND	mg/L	0.1						
Sample ID: LFB		Laboratory Fortified Blank				Run: ICP1-HE_091223A				12/23/09 10:09
Sodium		10.2	mg/L	1.0	**102**	85	115			
Sample ID: LCS		Laboratory Control Sample				Run: ICP1-HE_091223A				12/23/09 10:12
Sodium		20.9	mg/L	1.0	**105**	90	110			
Sample ID: H09120170-003BMS2		Sample Matrix Spike				Run: ICP1-HE_091223A				12/23/09 10:31
Sodium		23.3	mg/L	1.0	**103**	70	130			
Sample ID: H09120170-003BMSD2		Sample Matrix Spike Duplicate				Run: ICP1-HE_091223A				12/23/09 10:34
Sodium		23.5	mg/L	1.0	**104**	70	130	**0.9**	20	

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QA/QC Summary Report

Client: Genesis Inc.
Project: Troy Mine

Report Date: 01/07/10
Work Order: H09120170

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7										Batch: R59176
Sample ID: LFB		Laboratory Fortified Blank				Run: ICP1-HE_091223A				12/23/09 11:44
Sodium		10.2	mg/L	1.0	102	85	115			

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QA/QC Summary Report

Client: Genesis Inc.
Project: Troy Mine

Report Date: 01/07/10
Work Order: H09120170

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8								Analytical Run: ICPMS204-B_091217A		
Sample ID: QCS-090602A,090609	18	Initial Calibration Verification Standard								12/17/09 16:14
Aluminum		0.256	mg/L	0.10	102	90	110			
Antimony		0.0503	mg/L	0.050	101	90	110			
Arsenic		0.0503	mg/L	0.0050	101	90	110			
Barium		0.0504	mg/L	0.10	101	90	110			
Beryllium		0.0257	mg/L	0.0010	103	90	110			
Cadmium		0.0261	mg/L	0.0010	104	90	110			
Chromium		0.0499	mg/L	0.010	100	90	110			
Copper		0.0511	mg/L	0.010	102	90	110			
Lead		0.0509	mg/L	0.010	102	90	110			
Manganese		0.254	mg/L	0.010	102	90	110			
Mercury		0.00197	mg/L	0.0010	99	90	110			
Nickel		0.0498	mg/L	0.010	100	90	110			
Selenium		0.0497	mg/L	0.0050	99	90	110			
Silicon		0.500	mg/L	0.10	100	90	110			
Silver		0.0255	mg/L	0.0050	102	90	110			
Thallium		0.0510	mg/L	0.10	102	90	110			
Uranium		0.0199	mg/L	0.0010	100	90	110			
Zinc		0.0511	mg/L	0.010	102	90	110			
Sample ID: ICSA-090423A	18	Interference Check Sample A								12/17/09 16:20
Aluminum		44.4	mg/L	0.10	111	70	130			
Antimony		0.000263	mg/L	0.050						
Arsenic		0.000181	mg/L	0.0050						
Barium		0.000322	mg/L	0.10						
Beryllium		5.00E-06	mg/L	0.0010						
Cadmium		0.000452	mg/L	0.0010						
Chromium		0.000533	mg/L	0.010						
Copper		0.00151	mg/L	0.010						
Lead		7.50E-05	mg/L	0.010						
Manganese		0.00244	mg/L	0.010						
Mercury		3.00E-05	mg/L	0.0010						
Nickel		0.00123	mg/L	0.010						
Selenium		1.20E-05	mg/L	0.0050						
Silicon		0.00272	mg/L	0.10		0	0			
Silver		0.000206	mg/L	0.0050						
Thallium		3.80E-05	mg/L	0.10						
Uranium		1.10E-05	mg/L	0.0010						
Zinc		0.00113	mg/L	0.010						
Sample ID: ICSAB-090423A,09010	18	Interference Check Sample AB								12/17/09 16:27
Aluminum		44.6	mg/L	0.10	112	70	130			
Antimony		0.000177	mg/L	0.050		0	0			
Arsenic		0.0111	mg/L	0.0050	111	70	130			
Barium		7.80E-05	mg/L	0.10		0	0			

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QA/QC Summary Report

Client: Genesis Inc.
Project: Troy Mine

Report Date: 01/07/10
Work Order: H09120170

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8								Analytical Run: ICPMS204-B_091217A		
Sample ID: ICSAB-090423A,09010	18	Interference Check Sample AB								12/17/09 16:27
Beryllium		ND	mg/L	0.0010		0	0			
Cadmium		0.0112	mg/L	0.0010	**112**	70	130			
Chromium		0.0228	mg/L	0.010	**114**	70	130			
Copper		0.0233	mg/L	0.010	**117**	70	130			
Lead		6.80E-05	mg/L	0.010		0	0			
Manganese		0.0250	mg/L	0.010	**125**	70	130			
Mercury		1.90E-05	mg/L	0.0010		0	0			
Nickel		0.0234	mg/L	0.010	**117**	70	130			
Selenium		0.0109	mg/L	0.0050	**109**	70	130			
Silicon		0.00297	mg/L	0.10		0	0			
Silver		0.0213	mg/L	0.0050	**106**	70	130			
Thallium		3.20E-05	mg/L	0.10		0	0			
Uranium		7.00E-06	mg/L	0.0010		0	0			
Zinc		0.0120	mg/L	0.010	**120**	70	130			
Sample ID: QCS-090602A,090609	18	Initial Calibration Verification Standard								12/17/09 21:27
Aluminum		0.255	mg/L	0.10	**102**	90	110			
Antimony		0.0508	mg/L	0.050	**102**	90	110			
Arsenic		0.0502	mg/L	0.0050	**100**	90	110			
Barium		0.0513	mg/L	0.10	**103**	90	110			
Beryllium		0.0252	mg/L	0.0010	**101**	90	110			
Cadmium		0.0266	mg/L	0.0010	**106**	90	110			
Chromium		0.0510	mg/L	0.010	**102**	90	110			
Copper		0.0521	mg/L	0.010	**104**	90	110			
Lead		0.0502	mg/L	0.010	**100**	90	110			
Manganese		0.252	mg/L	0.010	**101**	90	110			
Mercury		0.00190	mg/L	0.0010	**95**	90	110			
Nickel		0.0513	mg/L	0.010	**103**	90	110			
Selenium		0.0501	mg/L	0.0050	**100**	90	110			
Silicon		0.490	mg/L	0.10	**98**	90	110			
Silver		0.0260	mg/L	0.0050	**104**	90	110			
Thallium		0.0509	mg/L	0.10	**102**	90	110			
Uranium		0.0199	mg/L	0.0010	**99**	90	110			
Zinc		0.0511	mg/L	0.010	**102**	90	110			
Sample ID: ICSA-090423A	18	Interference Check Sample A								12/17/09 21:34
Aluminum		43.8	mg/L	0.10	**109**	70	130			
Antimony		0.000268	mg/L	0.050						
Arsenic		0.000182	mg/L	0.0050						
Barium		0.000356	mg/L	0.10						
Beryllium		ND	mg/L	0.0010						
Cadmium		0.000439	mg/L	0.0010						
Chromium		0.000544	mg/L	0.010						
Copper		0.00145	mg/L	0.010						

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QA/QC Summary Report

Client: Genesis Inc.
Project: Troy Mine

Report Date: 01/07/10
Work Order: H09120170

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8								Analytical Run: ICPMS204-B_091217A		
Sample ID: ICSA-090423A	18	Interference Check Sample A								12/17/09 21:34
Lead		8.60E-05	mg/L	0.010						
Manganese		0.00246	mg/L	0.010						
Mercury		3.20E-05	mg/L	0.0010						
Nickel		0.00126	mg/L	0.010						
Selenium		9.80E-05	mg/L	0.0050						
Silicon		0.00267	mg/L	0.10		0	0			
Silver		0.000117	mg/L	0.0050						
Thallium		5.10E-05	mg/L	0.10						
Uranium		8.00E-06	mg/L	0.0010						
Zinc		0.00113	mg/L	0.010						
Sample ID: ICSAB-090423A,09010	18	Interference Check Sample AB								12/17/09 21:41
Aluminum		42.7	mg/L	0.10	**107**	70	130			
Antimony		0.000182	mg/L	0.050		0	0			
Arsenic		0.0113	mg/L	0.0050	**113**	70	130			
Barium		7.30E-05	mg/L	0.10		0	0			
Beryllium		2.00E-06	mg/L	0.0010		0	0			
Cadmium		0.0110	mg/L	0.0010	**110**	70	130			
Chromium		0.0226	mg/L	0.010	**113**	70	130			
Copper		0.0232	mg/L	0.010	**116**	70	130			
Lead		7.60E-05	mg/L	0.010		0	0			
Manganese		0.0244	mg/L	0.010	**122**	70	130			
Mercury		2.10E-05	mg/L	0.0010		0	0			
Nickel		0.0233	mg/L	0.010	**116**	70	130			
Selenium		0.0109	mg/L	0.0050	**109**	70	130			
Silicon		0.00276	mg/L	0.10		0	0			
Silver		0.0204	mg/L	0.0050	**102**	70	130			
Thallium		4.20E-05	mg/L	0.10		0	0			
Uranium		5.00E-06	mg/L	0.0010		0	0			
Zinc		0.0112	mg/L	0.010	**112**	70	130			
Method: E200.8										Batch: R59022
Sample ID: LRB	18	Method Blank				Run: ICPMS204-B_091217A				12/17/09 17:20
Aluminum		0.0001	mg/L	7E-05						
Antimony		ND	mg/L	3E-05						
Arsenic		ND	mg/L	2E-05						
Barium		4E-05	mg/L	3E-05						
Beryllium		ND	mg/L	1E-05						
Cadmium		ND	mg/L	1E-05						
Chromium		6E-05	mg/L	5E-05						
Copper		5E-05	mg/L	3E-05						
Lead		ND	mg/L	5E-06						
Manganese		5E-05	mg/L	2E-05						
Mercury		ND	mg/L	7E-06						

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QA/QC Summary Report

Client: Genesis Inc.
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Report Date: 01/07/10
Work Order: H09120170

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8										Batch: R59022
Sample ID: LRB	18	Method Blank				Run: ICPMS204-B_091217A				12/17/09 17:20
Nickel		ND	mg/L	3E-05						
Selenium		ND	mg/L	3E-05						
Silicon		0.002	mg/L	0.0004						
Silver		8E-05	mg/L	2E-05						
Thallium		ND	mg/L	1E-05						
Uranium		ND	mg/L	1E-05						
Zinc		0.0009	mg/L	0.0001						
Sample ID: LFB	18	Laboratory Fortified Blank				Run: ICPMS204-B_091217A				12/17/09 17:27
Aluminum		0.0504	mg/L	0.10	100	85	115			
Antimony		0.0491	mg/L	0.050	98	85	115			
Arsenic		0.0485	mg/L	0.0050	97	85	115			
Barium		0.0487	mg/L	0.10	97	85	115			
Beryllium		0.0510	mg/L	0.0010	102	85	115			
Cadmium		0.0487	mg/L	0.0010	97	85	115			
Chromium		0.0490	mg/L	0.010	98	85	115			
Copper		0.0485	mg/L	0.010	97	85	115			
Lead		0.0493	mg/L	0.010	99	85	115			
Manganese		0.0499	mg/L	0.010	100	85	115			
Mercury		0.000950	mg/L	0.0010	95	85	115			
Nickel		0.0486	mg/L	0.010	97	85	115			
Selenium		0.0497	mg/L	0.0050	99	85	115			
Silicon		0.202	mg/L	0.10	100	85	115			
Silver		0.0185	mg/L	0.0050	92	85	115			
Thallium		0.0494	mg/L	0.10	99	85	115			
Uranium		0.0503	mg/L	0.0010	101	85	115			
Zinc		0.0497	mg/L	0.010	97	85	115			
Sample ID: H09120173-001AMS	18	Sample Matrix Spike				Run: ICPMS204-B_091217A				12/17/09 19:27
Aluminum		0.0583	mg/L	0.10	103	70	130			
Antimony		0.0510	mg/L	0.0030	101	70	130			
Arsenic		0.0535	mg/L	0.0010	100	70	130			
Barium		0.0780	mg/L	0.10	98	70	130			
Beryllium		0.0523	mg/L	0.0010	105	70	130			
Cadmium		0.0491	mg/L	0.0010	98	70	130			
Chromium		0.0493	mg/L	0.010	97	70	130			
Copper		0.0506	mg/L	0.010	94	70	130			
Lead		0.0543	mg/L	0.0010	100	70	130			
Manganese		0.102	mg/L	0.010	98	70	130			
Mercury		0.000970	mg/L	0.00020	97	70	130			
Nickel		0.0478	mg/L	0.010	95	70	130			
Selenium		0.0532	mg/L	0.0050	106	70	130			
Silicon		11.0	mg/L	0.10		70	130			A
Silver		0.0176	mg/L	0.0050	88	70	130			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.

QA/QC Summary Report

Client: Genesis Inc.
Project: Troy Mine

Report Date: 01/07/10
Work Order: H09120170

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8									Batch: R59022	
Sample ID: H09120173-001AMS	18	Sample Matrix Spike				Run: ICPMS204-B_091217A			12/17/09 19:27	
Thallium		0.0502	mg/L	0.0010	100	70	130			
Uranium		0.0743	mg/L	0.0010	102	70	130			
Zinc		0.160	mg/L	0.010	81	70	130			
Sample ID: H09120173-001AMSD	18	Sample Matrix Spike Duplicate				Run: ICPMS204-B_091217A			12/17/09 19:33	
Aluminum		0.0569	mg/L	0.10	100	70	130		20	
Antimony		0.0507	mg/L	0.0030	101	70	130	0.6	20	
Arsenic		0.0546	mg/L	0.0010	102	70	130	2	20	
Barium		0.0779	mg/L	0.10	98	70	130		20	
Beryllium		0.0522	mg/L	0.0010	104	70	130	0.4	20	
Cadmium		0.0486	mg/L	0.0010	97	70	130	1	20	
Chromium		0.0497	mg/L	0.010	98	70	130	0.9	20	
Copper		0.0509	mg/L	0.010	95	70	130	0.6	20	
Lead		0.0539	mg/L	0.0010	100	70	130	0.7	20	
Manganese		0.101	mg/L	0.010	96	70	130	0.9	20	
Mercury		0.000949	mg/L	0.00020	95	70	130	2.2	20	
Nickel		0.0479	mg/L	0.010	95	70	130	0.3	20	
Selenium		0.0531	mg/L	0.0050	106	70	130	0.2	20	
Silicon		10.8	mg/L	0.10		70	130	2.3	20	A
Silver		0.0177	mg/L	0.0050	88	70	130	0.2	20	
Thallium		0.0497	mg/L	0.0010	99	70	130	1.2	20	
Uranium		0.0747	mg/L	0.0010	102	70	130	0.5	20	
Zinc		0.159	mg/L	0.010	79	70	130	0.6	20	

Qualifiers:

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ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
Toll Free 877.472.0711 * 406.442.0711 * FAX 406.442.0712 * helena@enerylab.com

QA/QC Summary Report

Client: Genesis Inc.
Project: Troy Mine

Report Date: 01/07/10
Work Order: H09120170

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8								Analytical Run: ICPMS204-B_091218A		
Sample ID: QCS-090602A,090609	2	Initial Calibration Verification Standard								12/18/09 11:45
Manganese		0.255	mg/L	0.010	**102**	90	110			
Silicon		0.480	mg/L	0.10	**96**	90	110			
Sample ID: ICSA-090423A	2	Interference Check Sample A								12/18/09 11:52
Manganese		0.00257	mg/L	0.010						
Silicon		0.00255	mg/L	0.10		0	0			
Sample ID: ICSAB-090423A,09010	2	Interference Check Sample AB								12/18/09 11:58
Manganese		0.0251	mg/L	0.010	**125**	70	130			
Silicon		0.00270	mg/L	0.10		0	0			
Method: E200.8										Batch: R59047
Sample ID: LRB	2	Method Blank				Run: ICPMS204-B_091218A				12/18/09 12:39
Manganese		6E-05	mg/L	2E-05						
Silicon		0.002	mg/L	0.0004						
Sample ID: LFB	2	Laboratory Fortified Blank				Run: ICPMS204-B_091218A				12/18/09 12:46
Manganese		0.0500	mg/L	0.010	**100**	85	115			
Silicon		0.200	mg/L	0.10	**99**	85	115			
Sample ID: H09120175-001BMS	2	Sample Matrix Spike				Run: ICPMS204-B_091218A				12/18/09 13:12
Manganese		1.30	mg/L	0.010		70	130			A
Silicon		11.9	mg/L	0.10		70	130			A
Sample ID: H09120175-001BMSD	2	Sample Matrix Spike Duplicate				Run: ICPMS204-B_091218A				12/18/09 13:19
Manganese		1.29	mg/L	0.010		70	130	**0.4**	20	A
Silicon		12.2	mg/L	0.10		70	130	**2.3**	20	A

Qualifiers:

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ENERGY LABORATORIES, INC. • P.O. Box 3658 • 3161 East Lyndale Ave. • Helena, MT 59604
877-472-0711 • 406-442-0711 • 406-442-0712 fax • helena@energylab.com

Energy Laboratories Inc
Workorder Receipt Checklist

H09120170

Genesis Inc Troy Mine

Login completed by: Tracy L. Lorash
Reviewed by: BL2000\wjohnson
Reviewed Date: 12/21/2009 9:20:08 AM

Date and Time Received: 12/17/2009 9:48 AM
Received by: rlt
Carrier name: Hand Del

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shipping container/cooler?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time?	Yes ☑	No ☐	
Container/Temp Blank temperature:	1.6°C On Ice		
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☑
Water - pH acceptable upon receipt?	Yes ☐	No ☑	Not Applicable ☐

Contact and Corrective Action Comments:

All dissolved metals/hardness/SAR samples filtered and preserved w/ 1ml. HNO3 in lab. Ferric Iron sample poured off and preserved in lab w/ 1ml. HNO3. TL

ENERGY LABORATORIES

Chain of Custody and Analytical Request Record

PLEASE PRINT- Provide as much information as possible.

Company Name:	Project Name, PWS, Permit, Etc.	Sample Origin	EPA/State Compliance:
CDM	TROY MINE	State: MT	Yes ☐ No ☒

Report Mail Address:	Contact Name:	Phone/Fax:	Email:	Sampler: (Please Print)
50 W 14TH ST, # 200 HELENA, MT 59601	DUSTIN KLEMPEL	(406) 441-1405	KLEMPELDT@CDM.COM	DUSTIN KLEMPEL

Invoice Address:	Invoice Contact & Phone:	Purchase Order:	Quote/Bottle Order:
TROY MINE PO. BOX 1660 TROY, MT 59935	PAUL KUKAY (406) 295-5882 x221 PKUKAY@HOTMAIL.COM		—

Special Report/Formats – ELI must be notified prior to sample submittal for the following:

- ☐ DW
- ☐ GSA
- ☐ POTW/WWTP
- ☐ State: _____
- ☐ Other: _____
- ☐ A2LA
- ☐ EDD/EDT (Electronic Data) Format: _____
- ☐ LEVEL IV
- ☐ NELAC

Contact ELI prior to **RUSH** sample submittal for charges and scheduling – See Instruction Page

Comments:

Shipped by: hand

Cooler ID(s):

Receipt Temp 1.6 °C

On Ice: (Yes) No

Custody Seal (Y) N

Bottles/Coolers B (C)

Intact (Y) N

Signature Match (Y) N

ANALYSIS REQUESTED

Number of Containers
Sample Type: A W S V B O
Air Water Soils/Solids Vegetation Bioassay Other

SAMPLE IDENTIFICATION (Name, Location, Interval, etc.)	Collection Date	Collection Time	MATRIX	SEE ATTACHED	Normal Turnaround (TAT)	RUSH	Comments	LABORATORY USE ONLY
1 MW 95-4	12/16/09	10:20	W	X	X			H09120170
2 DECANT POND	12/16/09	11:10	W	X	X			
3 MINE WATER	12/16/09	13:10	W	X	X			
4								
5								
6								
7								
8								
9								
10								

Custody Record MUST be Signed

Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
DUSTIN KLEMPEL	12/17/09 09:48	Dust Klempel			
Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
Sample Disposal: Return to Client: _____ Lab Disposal: _____			Received by Laboratory: Roxanne Tubbs	Date/Time: 12.17.09 9:48	Signature:

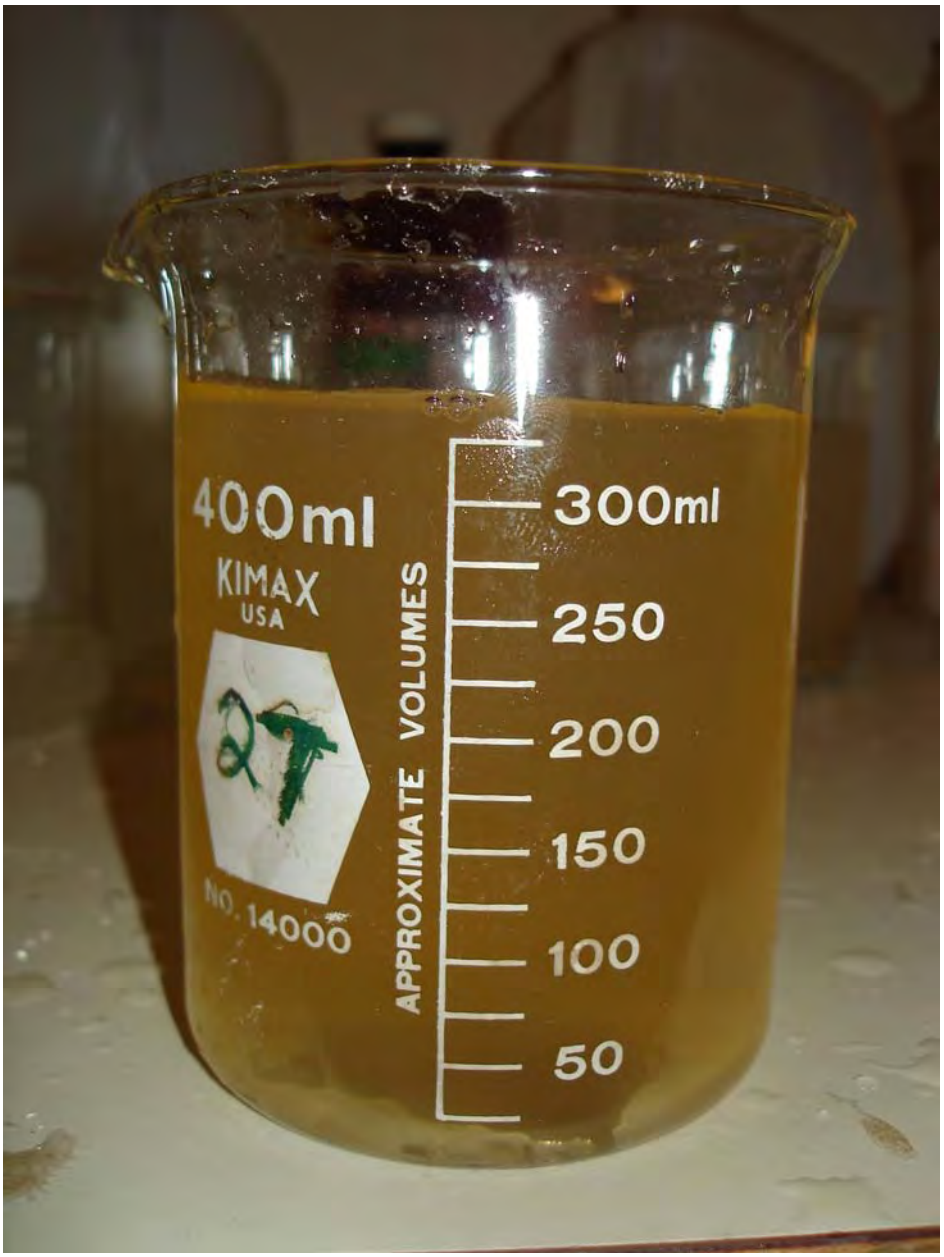
In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report.
Visit our web site at www.energylab.com for additional information, downloadable fee schedule, forms, and links.

Attachment 2
Photographs

Monitoring Well MW95-4.

Jar Test Sample from MW95-4.

Mixed Jar Sample #5 (mixture of MW95-4 and Mine Water).



Test sample of MW95-4 water with peroxide added – to show presence of iron.

Test Jar #4 after reaction period. Bottle on left is unfiltered. Bottle on right is filtered and preserved.

Appendix E
Troy Mine Mill Site Conceptual Channel Design

50 West 14th Street, Suite 200
Helena, Montana 59601
tel: 406 441-1400
fax: 406 449-7725

Draft Memorandum

To: *Emily Corsi, Herb Rolfes – DEQ*
Bobbie Lacklen, John McKay - KNF

From: *Bill Bucher- CDM*

Date: *December 3, 2010*

Subject: *Troy Mine Mill Site Conceptual Channel Design*

CDM has prepared a design and cost estimate for a conceptual drainage channel design at the Troy Mine mill site to support the *Draft Environmental Assessment* currently being prepared for final reclamation of the mine. The mill pad and waste rock dump located just below the mine portal are built across a drainage that enters the site from the west. Currently water from this drainage is collected in a detention basin on the upslope side of the millsite and routed beneath the mill site through two culverts to the downslope side of the site where it enters Stanley Creek. The culverts are over 600 feet long and could not be maintained with any assurance in the long term. Under the Agency-Mitigated Alternative for the reclamation plan, these culverts will be plugged and the drainage channel reconstructed over or around the mill pad/waste rock dump.

The purpose of this memorandum is to present a conceptual design for the new channel and provide approximate reclamation costs for construction of the new channel. Maintenance of the new channel is designed to be minimal and should not extend beyond the first few years after construction.

Alternative Considered but not Selected

The most desirable solution for channel design is removal of the fill at the mill site patio and construction of a channel along the original natural alignment at the original grade. This solution would eliminate the difficulty of maintaining a stable channel on the face of the fill and allow for a construction of a naturally functioning channel, which could minimize long-term maintenance costs. However, rebuilding the original channel for the larger drainage will require removing a large portion of the mill site fill. It will also require relocating the access road and buried pipeline that are currently at the mill site.

Two scenarios were investigated to determine the feasibility of establishing a more natural channel gradient across the site. In the first scenario, the existing twin culverts would be

plugged and the surrounding depression filled. The channel would cross the filled depression and follow an approximate 4H:1V grade to the toe of the mill site fill slope at the location of the original channel. For estimation purposes, it is assumed that the bottom width of the cut would be 24 feet to accommodate the new channel, and the side slopes of the cut would rise at 2H:1V. An AutoCAD drawing of the required cut is attached as Figure 1. The volume of cut would be 71,000 cy. The excavated material would be transported to the relatively flat portion of the mill site, where it would be placed in lifts and compacted to form a fill at a slope no greater than 2H:1V.

A second scenario would plug the twin culverts but begin excavation approximately at the top of the culverts. The channel would be excavated at a slightly lesser gradient because it is starting at a lower elevation, and would terminate at the some point in the original channel. This layout results in about 110,000 cy of excavation. Although this channel is presumably near the original channel grade, it may not replicate the original channel because we do not know the alignment of the original channel.

If we assume the excavation can be accomplished for about $4 per cubic yard, the cost of excavation would be in the range of $280,000 to $440,000. This cost would be in addition to costs for building the new channel and revegetating the fresh cut slopes. Because of the greatly increased cost of this alternative compared to the costs of the options discussed below, this alternative was not pursued further.

Selected Alternative

Two options for the selected alternative were considered for evaluation as shown in the attached Figure 2. Both options originate from the end of the natural channel above the current detention basin, which will be backfilled during reclamation. Option 1 routes the drainage in an easterly direction across the top of the reclaimed mill pad/waste rock dump, down the face of the dump and into an energy dissipation basin before discharging to the original channel and Stanley Creek. These options are shown on the attached layout for the mill site.

Option 2 routes the water to the northeast on reclaimed ground until it reaches the north end of the mill pad/waste rock dump where it descends a steep slope. At the base of the steepest portion of the slope, an energy dissipation basin will reduce the velocity of the stream before it is routed through a constructed channel the remaining distance to Stanley Creek.

There is a minor drainage that enters the southern portion of the mill site that would also be routed across the mill patio to the road. Then it would be routed on the uphill (west) side of the road to the larger channel.. This would require shaping a small channel through the reclaimed area and lining it with appropriately sized rock. This design applies to Option 1 or Option 2. These costs are incidental compared to the costs for the main drainage and are not considered further in this memorandum.

Hydrology and Hydraulics

The design storm for permanent drainage channels at mine sites in Montana is the 100-year 24-hour storm. The Forest Service sizes culverts for the 100-year peak flow, which is the event that occurs with a probability of 1% in any given year. The 100-year flow was calculated using the USGS *Methods for Estimating Flood Frequency in Montana Based on Data through Water Year 1998* (Parrett and Johnson, 2004). It was assumed that a burn could occur in the even-aged forest in this tributary drainage so a forest cover factor of 50% was used to represent 50% crown kill. The calculated 100-year flow under this condition is 33 cfs. An attachment provides documentation of the calculation.

Hydraulic calculations were performed using the Bathurst resistance calculation method as described in the *Stormwater Collection Systems Design Handbook* (Mays, 2001, Section 16.5). This iterative method determines the rock size necessary to prevent movement of the rock with a selected factor of safety. A typical industry standard factor of safety of 1.3 was selected for this calculation. This method is specifically meant for steep (greater than 10%) channel slopes where Manning's equation is not valid. Calculations show that a channel with a bottom width of 3 feet and side slopes of 2H:1V will be more than adequate to accommodate the calculated peak flow. The attached sketch shows the typical cross-sections for gentler and steeper portions of the channel.

For the portions of the channel with a slope of less than 10%, a rock size of d_{50} = 16 inches was calculated. For the steeper portions of the channels (77% for Option 1 and 50% for Option 2) a d_{50} = 5.6 feet is required. The latter gradation will range from a d_{10} of 2.8 feet to a d_{90} of 7 feet. Excel spreadsheet calculations are attached.

Conceptual Design

The channel options were designed as rock-lined channels using guidance from the USACE manual *Hydraulic Design of Flood Control Channels* (ASCE, 1995). The design includes a 9-inch thick filter bed of d_{50} = 6 inches beneath the riprap. Below this will be 1-inch minus bedding to protect the liner to be constructed where the channel crosses the mill patio. The liner will prevent infiltration of water into the mill fill. This liner could be constructed of HDPE, geosynthetic clay liner (GCL), or clay. Bedding material may need to be placed below the liner as well to provide a suitable surface for installation.

On the steep portion of the channel, installation of a liner will not be feasible. Riprap should be underlain by rock filter layers that prevent scour of the underlying material. It may be that appropriate sized material is already in place in this portion of the mill site, and it will not be necessary to place filter layers in that case.

The design includes a four foot culvert for passage of the drainage beneath the realigned and reconstructed road. A four foot culvert is oversized for the design flow and slope but is preferred to smaller sizes because of its ability to pass debris more readily.

The energy dissipation basin at the base of the steep slopes is intended to reduce velocities before a milder channel routes the discharge to Stanley Creek. The final design of this basin is recommended to be in accordance with US Department of Transportation (USDOT) guidelines (USDOT, 1975) for energy dissipaters. For purposes of this conceptual design, it is assumed that a basin 30 feet wide and 50 feet long will be more than adequate to dissipate energy from the design storm. The rock size for the basin is assumed to have a d_{50} of 16 inches but this may need to be adjusted during final design.

Although this channel has been designed for cost estimating purposes as a riprap channel, modifications can be made to provide a more natural appearance and function, especially in the gentler reaches. Woody debris can be incorporated between the rocks, rocks can be arranged to create step pools, and shrubs and trees can be planted between rocks on the banks. However, the framework of large rock sizes is still needed throughout the channel to provide stability under high flows. Addition of these items will increase installation time but should not significantly affect material costs relative to the high cost of the rock.

Both options present construction problems with using large rock on steep slopes. The 2H:1V slope of Option 2 is tractable with conventional equipment. Placement of large rock on the angle of repose slope of Option 1 will be more difficult. Equipment tethered from above may be able to shape the channel and place the required large rock. If sufficiently large rock is already present in the face of the dump, it may not be necessary to place rock here, making this option more attractive. However, without incising a channel in the face with equipment there will be no certainty that the discharge will be funneled to the energy dissipation basin.

Cost Estimate

A cost estimate for each option was prepared and these are attached to this memorandum. The largest and most uncertain cost is the cost of providing and placing rock. It is assumed that the d_{50} = 16-inch and d_{50} = 6-inch gradations can be found in the waste rock dump or other nearby areas and a cost of $30/cy will be sufficient for collection and placement of these materials. However, the d_{50} = 5-foot plus rock may need to be imported from a greater distance. A cost of $60/cy has been used for this rock assuming it can be found within 30 miles.

Other elements accounted for in the cost estimates are mobilization, erosion control, clearing and grubbing of timbered areas, installation of a culvert, and construction of an access road from the existing access road to construct the energy dissipater. Construction costs include a 15% contingency. Engineering design and oversight costs are estimated at 20% of construction costs. The total cost estimate for Option 1 is about $238,000 and the estimated total cost of Option 2 is $290,000. The attached cost sheets present breakdowns of the estimated costs of the two options.

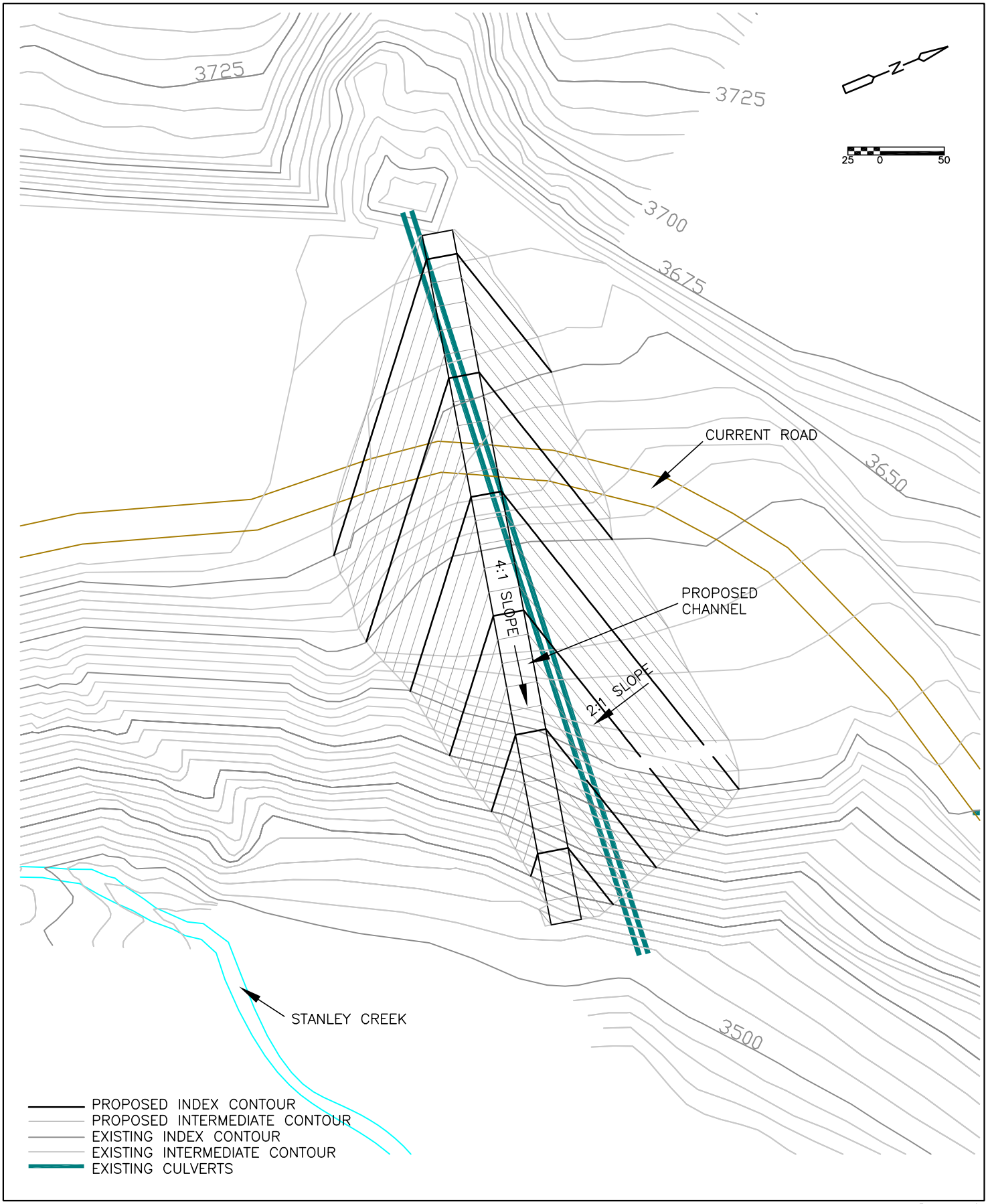
References

American Society of Civil Engineers, 1995. Hydraulic Design of Flood Control Channels. Technical Engineering and Design Guides as Adapted from the US Army Corps of Engineers, No. 10. New York, N. Y.

Mays, L., 2001. Stormwater Collection Systems Design Handbook.

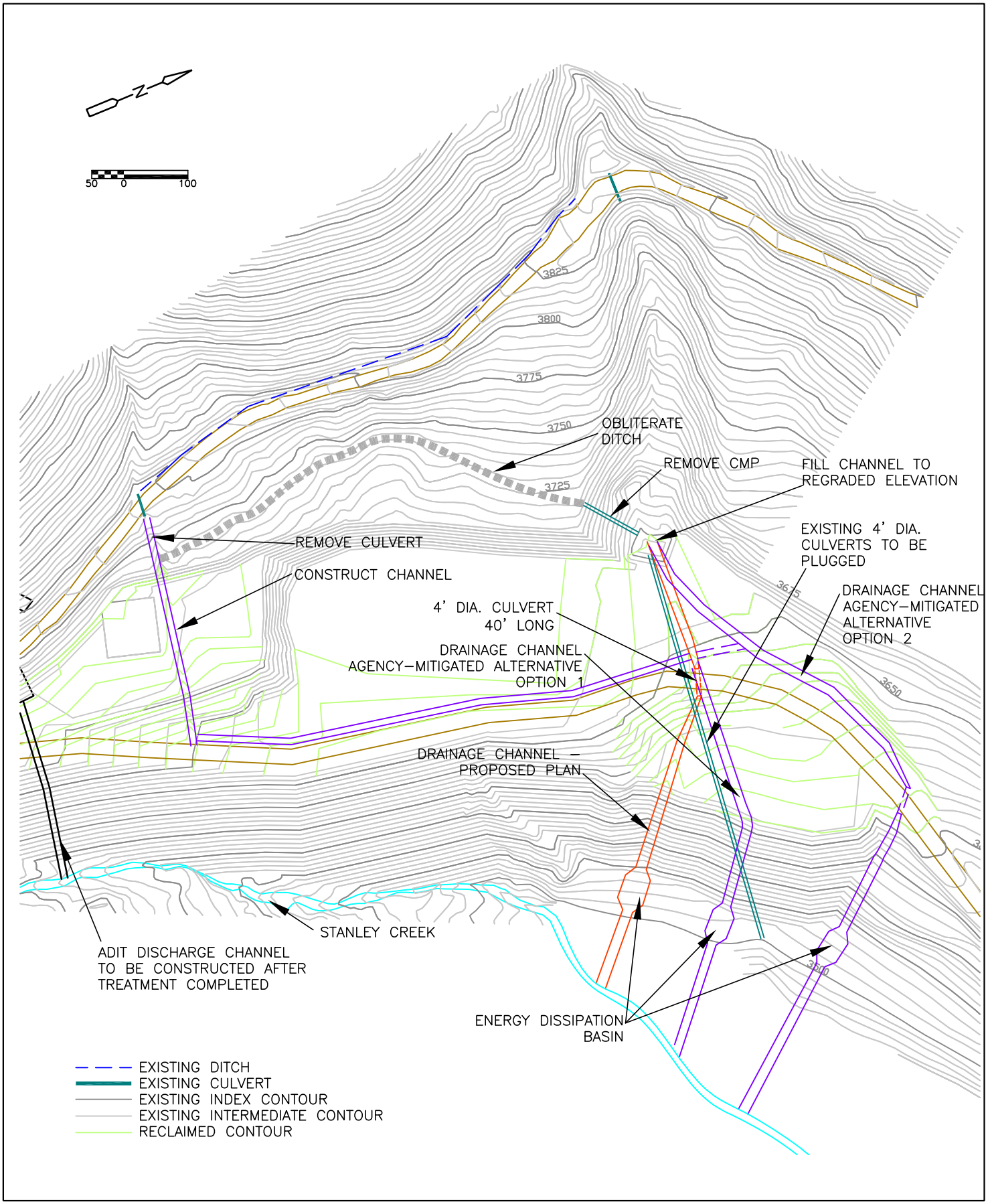
Parrett, C. and D.LR. Johnson, 2004. Methods for Estimating Flood Frequency in Montana Based on Data through Water Year 1998. US Geological Survey Water-Resources Investigations Report 03-4308, Helena MT. February 2004.

US Department of Transportation, 1975. Hydraulic Design of Energy Dissipators for Culverts and Cahnnels. Hydraulic Engineering Circular No. 14. June 1975.



K:\Troy Mine\DWG\CSTP001.dwg SAVED:12/3/10 PRINTED:12/3/10 BY:KOTSONJF

FIGURE 1
Excavation for 4:1 Channel Slope
Troy Mine Waterline Conceptual
Channel Design



K:\Troy Mine\DWG\Channel Discharge Pipelines.dwg SAVED12/2/10 PRINTED12/3/10 BY:KDTSONJF

FIGURE 2
Channel Options
Troy Mine Conceptual
Channel Design

CDM

CLIENT	MDEQ	JOB NO.		COMPUTED BY	WHB
PROJECT	Troy Mine EA	DATE CHECKED		DATE	12/1/2010
DETAIL	Peak Flow Calc. Trib to Stanley Cr.	CHECKED BY		PAGE NO.	1 of 1

Determine peak flow of 100 year event at mill site drainage. Use WRIR 03-4308 (Parrett & Johnson, 2004) to calculate 100-yr flow.

Drainage Area = 0.179 sq. mi (USGS topo)
Ave Annual precip = 24" (Troy average precip)
Forest cover = 50% Burned condition with 50% crown kill.

Use West Region Equation

$$Q_{100} = 18.7\, A^{0.812}\, P^{1.06}\, (F+1)^{-0.664}$$

$$Q_{100} = 18.7 \times (0.179)^{0.812}\, (24)^{1.06}\, (51)^{-0.664}$$

$$Q_{100} = 33 \text{ cfs.}$$

Steep Slope Riprap Design
Ref: Stormwater Collection Systems Design Handbook, Larry Mays, 2001, Section 16.5
Troy - Mine, Millpad Channel, 10% slope
Target Flow = 33 cfs

Channel Dimensions

Bottom Width(ft) =	3.28	
Bottom Width(m) =	1	
Sideslopes =	2	:1(H:V)
Slope (m/m) =	0.1	
Length (ft) =	581	
Length (m) =	177	

Trial Lining

D90 (ft) =	1.64
D90 (m) =	0.5
D50 (ft) =	1.31
D50 (m) =	0.4
D10 (ft) =	0.66
D10 (m) =	0.2

Range of Depth to be Evaluated

Least Depth (m) =	0.1
Maximum Depth (m)=	2
Increment (m) =	0.02

Angles

Side Slope, degrees	26.57
Bed Slope, degrees	5.74
Riprap Angle of Repose, degrees (Get from Charts)	43
Factor of Safety	1.3

Hydraulic Calculations

Depth (ft)	Depth (m)	Area (sf)	Area (sm)	Wetted Perimeter (ft)	Wetted Perimeter (m)	Top Width (ft)	Top Width (m)	Hydraulic Radius (ft)	Hydraulic Radius (m)
0.328	0.100	1.292	0.120	4.748	1.447	4.593	1.4	0.272	0.083
0.394	0.120	1.602	0.149	5.042	1.537	4.856	1.48	0.318	0.097
0.459	0.140	1.929	0.179	5.335	1.626	5.118	1.56	0.362	0.110
0.525	0.160	2.273	0.211	5.628	1.716	5.381	1.64	0.404	0.123
0.591	0.180	2.635	0.245	5.922	1.805	5.643	1.72	0.445	0.136
0.656	0.200	3.014	0.280	6.215	1.894	5.906	1.8	0.485	0.148
0.722	0.220	3.410	0.317	6.509	1.984	6.168	1.88	0.524	0.160
0.787	0.240	3.823	0.355	6.802	2.073	6.430	1.96	0.562	0.171
0.853	0.260	4.254	0.395	7.096	2.163	6.693	2.04	0.600	0.183
0.919	0.280	4.702	0.437	7.389	2.252	6.955	2.12	0.636	0.194
0.984	0.300	5.167	0.480	7.683	2.342	7.218	2.2	0.673	0.205
1.050	0.320	5.649	0.525	7.976	2.431	7.480	2.28	0.708	0.216
1.115	0.340	6.148	0.571	8.269	2.521	7.743	2.36	0.744	0.227
1.181	0.360	6.665	0.619	8.563	2.610	8.005	2.44	0.778	0.237
1.247	0.380	7.199	0.669	8.856	2.699	8.268	2.52	0.813	0.248
1.312	0.400	7.750	0.720	9.150	2.789	8.530	2.6	0.847	0.258
1.378	0.420	8.318	0.773	9.443	2.878	8.793	2.68	0.881	0.268
1.444	0.440	8.904	0.827	9.737	2.968	9.055	2.76	0.914	0.279
1.509	0.460	9.507	0.883	10.030	3.057	9.318	2.84	0.948	0.289
1.575	0.480	10.127	0.941	10.324	3.147	9.580	2.92	0.981	0.299
1.640	0.500	10.764	1.000	10.617	3.236	9.843	3	1.014	0.309
1.706	0.520	11.418	1.061	10.910	3.326	10.105	3.08	1.047	0.319
1.772	0.540	12.090	1.123	11.204	3.415	10.367	3.16	1.079	0.329
1.837	0.560	12.779	1.187	11.497	3.504	10.630	3.24	1.111	0.339
1.903	0.580	13.485	1.253	11.791	3.594	10.892	3.32	1.144	0.349
1.969	0.600	14.208	1.320	12.084	3.683	11.155	3.4	1.176	0.358
2.034	0.620	14.949	1.389	12.378	3.773	11.417	3.48	1.208	0.368
2.100	0.640	15.707	1.459	12.671	3.862	11.680	3.56	1.240	0.378
2.165	0.660	16.482	1.531	12.965	3.952	11.942	3.64	1.271	0.387

Note: Gradation calculation (D90 and D10) based on USFS Specs. for Roads and Bridges

Bathurst Resistance Calculations

Depth (ft)	Depth (m)	b	c1	f(FR)	c2	f(REG)	f(CG)	V*	Sum of f (functions)	n	V/V*	Velocity (V) m/sec	Froude Number	Correction for slope 0.98 Flow, Q m^3/sec	Flow, Q ft^3/sec	To N/m^2
0.33	0.1	0.180	0.624	1.319 *v^c1	1.745	3.233	0.602	0.313	2.568	0.082	2.650	0.830	0.838	0.100	3.5	80.9
0.39	0.12	0.199	0.580	1.220 *v^c1	1.944	3.700	0.582	0.343	2.627	0.082	2.722	0.934	0.861	0.139	4.9	94.5
0.46	0.14	0.215	0.545	1.153 *v^c1	2.118	4.137	0.565	0.371	2.696	0.082	2.805	1.040	0.887	0.186	6.6	107.6
0.52	0.16	0.231	0.515	1.105 *v^c1	2.273	4.552	0.550	0.396	2.770	0.081	2.893	1.146	0.915	0.242	8.5	120.2
0.59	0.18	0.244	0.490	1.070 *v^c1	2.413	4.946	0.538	0.420	2.846	0.080	2.983	1.253	0.943	0.307	10.8	132.4
0.66	0.2	0.256	0.469	1.042 *v^c1	2.540	5.324	0.527	0.443	2.922	0.079	3.073	1.361	0.972	0.381	13.4	144.3
0.72	0.22	0.268	0.450	1.020 *v^c1	2.656	5.687	0.517	0.465	2.998	0.078	3.162	1.469	1.000	0.465	16.4	155.9
0.79	0.24	0.278	0.433	1.003 *v^c1	2.763	6.039	0.508	0.485	3.073	0.077	3.250	1.577	1.028	0.560	19.8	167.2
0.85	0.26	0.288	0.419	0.988 *v^c1	2.862	6.379	0.499	0.505	3.147	0.076	3.337	1.685	1.055	0.666	23.5	178.4
0.92	0.28	0.297	0.405	0.976 *v^c1	2.954	6.711	0.491	0.524	3.219	0.075	3.422	1.794	1.082	0.783	27.6	189.3
0.98	0.3	0.306	0.393	0.966 *v^c1	3.040	7.034	0.484	0.542	3.290	0.075	3.506	1.902	1.109	0.913	32.2	200.1
1.05	0.32	0.314	0.381	0.958 *v^c1	3.122	7.350	0.477	0.560	3.360	0.074	3.588	2.010	1.135	1.055	37.2	210.7
1.12	0.34	0.321	0.371	0.950 *v^c1	3.198	7.660	0.471	0.578	3.429	0.073	3.669	2.119	1.160	1.210	42.7	221.2
1.18	0.36	0.328	0.361	0.944 *v^c1	3.271	7.963	0.465	0.594	3.496	0.072	3.748	2.227	1.185	1.379	48.7	231.6
1.25	0.38	0.335	0.352	0.938 *v^c1	3.341	8.262	0.459	0.611	3.562	0.071	3.825	2.335	1.210	1.562	55.1	241.8
1.31	0.4	0.342	0.344	0.934 *v^c1	3.407	8.556	0.454	0.626	3.627	0.070	3.901	2.444	1.234	1.760	62.1	252.0
1.38	0.42	0.348	0.336	0.929 *v^c1	3.470	8.846	0.449	0.642	3.690	0.069	3.976	2.552	1.257	1.972	69.6	262.1
1.44	0.44	0.354	0.329	0.926 *v^c1	3.531	9.132	0.444	0.657	3.753	0.069	4.050	2.661	1.281	2.201	77.7	272.1
1.51	0.46	0.360	0.322	0.922 *v^c1	3.589	9.415	0.439	0.672	3.815	0.068	4.122	2.769	1.303	2.446	86.3	282.0
1.57	0.48	0.366	0.315	0.919 *v^c1	3.646	9.694	0.435	0.686	3.875	0.067	4.193	2.877	1.326	2.707	95.5	291.8
1.64	0.5	0.371	0.309	0.917 *v^c1	3.700	9.971	0.430	0.700	3.935	0.067	4.263	2.986	1.348	2.986	105.4	301.6
1.71	0.52	0.376	0.303	0.915 *v^c1	3.753	10.245	0.426	0.714	3.993	0.066	4.332	3.094	1.370	3.282	115.8	311.4
1.77	0.54	0.381	0.297	0.913 *v^c1	3.804	10.516	0.422	0.728	4.051	0.065	4.400	3.203	1.391	3.597	126.9	321.0

Maximum Boundary Shear Stresses

Depth (ft)	d (m)	B/R	Kbs	Kss	Fsf	T bed N/m^2	T bank N/m^2	Stresses Allowable? Bed	Bank
0.33	0.1	12.060	1.176	0.923	0.892	95.2	84.9	OK	OK
0.39	0.12	10.327	1.201	0.942	0.895	113.5	101.6	OK	OK
0.46	0.14	9.074	1.223	0.960	0.898	131.6	118.2	OK	OK
0.52	0.16	8.123	1.244	0.977	0.901	149.5	134.7	OK	OK
0.59	0.18	7.373	1.264	0.992	0.904	167.3	151.3	OK	OK
0.66	0.2	6.766	1.282	1.006	0.907	185.0	167.8	OK	OK
0.72	0.22	6.262	1.299	1.020	0.910	202.5	184.3	OK	OK
0.79	0.24	5.837	1.315	1.033	0.913	220.0	200.8	OK	OK
0.85	0.26	5.473	1.331	1.045	0.915	237.4	217.3	OK	OK
0.92	0.28	5.156	1.345	1.056	0.918	254.7	233.8	OK	OK
0.98	0.3	4.878	1.359	1.067	0.920	272.0	250.3	OK	OK
1.05	0.32	4.632	1.373	1.078	0.923	289.2	266.9	OK	
1.12	0.34	4.413	1.386	1.088	0.925	306.5	283.4	OK	
1.18	0.36	4.215	1.398	1.097	0.927	323.7	300.0	OK	
1.25	0.38	4.036	1.410	1.106	0.929	340.9	316.7	OK	
1.31	0.4	3.873	1.421	1.115	0.931	358.1	333.3	OK	
1.38	0.42	3.725	1.432	1.124	0.933	375.2	350.1	OK	
1.44	0.44	3.588	1.442	1.132	0.935	392.4	366.8	OK	
1.51	0.46	3.461	1.453	1.140	0.936	409.6	383.6	OK	
1.57	0.48	3.345	1.463	1.148	0.938	426.8	400.4	OK	
1.64	0.5	3.236	1.472	1.156	0.940	444.0	417.3	OK	
1.71	0.52	3.135	1.481	1.163	0.941	461.3	434.2	OK	
1.77	0.54	3.040	1.490	1.170	0.943	478.5	451.2		

Where C is = 0.785

z	C
1.5	0.76
2	0.785
3	0.85
4	0.935
6	0.97

Permissible Shear Stresses

D50 = (m)	Tc = (N/m^2)	SF =	Cz =	Cw=	Cr=	Tpbed = N/m^2
0.4	600	1.3	0.89	1	0.54	461.54

Depth (ft)	d	E	Ab	Cl	Cb	Ca	Al (estimated)	Tp_bank N/m^2
0.33	0.1	6.78	0.15	2.01	1.00	0.42	0	250.8
0.39	0.12	5.67	0.18	2.01	1.00	0.42	0	250.9
0.46	0.14	4.87	0.21	2.01	1.00	0.42	0	251.0
0.52	0.16	4.27	0.23	2.01	1.00	0.42	0	251.2
0.59	0.18	3.80	0.26	2.01	1.00	0.42	0	251.3
0.66	0.2	3.43	0.29	2.01	1.00	0.42	0	251.4
0.72	0.22	3.12	0.32	2.01	1.00	0.42	0	251.5
0.79	0.24	2.87	0.35	2.01	1.00	0.42	0	251.7
0.85	0.26	2.65	0.38	2.01	1.00	0.42	0	251.8
0.92	0.28	2.46	0.41	2.01	1.00	0.42	0	251.9
0.98	0.3	2.30	0.43	2.02	1.00	0.42	0	252.0
1.05	0.32	2.16	0.46	2.02	1.00	0.42	0	252.2
1.12	0.34	2.03	0.49	2.02	1.00	0.42	0	252.3
1.18	0.36	1.92	0.52	2.02	1.00	0.42	0	252.4
1.25	0.38	1.82	0.55	2.02	1.00	0.42	0	252.6
1.31	0.4	1.73	0.58	2.02	1.00	0.42	0	252.7
1.38	0.42	1.64	0.61	2.02	1.00	0.42	0	252.8
1.44	0.44	1.57	0.64	2.02	1.00	0.42	0	253.0
1.51	0.46	1.50	0.67	2.02	1.00	0.42	0	253.1
1.57	0.48	1.44	0.70	2.02	1.00	0.42	0	253.2
1.64	0.5	1.38	0.73	2.03	1.00	0.42	0	253.3
1.71	0.52	1.33	0.75	2.03	1.00	0.42	0	253.5
1.77	0.54	1.28	0.78	2.03	1.00	0.42	0	253.6

Steep Slope Riprap Design
Ref: Stormwater Collection Systems Design Handbook, Larry Mays, 2001, Section 16.5
Troy - Mine, Millpad Channel, 77% slope
Target Flow = 33 cfs

Channel Dimensions

Bottom Width(ft) =	2.99	
Bottom Width(m) =	0.91	
Sideslopes =	2	:1(H:V)
Slope (m/m) =	0.77	
Length (ft) =	200	
Length (m) =	61	

Trial Lining

D90 (ft) =	6.97
D90 (m) =	2.125
D50 (ft) =	5.58
D50 (m) =	1.7
D10 (ft) =	2.79
D10 (m) =	0.85

Range of Depth to be Evaluated

Least Depth (m) =	0.1
Maximum Depth (m)=	2
Increment (m) =	0.02

Angles

Side Slope, degrees	26.57
Bed Slope, degrees	50.35
Riprap Angle of Repose, degrees (Get from Charts)	43
Factor of Safety	1.3

Hydraulic Calculations

Depth (ft)	Depth (m)	Area (sf)	Area (sm)	Wetted Perimeter (ft)	Wetted Perimeter (m)	Top Width (ft)	Top Width (m)	Hydraulic Radius (ft)	Hydraulic Radius (m)
0.328	0.100	1.195	0.111	4.453	1.357	4.298	1.31	0.268	0.082
0.394	0.120	1.485	0.138	4.746	1.447	4.560	1.39	0.313	0.095
0.459	0.140	1.793	0.167	5.040	1.536	4.823	1.47	0.356	0.108
0.525	0.160	2.118	0.197	5.333	1.626	5.085	1.55	0.397	0.121
0.591	0.180	2.461	0.229	5.627	1.715	5.348	1.63	0.437	0.133
0.656	0.200	2.820	0.262	5.920	1.804	5.610	1.71	0.476	0.145
0.722	0.220	3.197	0.297	6.213	1.894	5.873	1.79	0.515	0.157
0.787	0.240	3.591	0.334	6.507	1.983	6.135	1.87	0.552	0.168
0.853	0.260	4.002	0.372	6.800	2.073	6.398	1.95	0.588	0.179
0.919	0.280	4.430	0.412	7.094	2.162	6.660	2.03	0.625	0.190
0.984	0.300	4.876	0.453	7.387	2.252	6.923	2.11	0.660	0.201
1.050	0.320	5.339	0.496	7.681	2.341	7.185	2.19	0.695	0.212
1.115	0.340	5.819	0.541	7.974	2.431	7.448	2.27	0.730	0.222
1.181	0.360	6.316	0.587	8.268	2.520	7.710	2.35	0.764	0.233
1.247	0.380	6.831	0.635	8.561	2.609	7.972	2.43	0.798	0.243
1.312	0.400	7.363	0.684	8.855	2.699	8.235	2.51	0.831	0.253
1.378	0.420	7.911	0.735	9.148	2.788	8.497	2.59	0.865	0.264
1.444	0.440	8.478	0.788	9.441	2.878	8.760	2.67	0.898	0.274
1.509	0.460	9.061	0.842	9.735	2.967	9.022	2.75	0.931	0.284
1.575	0.480	9.662	0.898	10.028	3.057	9.285	2.83	0.963	0.294
1.640	0.500	10.280	0.955	10.322	3.146	9.547	2.91	0.996	0.304
1.706	0.520	10.915	1.014	10.615	3.236	9.810	2.99	1.028	0.313
1.772	0.540	11.567	1.075	10.909	3.325	10.072	3.07	1.060	0.323
1.837	0.560	12.236	1.137	11.202	3.414	10.335	3.15	1.092	0.333
1.903	0.580	12.923	1.201	11.496	3.504	10.597	3.23	1.124	0.343
1.969	0.600	13.627	1.266	11.789	3.593	10.860	3.31	1.156	0.352
2.034	0.620	14.348	1.333	12.082	3.683	11.122	3.39	1.188	0.362
2.100	0.640	15.087	1.402	12.376	3.772	11.385	3.47	1.219	0.372
2.165	0.660	15.842	1.472	12.669	3.862	11.647	3.55	1.250	0.381

Note: Gradation calculation (D90 and D10) based on USFS Specs. for Roads and Bridges

Bathurst Resistance Calculations

Depth (ft)	Depth (m)	b	c1	f(FR)	c2	f(REG)	f(CG)	V*	Sum of f (functions)	n	V/V*	Velocity (V) m/sec	Froude Number	Correction for slope 0.98 Flow, Q m^3/sec	Flow, Q ft^3/sec	To N/m^2
0.33	0.1	0.109	0.842	2.222 *v^c1	1.478	1.300	0.740	0.869	2.138	0.098	2.210	1.921	1.940	0.213	7.5	394.2
0.39	0.12	0.120	0.800	1.972 *v^c1	1.605	1.454	0.726	0.952	2.081	0.104	2.162	2.058	1.897	0.284	10.0	459.8
0.46	0.14	0.130	0.765	1.803 *v^c1	1.714	1.596	0.713	1.028	2.053	0.107	2.142	2.203	1.880	0.367	13.0	522.7
0.52	0.16	0.138	0.737	1.681 *v^c1	1.809	1.728	0.703	1.099	2.041	0.110	2.138	2.351	1.877	0.463	16.3	583.5
0.59	0.18	0.146	0.713	1.588 *v^c1	1.891	1.853	0.693	1.166	2.040	0.112	2.145	2.501	1.882	0.572	20.2	642.4
0.66	0.2	0.153	0.692	1.516 *v^c1	1.965	1.970	0.685	1.229	2.046	0.113	2.158	2.652	1.894	0.695	24.5	699.8
0.72	0.22	0.160	0.674	1.458 *v^c1	2.030	2.082	0.677	1.289	2.056	0.114	2.175	2.804	1.909	0.833	29.4	755.8
0.79	0.24	0.166	0.658	1.410 *v^c1	2.090	2.190	0.670	1.346	2.069	0.115	2.195	2.956	1.926	0.986	34.8	810.7
0.85	0.26	0.172	0.643	1.369 *v^c1	2.144	2.293	0.664	1.401	2.085	0.115	2.218	3.108	1.946	1.155	40.8	864.5
0.92	0.28	0.177	0.630	1.335 *v^c1	2.193	2.393	0.658	1.454	2.101	0.115	2.241	3.259	1.966	1.341	47.3	917.5
0.98	0.3	0.182	0.618	1.305 *v^c1	2.239	2.490	0.652	1.505	2.119	0.115	2.265	3.410	1.988	1.545	54.5	969.6
1.05	0.32	0.187	0.607	1.279 *v^c1	2.281	2.584	0.647	1.555	2.138	0.115	2.290	3.561	2.010	1.766	62.3	1021.1
1.12	0.34	0.191	0.597	1.256 *v^c1	2.321	2.676	0.642	1.603	2.157	0.115	2.316	3.711	2.032	2.006	70.8	1072.0
1.18	0.36	0.195	0.588	1.236 *v^c1	2.358	2.765	0.637	1.649	2.177	0.115	2.341	3.860	2.054	2.265	79.9	1122.3
1.25	0.38	0.199	0.579	1.218 *v^c1	2.393	2.853	0.632	1.694	2.197	0.115	2.367	4.010	2.077	2.545	89.8	1172.1
1.31	0.4	0.203	0.571	1.202 *v^c1	2.426	2.939	0.628	1.738	2.217	0.115	2.392	4.158	2.099	2.844	100.4	1221.5
1.38	0.42	0.207	0.563	1.187 *v^c1	2.457	3.023	0.624	1.781	2.237	0.114	2.418	4.306	2.122	3.165	111.7	1270.5
1.44	0.44	0.210	0.556	1.173 *v^c1	2.487	3.106	0.620	1.823	2.257	0.114	2.443	4.454	2.144	3.508	123.8	1319.1
1.51	0.46	0.213	0.549	1.160 *v^c1	2.515	3.187	0.616	1.864	2.278	0.114	2.469	4.601	2.166	3.874	136.7	1367.3
1.57	0.48	0.217	0.542	1.149 *v^c1	2.543	3.267	0.612	1.904	2.298	0.113	2.494	4.748	2.188	4.262	150.4	1415.3
1.64	0.5	0.220	0.536	1.138 *v^c1	2.569	3.346	0.608	1.943	2.318	0.113	2.519	4.895	2.210	4.674	165.0	1463.0
1.71	0.52	0.223	0.530	1.129 *v^c1	2.594	3.424	0.605	1.982	2.338	0.113	2.543	5.041	2.232	5.111	180.4	1510.4
1.77	0.54	0.226	0.524	1.119 *v^c1	2.618	3.501	0.601	2.020	2.357	0.112	2.568	5.186	2.253	5.573	196.7	1557.7

Maximum Boundary Shear Stresses

Depth (ft)	d (m)	B/R	Kbs	Kss	Fsf	T bed N/m^2	T bank N/m^2	Stresses Allowable? Bed	Bank
0.33	0.1	11.127	1.188	0.933	0.976	468.4	457.2	OK	OK
0.39	0.12	9.540	1.214	0.953	0.974	558.2	543.7	OK	OK
0.46	0.14	8.390	1.238	0.972	0.973	647.1	629.6	OK	OK
0.52	0.16	7.516	1.260	0.989	0.973	735.1	715.1	OK	OK
0.59	0.18	6.827	1.280	1.005	0.973	822.4	800.3	OK	OK
0.66	0.2	6.267	1.299	1.020	0.974	909.1	885.2	OK	OK
0.72	0.22	5.803	1.317	1.034	0.975	995.3	970.0	OK	OK
0.79	0.24	5.410	1.334	1.047	0.975	1081.1	1054.6	OK	OK
0.85	0.26	5.073	1.350	1.059	0.976	1166.7	1139.2	OK	
0.92	0.28	4.780	1.365	1.071	0.978	1252.0	1223.9	OK	
0.98	0.3	4.523	1.379	1.082	0.979	1337.1	1308.5	OK	
1.05	0.32	4.295	1.393	1.093	0.980	1422.1	1393.3	OK	
1.12	0.34	4.091	1.406	1.104	0.981	1507.0	1478.1	OK	
1.18	0.36	3.908	1.418	1.113	0.982	1591.9	1563.1	OK	
1.25	0.38	3.742	1.431	1.123	0.983	1676.8	1648.2	OK	
1.31	0.4	3.591	1.442	1.132	0.984	1761.6	1733.6	OK	
1.38	0.42	3.452	1.453	1.141	0.985	1846.5	1819.1	OK	
1.44	0.44	3.325	1.464	1.149	0.986	1931.4	1904.7	OK	
1.51	0.46	3.208	1.475	1.158	0.987	2016.4	1990.6		
1.57	0.48	3.099	1.485	1.166	0.988	2101.5	2076.8		
1.64	0.5	2.998	1.495	1.173	0.989	2186.7	2163.1		
1.71	0.52	2.904	1.504	1.181	0.990	2271.9	2249.6		
1.77	0.54	2.816	1.513	1.188	0.991	2357.3	2336.4		

Where C is = 0.785

z	C
1.5	0.76
2	0.785
3	0.85
4	0.935
6	0.97

Permissible Shear Stresses

D50 = (m)	Tc = (N/m^2)	SF =	Cz =	Cw=	Cr=	Tpbed = N/m^2
1.7	2550	1.3	0.89	1	0.54	1961.54

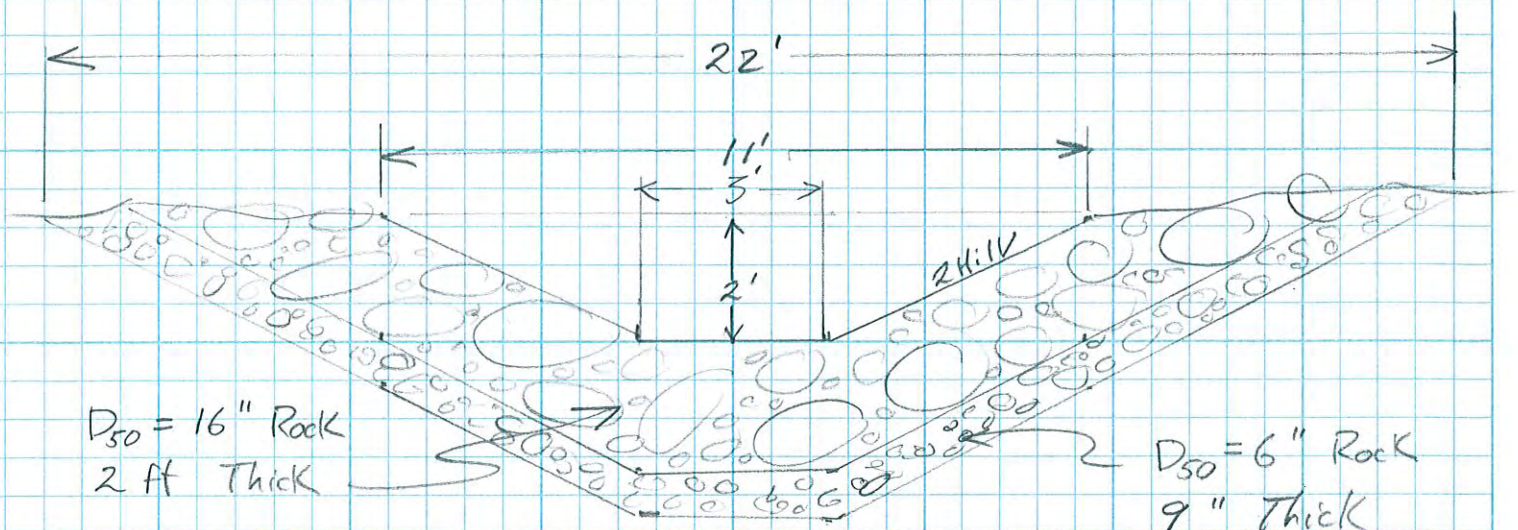
Depth (ft)	d	E	Ab	Cl	Cb	Ca	Al (estimated)	Tp_bank N/m^2
0.33	0.1	5.35	0.19	2.01	1.00	0.42	0	1066.5
0.39	0.12	4.50	0.22	2.01	1.00	0.42	0	1067.2
0.46	0.14	3.88	0.26	2.01	1.00	0.42	0	1067.9
0.52	0.16	3.42	0.29	2.01	1.00	0.42	0	1068.5
0.59	0.18	3.06	0.33	2.01	1.00	0.42	0	1069.2
0.66	0.2	2.76	0.36	2.01	1.00	0.42	0	1069.8
0.72	0.22	2.52	0.40	2.01	1.00	0.42	0	1070.5
0.79	0.24	2.32	0.43	2.02	1.00	0.42	0	1071.1
0.85	0.26	2.15	0.47	2.02	1.00	0.42	0	1071.8
0.92	0.28	2.00	0.50	2.02	1.00	0.42	0	1072.4
0.98	0.3	1.87	0.53	2.02	1.00	0.42	0	1073.1
1.05	0.32	1.76	0.57	2.02	1.00	0.42	0	1073.8
1.12	0.34	1.65	0.60	2.02	1.00	0.42	0	1074.4
1.18	0.36	1.56	0.64	2.02	1.00	0.42	0	1075.1
1.25	0.38	1.48	0.67	2.02	1.00	0.42	0	1075.7
1.31	0.4	1.41	0.71	2.02	1.00	0.42	0	1076.4
1.38	0.42	1.34	0.74	2.03	1.00	0.42	0	1077.1
1.44	0.44	1.28	0.78	2.03	1.00	0.42	0	1077.7
1.51	0.46	1.23	0.81	2.03	1.00	0.42	0	1078.4
1.57	0.48	1.18	0.85	2.03	1.00	0.42	0	1079.1
1.64	0.5	1.13	0.88	2.03	1.00	0.42	0	1079.8
1.71	0.52	1.09	0.92	2.03	1.00	0.42	0	1080.4
1.77	0.54	1.05	0.96	2.03	1.00	0.42	0	1081.1

CDM

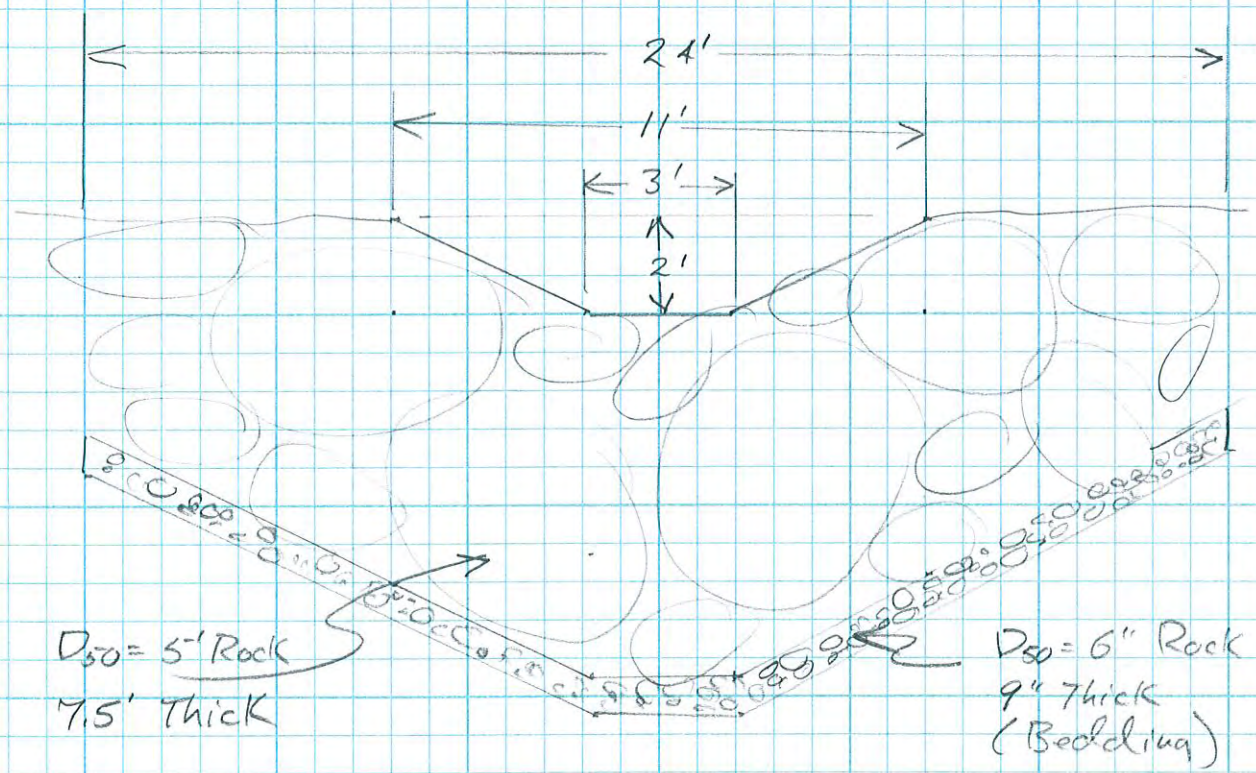
CLIENT MDEQ
PROJECT Troy Mine EA
DETAIL Millsite Channel Sections

JOB NO.
DATE CHECKED
CHECKED BY

COMPUTED BY WHB
DATE 6/17/2010
PAGE NO.



10% Slope Channel Section
1" = 3'



1.3:1 to 2:1 Channel Section
1" = 4'

TROY MINE RECLAMATION
MILLSITE CHANNEL COST
December 2, 2010

OPTION 1

Item			Quanity		Unit Cost	Cost	
Mobilization @ 10%						$15,681	
Erosion control @ 5%						$7,467	
Clear and Grub (wooded areas)			1	AC	4000	$4,000	
Access Road			700	LF	16	$11,200	USDA FS Cost Estimating Guide for Road Construction
Channel	length (ft)	section (ft ^{2})					
D_{50} = 16" Rock	650	30	722	CY	$30.00	$21,667	
D_{50} = 5' Rock	150	180	1000	CY	$60.00	$60,000	
D_{50} = 6" Rock	800	18	533	CY	$30.00	$16,000	
Energy Dissipation Basin							
D_{50} = 16" Rock	30	46	51	CY	$30.00	$1,533	
D_{50} = 6" Rock	30	23	26	CY	$30.00	$767	
Liner							
HDPE			1200	SY	$15.00	$18,000	
Bedding			400	CY	$20.00	$8,000	
Culvert							
4' Dia. CMP			40	LF	$143.00	$5,720	Means 33 41 13 40 2200
Excavation, Backfill, Compaction			40	LF	$61.30	$2,452	Means 31 23 16 13 0500, 2020 and 31 23 23 23 7000
Construction contingency @ 15%						$25,873	
Total Construction Cost						**$198,359**	
Engineering @ 20%						$39,672	
Total Project Cost						**$238,031**	

TROY MINE RECLAMATION
MILLSITE CHANNEL COST
December 2, 2010

OPTION 2

Item			Quanity		Unit Cost	Cost	
Mobilization @ 10%						$19,086	
Erosion control @ 5%						$9,089	
Clear and Grub (wooded areas)			1	AC	4000	$4,000	
Access Road			400	LF	16	$6,400	USDA FS Cost Estimating Guide for Road Construction
Channel	length (ft)	section (ft ^{2})					
D_{50} = 16" Rock	870	30	967	CY	$30.00	$29,000	
D_{50} = 5' Rock	200	180	1333	CY	$60.00	$80,000	
D_{50} = 6" Rock	970	18	647	CY	$30.00	$19,400	
Energy Dissipation Basin							
D_{50} = 16" Rock	30	46	51	CY	$30.00	$1,533	
D_{50} = 6" Rock	30	23	26	CY	$30.00	$767	
Liner							
HDPE			1500	SY	$15.00	$22,500	
Bedding			500	CY	$20.00	$10,000	
Culvert							
4' Dia. CMP			40	LF	$143.00	$5,720	Means 33 41 13 40 2200
Excavation, Backfill, Compaction			40	LF	$61.30	$2,452	Means 31 23 16 13 0500, 2020 and 31 23 23 23 7000
Construction contingency @ 15%						$31,492	
Total Construction Cost						**$241,439**	
Engineering @ 20%						$48,288	
Total Project Cost						**$289,726**	

Appendix F
Troy Mine Area Surface Water Evaluation

Technical Memorandum

To: *Emily Corsi, Herb Rolfes – DEQ*
Bobbie Lacklen, John McKay – KNF

From: *Kent Whiting, Mark Hills, Bill Bucher – CDM Helena*

Date: *December 3, 2010*

Subject: *Troy Mine Area Surface Water Evaluation*

The purpose of this memorandum is to evaluate the potential for adverse effects to surface water, seeps and springs in the vicinity of the Troy mine workings after closure of the mine. After closure the groundwater entering the mine will be allowed to flood up to a level of 4,225 feet, where it will be routed through the Service and Conveyor adits and transported by pipeline to the tailings impoundment area. The current decant ponds at this location will be used to infiltrate the water. This water will be treated through attenuation of metals as it infiltrates through the underlying soils as described in *Troy Mine Copper Attenuation Study – Secondary Processes* (CDM, 2010a). Further descriptions of this system are presented in the *Mine Water Management Technical Memorandum* (CDM, 2010b) and the *Conceptual Design of New Water Line for Transport of Mine Water after Mine Closure* (CDM, 2010c).

The primary concern is that as the elevation of water in the mine workings increases, the increased head in the mine workings will force mine water through permeable pathways in the vicinity of the mine. Movement of untreated mine pool water through these pathways has the potential to cause contamination of existing surface water, seeps and springs and create new seeps or springs, which may discharge contaminated water. This evaluation investigates the relationship between surface water, seeps and springs and the mine workings using a hydrogeological approach with a geochemical perspective. In the hydrogeologic evaluation, the surface water expressions in the vicinity of the mine workings are related to the present and future water elevations, and the expected changes are described. In the geochemical evaluation, the present water quality of the surface water, seeps and springs is described and used to determine the potential connection between the surface water, springs and seeps and the flooded mine workings.

Hydrogeologic Evaluation

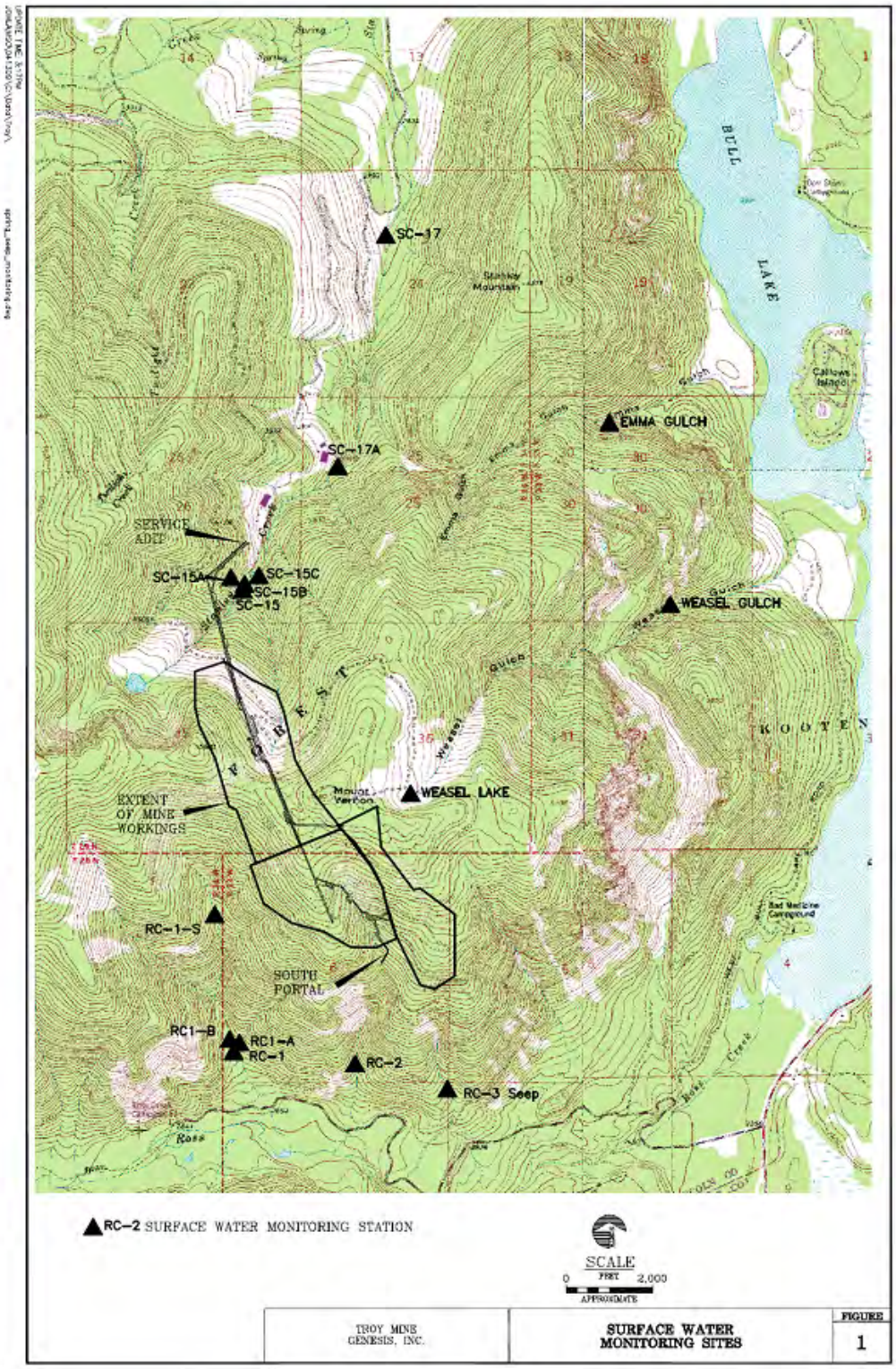
When the mine is closed, dewatering pumps will be shut-off and water will flood the workings. The physical and hydrologic features of the mine workings and terrain in the vicinity of the

Troy Mine were evaluated to assess changes that would occur in the hydrologic system. Data used in the evaluation were limited to the location, elevation, and distribution of identified springs and seeps near the Troy Mine, the current pumped mine water elevation in the mine workings, the expected flooded post-mine water elevation, and the local topography. Limited geologic and quantitative hydrologic data were available for this evaluation. For example, fracture systems are only well mapped within the ore body but not in the surrounding formations, and no wells were available outside the mine footprint to verify static water elevations in the surrounding area.

The general extent of the mine workings and the location of identified surface water sites in the vicinity of the Troy Mine are shown in **Figure 1**. The monitored surface water sites are located in low lying areas within the Stanley Creek drainage north of the mine and the Ross Creek drainage south of the mine. These surface water sites represent known points of groundwater discharge during the period of mine operation and dewatering. Hydrometrics (2009) reported two springs (RC-1-S and RC-3) in the Ross Creek drainage and apparent groundwater-supplied baseflow in two Ross Creek tributaries (RC-1 and RC-2). Hydrometrics also reported that expressions of groundwater exist in Stanley Creek within the defined stream channel. These springs appear to represent groundwater expression at elevations from 3,800 to 3,900 feet. The SC-15 sites (near the mine Service Adit) generally have flow even during late summer and fall. This discharge during the dry portion of the annual water cycle suggests that these springs are connected to an aquifer of significant extent.

To assess the potential impacts on groundwater discharge in the vicinity of the mine after closure, a series of cross-sections were drawn. Sections A-A' through E-E' intersect the mine workings and surface water monitoring sites. The cross-sections are attachments to this document. The plan view of the mine area is shown on each of the drawings to reference the respective sections. During mine operation, the active workings are dewatered to 4,050 feet above mean sea level (amsl). After mine closure, the maximum "flooded" groundwater elevation will be 4,225 feet amsl. The maximum flooded elevation is set by the base of the high point in the service adit that will remain open and serve to drain the mine workings. Following mine closure, elevation head within the mine workings will increase about 175 feet. The projected "flooded" water table (light blue line) relative to the current "pumped" water table (dark blue line) on the sections depicts the relative magnitude of shift that is anticipated for the surface water monitoring sites.

The cross-sections indicate the approximate stratigraphy and elevation of the geologic units. This information is most accurate in the immediate vicinity of the mine workings and is extrapolated in areas more distant from the mine workings. The geologic sections show that current and post-closure water levels are within the Revett formation. The Revett Formation consists of fractured quartzite and groundwater flow is through fractures. At the coarse scale of these cross-sections, fracture flow can be represented similarly to that of a porous medium, and groundwater elevations have been estimated based on this assumption.



Source: Genesis, Inc.

The evaluation of the hydrogeology of the area surrounding the mine workings indicates that the surface water measurement sites are typically far below the elevation of the mine workings. The monitoring sites in Stanley Creek are 250 feet below the elevation of the operational (pumped) water level in the mine, and the monitoring sites in Ross Creek drainage are at least 700 feet below the operational water level. The projected post-closure rise of water level would be relatively small compared to the hydraulic head difference between the operational (pumped) mine water level and most surface water measurement sites (see attachments). Using the principles of groundwater flow, it is expected that this head difference would decrease in an outward direction from the mine to no more than a few tens of feet in the vicinity of the monitoring sites. This would limit the potential for migration of water sources in the vicinity of these sites horizontally and vertically, as well as limit the potential increase inflow to a small percentage of current flow.

It is known that there are perennial surface water flows in the upper reaches of Stanley Creek. One small perennial stream originates above the elevation of the mine workings presumably from a local aquifer. The upper portions of this stream would not be affected by flooding of the mine because it originates above the maximum mine flooding elevation. However, other springs and seeps may become active at elevations below the final mine pool elevation after mine closure. These springs would most likely occur in the interval between the current pumping level of 4,050 feet and the final pool elevation of 4,225 feet, an interval of 175 feet. Whether these springs appear depends largely on whether faults that intercept the ground surface in this interval can transmit sufficient water to result in surface expressions. Although there is limited knowledge of surface faults in the perimeter around the mine workings, it is known that most faults within the mine workings tend to be vertically oriented. They therefore transmit groundwater primarily in the vertical direction, with horizontal flow being limited by their length and a lesser hydraulic gradient. Horizontal joints, fractures, and faults that could transmit water to the surface are not documented. This geological understanding suggests that the potential for development of new springs in the interval of the flooded mine workings is limited.

Geochemical Evaluation

The data available for surface water, springs and seeps analysis was spotty, both in terms of the collection frequency and the parameters analyzed. The data used in the analysis were collected from a number of sources, which were collected as needed for different reasons. A summary of the data includes:

- ASARCO, mostly pre-mining baseline data, 1977-1985 (Genesis Appendix E of March 2008 Annual Report)
- Forest Service Database, 1973-2005

- DEQ Field Inspection Reports, 1991-2009
- Genesis Springs and Seep Data, February 2009
- Miscellaneous ASARCO data, 1979-1985
- Supplemental spring sampling performed by DEQ in August 2010

The surface water data were compared to data for the mine pool, the decant pond, and the mine adit collected mainly by Genesis but also with some data collected by DEQ and CDM. A summary of the data used is provided in Table 1.

Table 1 – Summary of Sample Data for Used for the Geochemical Evaluation.

Diagram	Number of Samples	Date Range
TDS Box Plot	31	1973-2007
Ternary Diagram	13	1975-2010
Dissolved Copper Box Plot	5	2002-2006
Dissolved Iron Box Plot	5	2003-2004

Major Ions

Major ions, such as calcium, magnesium, sulfate, chloride, sodium, and potassium, can be used to evaluate the source of a groundwater. Often, groundwaters derived from distinct aquifers will have distinct major ion chemistry, both in terms of the total dissolved load (i.e. TDS) and in the ratios of one ion to another. A comparison of the TDS concentrations for the mine area surface water compared to other water sources is provided in **Figure 2** below.

The mine area springs and seeps and surface waters have low TDS values compared to the mining related waters (mine void, decant pond, service adit) and the groundwaters in the vicinity of the tailings impoundment (a.k.a. "Lake Creek GW"). Most of the TDS in the mine related waters and tailings impoundment area groundwaters is composed of calcium, magnesium, and bicarbonate, although there is a higher contribution of sodium and potassium in the decant pond water, which may reflect the addition of reagents during the flotation process. The higher TDS and the calcium-magnesium carbonate composition of these waters likely is the result of fairly long residence times of ground water in local rocks, such as dolostone or clastic sediments cemented by the mineral dolomite ($CaMg(CO_3)_2$). The surface waters and mine area seeps and springs are not calcium-magnesium bicarbonate waters and are low in dissolved solids, suggesting that the source of these waters is precipitation runoff and/or

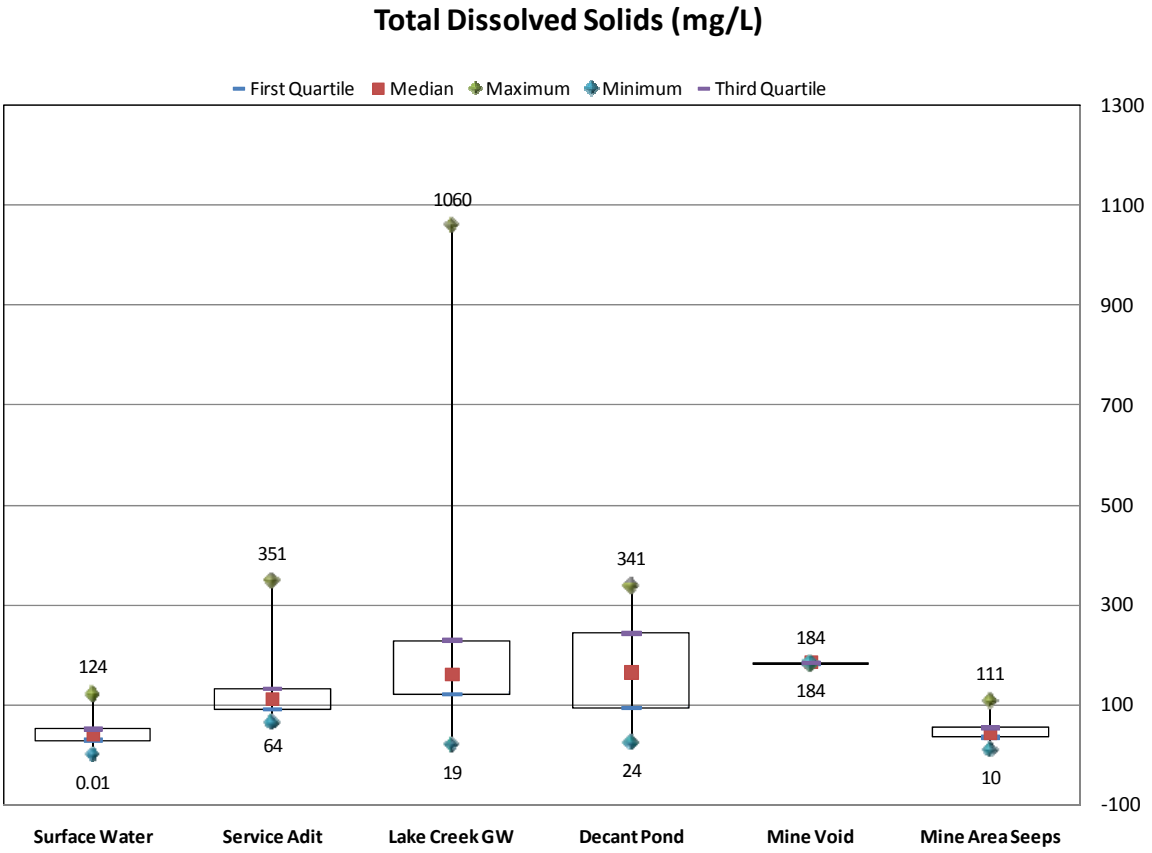


Figure 2 – Comparison of the TDS values for the mine area surface water (seeps) to other water types.

near-surface groundwater which has not had enough residence time or sufficient contact with dolomite-bearing aquifer materials.

Figure 3 is a ternary diagram showing the differences in the relative chemistry between the mine area surface water (as represented by a single sample collected within the Ross Creek drainage) and some of the mine-related waters. The triangular field on the bottom left is used to plot the positively-charged ions (calcium, magnesium, sodium, potassium), and the triangular field on the bottom right is used to plot the negatively-charged ions (chloride, sulfate, bicarbonate). The central diamond-shaped field reflects the whole chemistry composition of the water. In general, similar waters plot close to each other on a ternary diagram, while dissimilar waters plot at a distance from each other. The Ross Creek baseline data indicate a calcium-magnesium sulfate water, while the mine-related waters and springs in the vicinity are calcium-

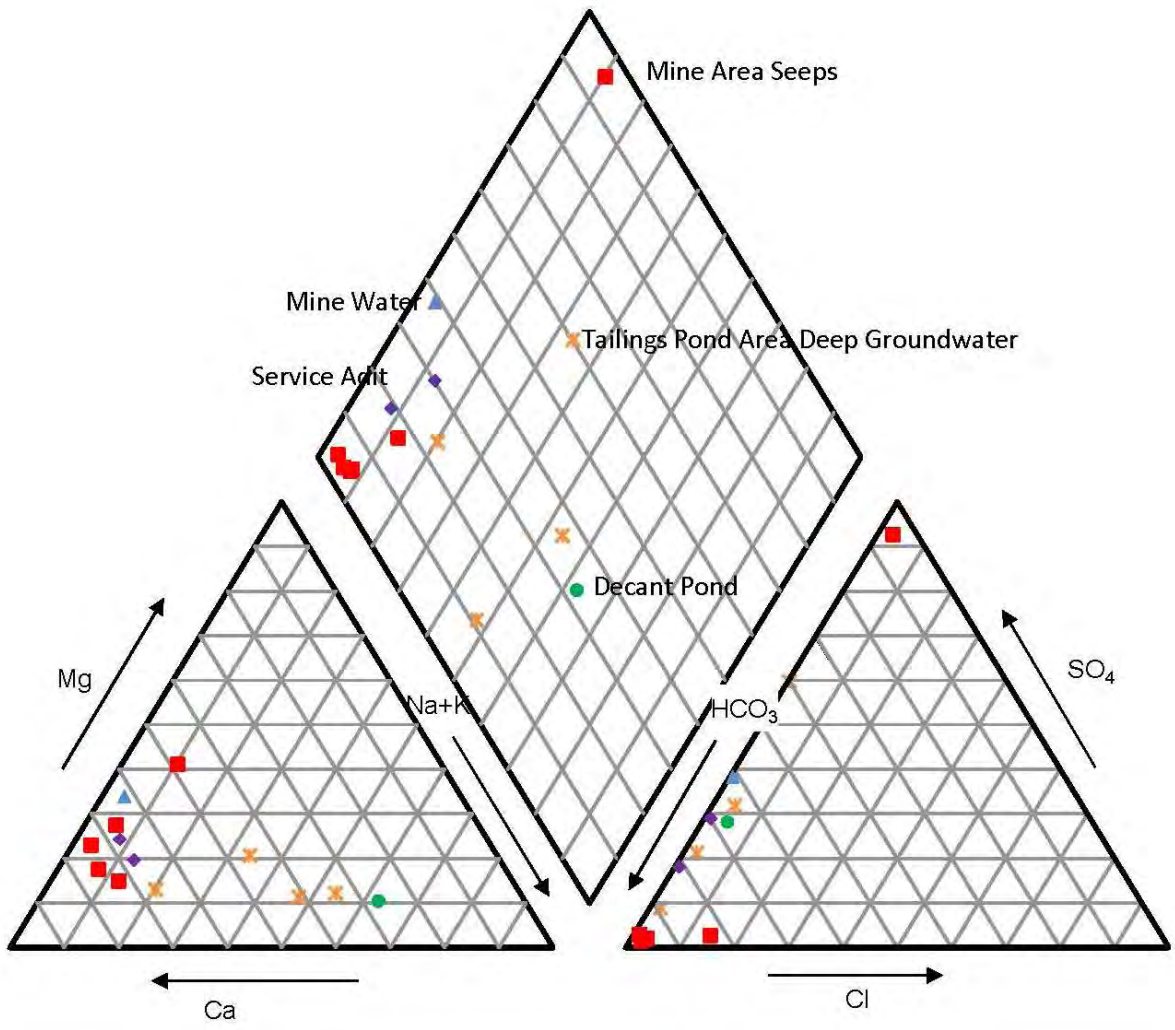


Figure 3 – Ternary diagram showing the ratios of the major ions for each water type.

magnesium carbonate waters with relatively lower magnesium ratios. A summary of the samples used for the diagram is shown in Table 2.

Figure 3 shows that Ross Creek surface water is very different from the mine-related waters. The difference in major ion ratios and TDS between the Ross Creek surface water and the other waters is a strong confirmation that the surface water in Ross Creek tributaries is not derived from the mine void.

Table 2 – Summary of Sample Data Used in Ternary Diagram

Sample ID	Date Collected	Type
Service Adit-D	5/12/09	Adit
Service Adit-P	5/12/09	
Decant Pond	5/14/2009	Decant Pond
Mine Water	12/16/2009	Mine Water
95-4	5/12/2009	Tailings Pond Area Deep Groundwater
95-5	5/12/2009	
95-8	6/12/2009	
MW-01-15	6/8/2009	
SC-15A	8/12/10	Mine Area Surface Water
SC-15C	8/12/10	
Ross Creek #11	8/12/10	
RC-1	8/12/10	
Ross Creek #10	8/12/10	
Ross Cr 74-10	5/20/75	

Metals

The metals data for mine area surface water is limited to dissolved and total recoverable concentrations of arsenic, antimony, copper, lead, iron, manganese, and zinc. Of these, few values above the analytical reporting limit were observed, namely total recoverable and dissolved copper, iron, and manganese, and dissolved zinc. In general, when detections were observed, the concentrations were low, as shown by the comparion of dissolved copper concentrations for each water type (**Figure 4**).

Dissolved zinc concentrations of 0.003 mg/L were reported for Ross Creek drainage sites RC-1 and RC-3 for samples collected in July 2006. Dissolved zinc concentrations within the mine void waters were higher, at 0.020 mg/L for the sample collected in December 2009. However, much of the other zinc data could not be compared to these two detections, as the reporting limit was too high (0.010 mg/L).

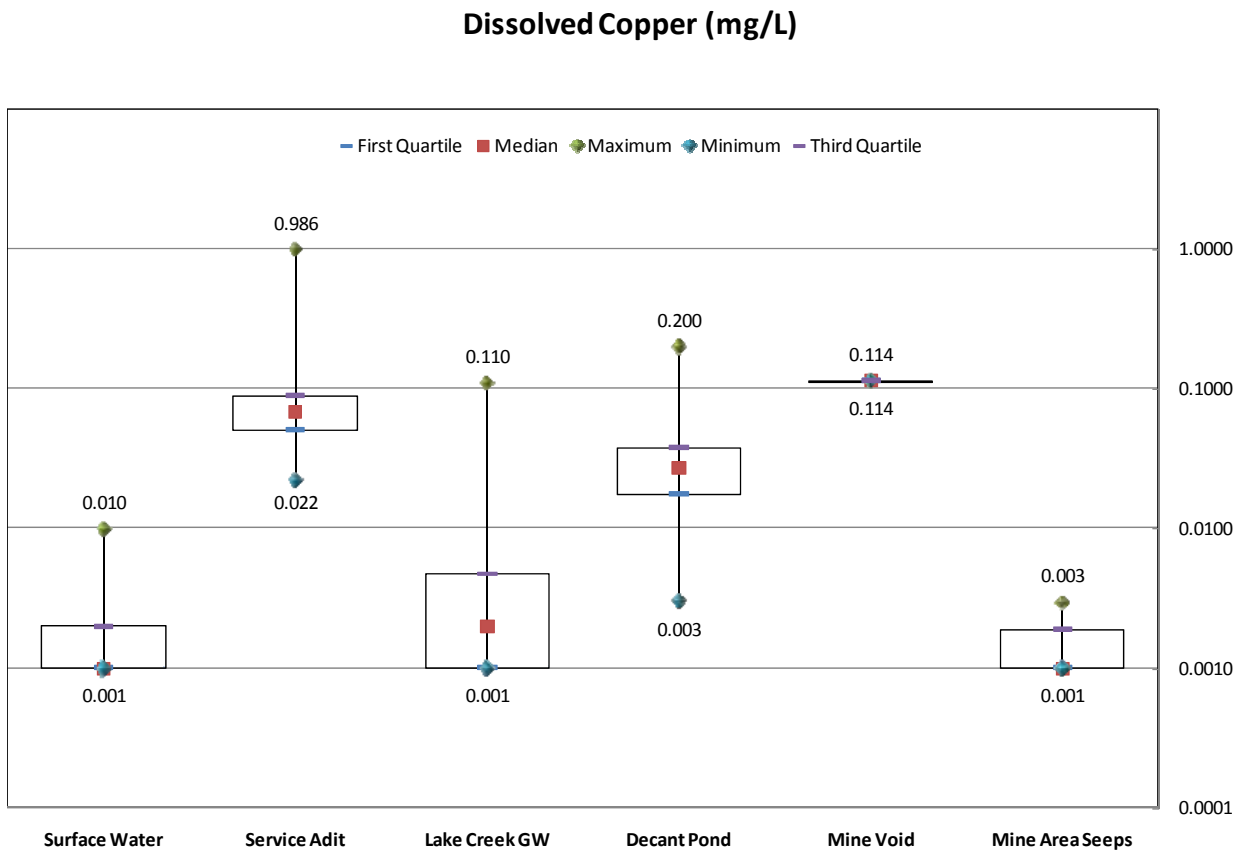


Figure 4 – Comparison of dissolved copper concentrations between the mine area surface water (seeps) and other waters on the site (note the logarithmic scale).

A comparison of the dissolved iron concentrations is shown in **Figure 5** below.

The highest dissolved iron concentrations (up to 69 mg/L) are associated with the deep groundwaters in the vicinity of the tailings impoundment. These waters have variable chemistry, as shown in the wide spread of the data points on the ternary diagram (Figure 3). The geochemical conditions are sometimes reducing, which results in high iron concentrations, while at other times are more oxidizing and have lower iron concentrations (see the *Troy Mine Copper Attenuation Study*, CDM, 2010, for more details). The wells completed in the Lake Creek Valley near the tailings impoundment ("MW" series) have shown erratic iron concentrations over time, which likely reflects a fluctuating redox gradient. The mine area surface waters generally have higher dissolved iron concentrations than the mine related waters, but not as high as the deep groundwaters in the vicinity of Lake Creek and the tailings impoundment.

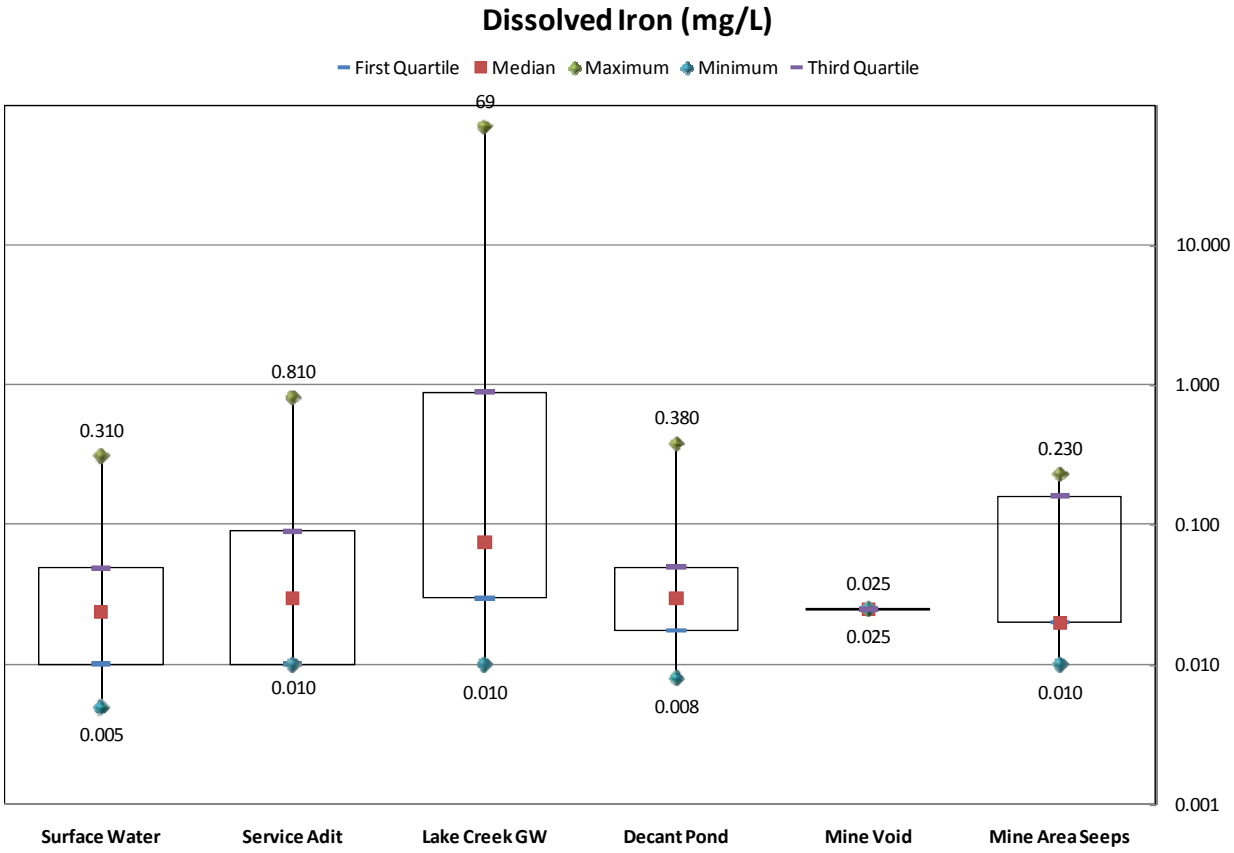


Figure 5 – Comparison of dissolved iron concentrations between the mine area surface water (seeps) and the other waters (note the logarithmic scale).

Post Closure Mine Water Quality

Following closure of the mine, the underground workings will be flooded up to the spillover point at the Service and Conveyor adits. Copper (Cu^{+2}) is released into water flooding the workings from the mineralized wall rocks by oxidation of the copper sulfide minerals present. The reaction requires an oxidant, such as dissolved oxygen (O_2) in order to occur. An example for the oxidation of chalcopyrite ($CuFeS_2$) is shown in equation 1.

$$CuFeS_2(s) + 4O_2(aq) \rightarrow Fe^{+2}(aq) + Cu^{+2}(aq) + 2SO_4^{-2}(aq) \qquad (1)$$

Under flooded conditions, the dissolved oxygen concentrations will be expected to decrease within the flooded portions of the workings, and the rate of oxidation of copper sulfide minerals should decrease as well. Skousen et al. (2006) in a study of several coal mines in the eastern United States over a 35 year period found that after the first few mine volumes of water pass through the system the water becomes much less acid or even net alkaline, and metals concentrations decrease. Although the Troy Mine is not acid producing, a similar beneficial

effect of flooding on metals concentrations is expected. The quality of the mine water is expected to improve or remain constant after closure.

Nitrate and ammonia concentrations would also decrease once blasting is discontinued. Nitrogen compounds in adit water result from incomplete detonations or from poor housekeeping (spilled explosives). Explosives typically contain nitrogen compounds, which are present in the mine water as ammonia, and once oxidized, as nitrate and/or nitrite. Once the initial mine water is flushed from the system (by discharge at the spillover point and transport to the decant ponds), nitrate and ammonia concentrations would decline. In fact, nitrate+nitrite and ammonia concentrations within the disused and partially flooded portions of the mine are significantly lower than for the decant pond water, and to some extent, the adit discharge as shown in Table 3.

Table 3 – Comparison of Nitrate and Ammonia Concentrations for the Active and Inactive Portions of the Mine.

Water	Sample Date	Ammonia Concentration (mg/L)	Nitrate+Nitrite Concentration (mg/L)
Mine Water (disused area)	12/16/09	0.39	7.4
Decant Pond	12/16/09	11.2	37.6
Decant Pond (Decant 1)	5/14/09	6	17.6
Decant Pond (Decant)	5/14/09	6	19.4
Decant Pond	6/9/09	4.4	14.5
Adit Pipe	5/12/09	2.33	7.99

The difference in the concentrations of ammonia and nitrite+nitrate is not as pronounced for the adit discharge as for the decant pond. However, the adit discharge is composed of drainage from both used and disused portions of the mine, and would be expected to have an intermediate concentration between the active and disused water quality. The decant pond water, which is derived from the mill circuit, would be expected to have the highest ammonia and nitrate+nitrite as the crushed ore bears fresh blasting residue.

Table 4 shows data for the decant ponds and the service adit before, during and after the mine shutdown from April 1993 to December 2004. For both the decant ponds and the Service Adit, there is a decrease in nitrate plus nitrate during mine shutdown, indicating that mine water quality improved for this parameter when operations ceased. Again, the effect is more pronounced in decant ponds water than service adit water although the mill was not operating in this period. A similar decrease in nitrite plus nitrate is expected after final closure of the mine.

Table 4 – Comparison of Average Nitrate plus Nitrite Concentrations (mg/L) before, during and after Mine Shutdown.

Water	Pre-Shutdown	Shutdown	Post Shutdown
Decant Pond	17.6	1.72	12.0
Service Adit	10.0	1.43	7.24

Conclusions

The evaluation of the hydrogeology of the area surrounding the mine workings shows that most identified springs are well below the elevation of the present (pumped) water level in the mine. The geochemical evaluation indicates that identified surface waters in the vicinity of the mine are not being impacted by mine water. The expected water level rise after mine closure is relatively small compared to the current head difference between the mine water level and most surface water expressions in the mine area. Using the principles of groundwater flow, it is expected that this head difference will decrease in an outward direction from the mine and become no more than tens of feet in the vicinity of the springs. Thus, the rate of discharge from the existing surface water expressions may increase to some degree due to the increased head, but the location and spatial distribution of the expressions is not expected to change appreciably after mine closure.

The evaluation of the major ions and metals within the mine area surface water and other mine waters reveals that the mine area surface waters are chemically distinct from the deep groundwater and mine related waters but quite similar to area surface waters. The data suggest that the source of mine area surface water is not from the mine void, but is likely derived from precipitation or freshly recharged near-surface aquifers. After the mine is flooded at closure, it is expected that mine water will improve in quality as oxidation is reduced in the flooded portions of the mine void and concentrations of metals and nitrogen compounds decrease. Therefore, any effects of mine water that may reach surface water expressions are expected to be reduced after mine flooding.

References

CDM. 2010a. *Troy Mine Copper Attenuation Study – Secondary Processes*. Prepared for DEQ by CDM, Inc. July 2010.

CDM, 2010b. Mine Water Management Analysis – Troy Mine. Technical Memorandum prepared for Montana Department of Environmental Quality and USDA Forest Service, Kootenai National Forest dated December 3, 2010.

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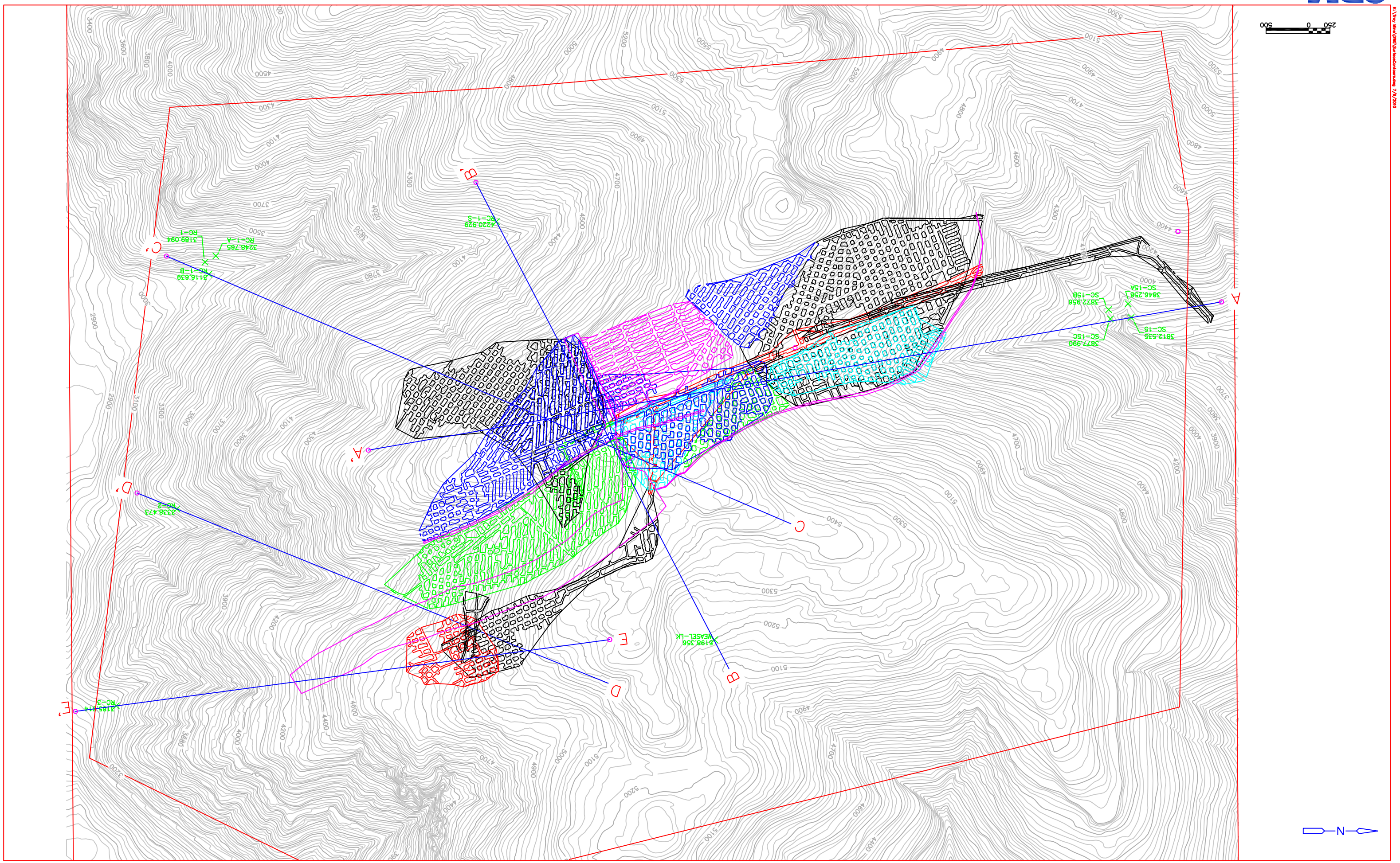
Skousen, J., L. McDonald, B. Mack, and J. Demchak, 2006. Water quality from above-drainage underground mines over a 35-year period. *Proceedings of the 7th International Conference on Acid Rock Drainage (ICARD), March 26-30, 2006, St. Louis, MO*.



OVERALL SITE PLAN

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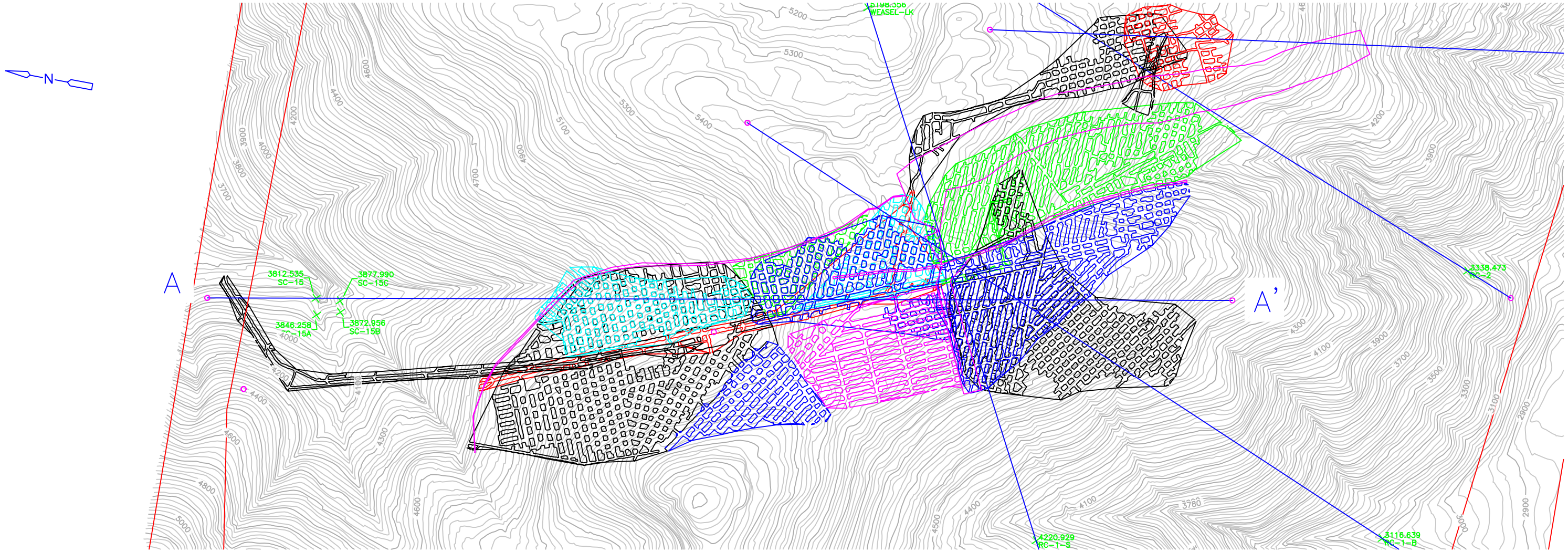
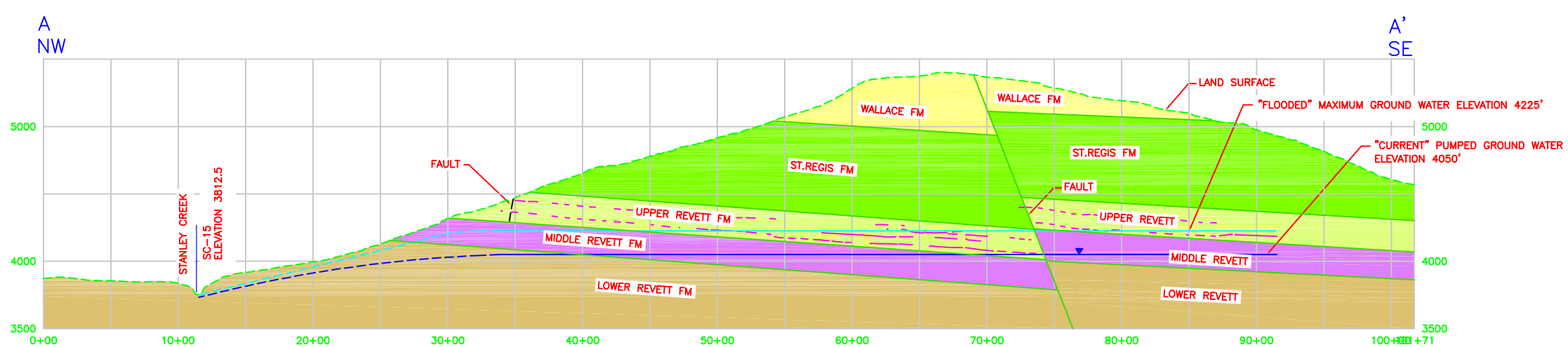


NOTES:
1. THE GEOLOGICAL CROSS-SECTIONS AND WATER LEVELS ARE BASED ON AVAILABLE DATA. THESE SECTIONS PRESENT SIMPLIFIED CONCEPTUAL INTERPRETATIONS OF THIS DATA.
2. FLOODED GROUNDWATER ELEVATION CONTROLLED BY HIGH POINT OF SERVICE ADIT.



LEGEND

- LAND SURFACE
- TOP OF MINE WORKINGS
- CURRENT PUMPED ELEVATION
- MAXIMUM FLOODED ELEVATION
- FAULTS

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SECTION A

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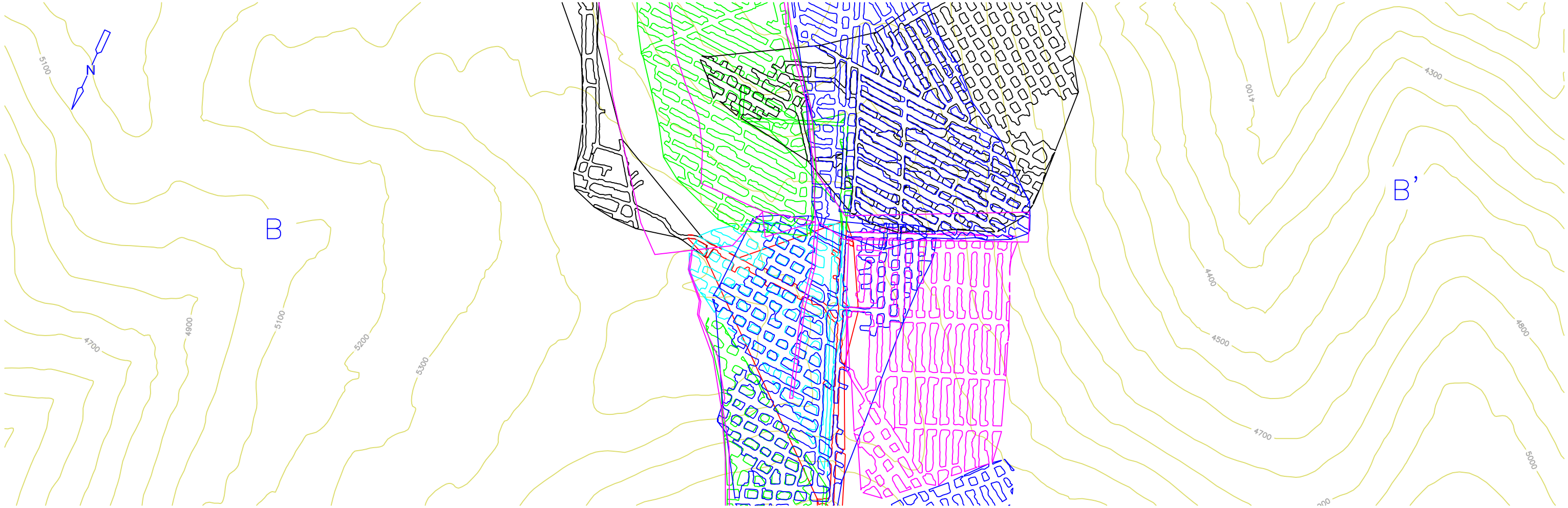

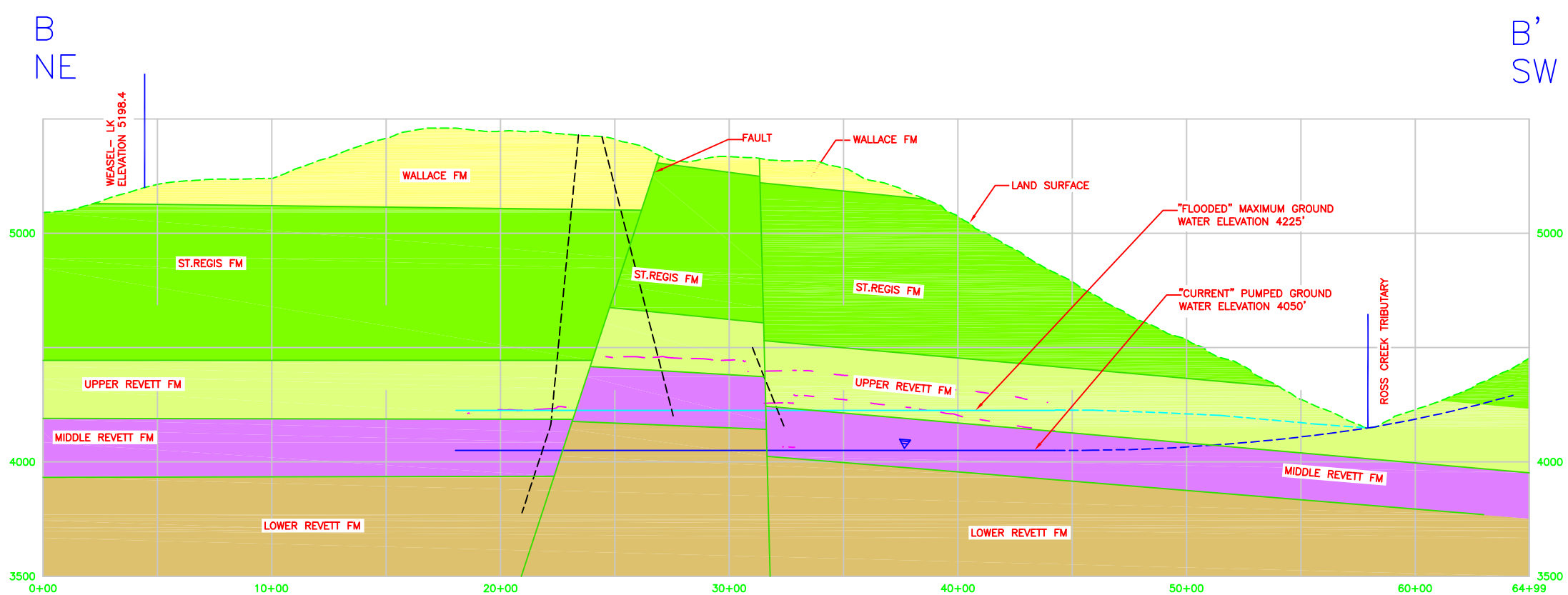

LEGEND

- LAND SURFACE
- TOP OF MINE WORKINGS
- CURRENT PUMPED ELEVATION
- MAXIMUM FLOODED ELEVATION
- FAULTS

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2. FLOODED GROUNDWATER ELEVATION CONTROLLED BY HIGH POINT OF SERVICE ADIT.

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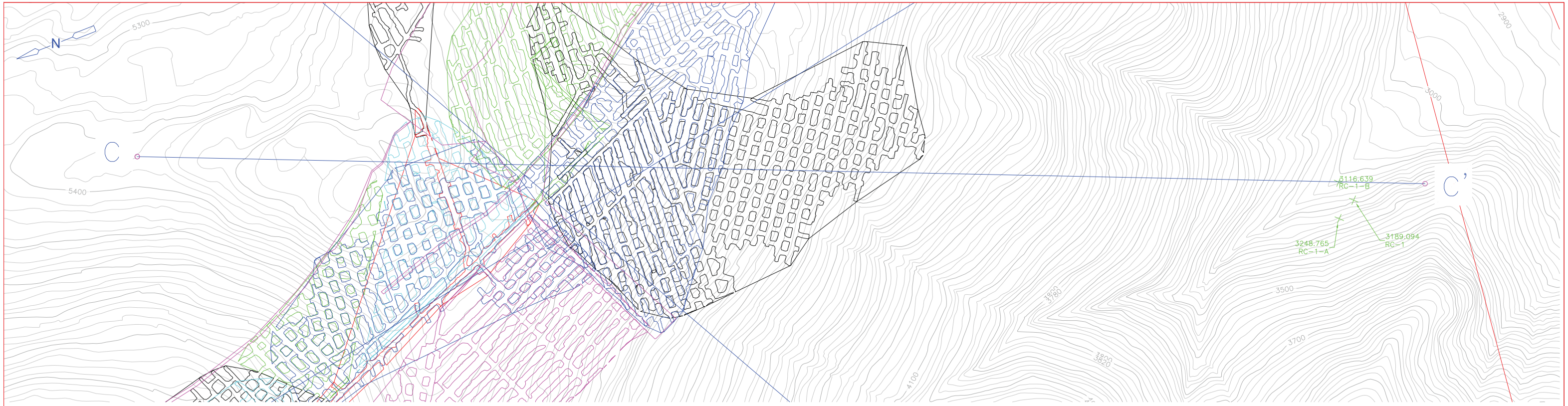
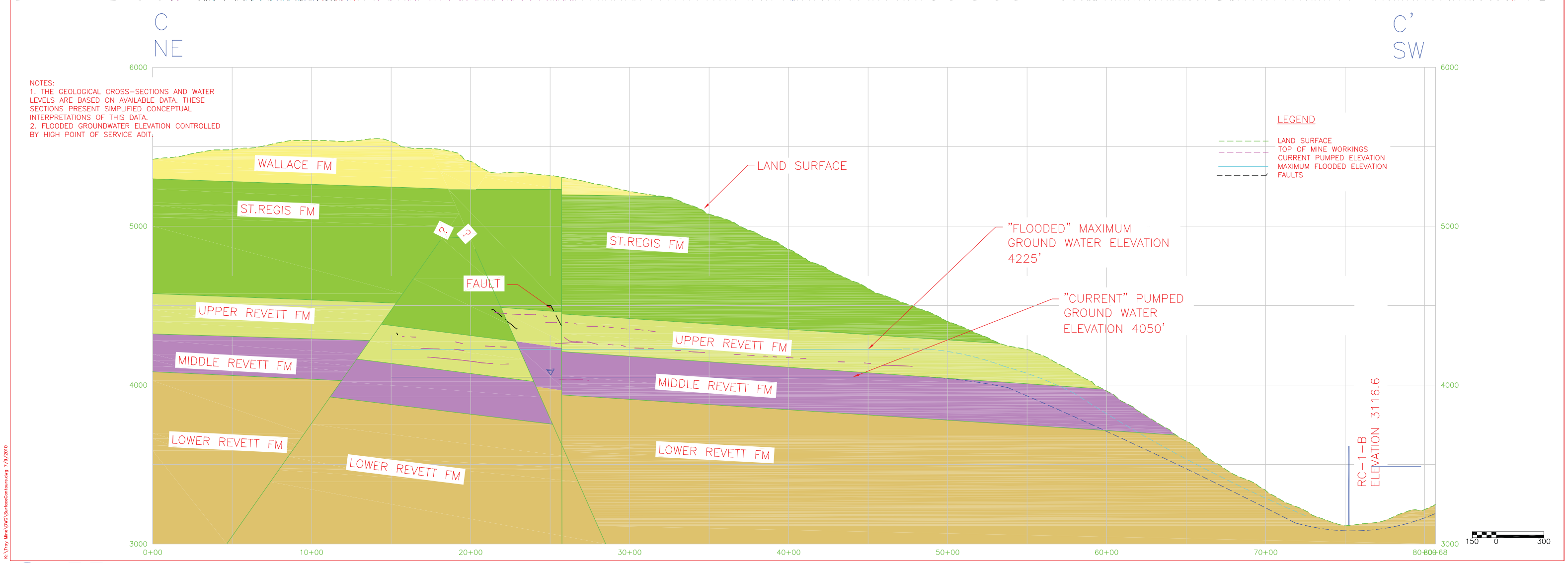
SECTION B





NOTES:
1. THE GEOLOGICAL CROSS-SECTIONS AND WATER LEVELS ARE BASED ON AVAILABLE DATA. THESE SECTIONS PRESENT SIMPLIFIED CONCEPTUAL INTERPRETATIONS OF THIS DATA.
2. FLOODED GROUNDWATER ELEVATION CONTROLLED BY HIGH POINT OF SERVICE ADIT.

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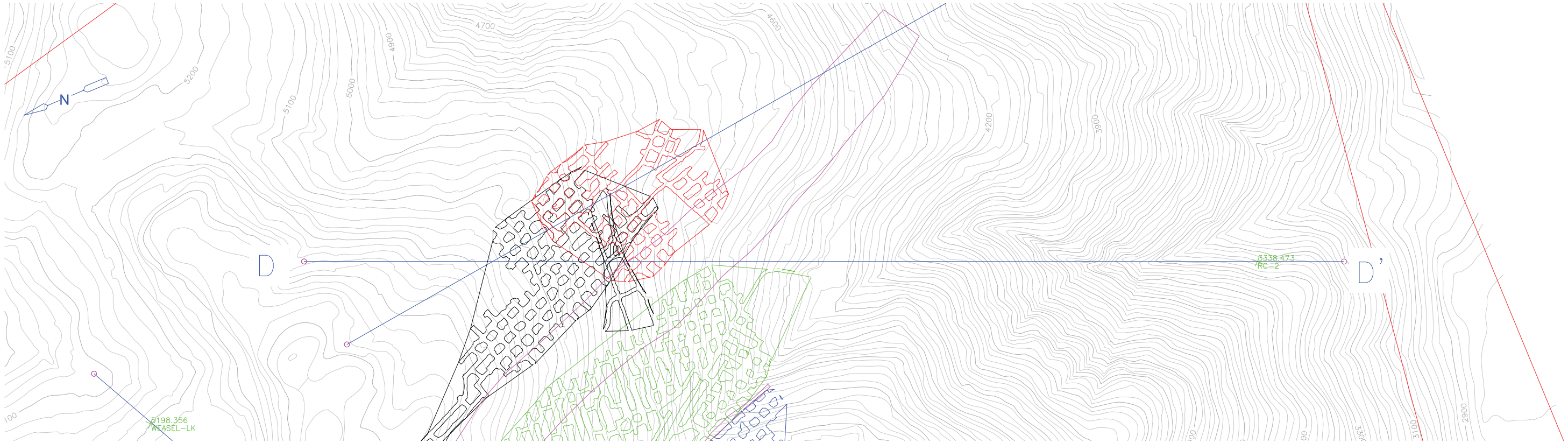
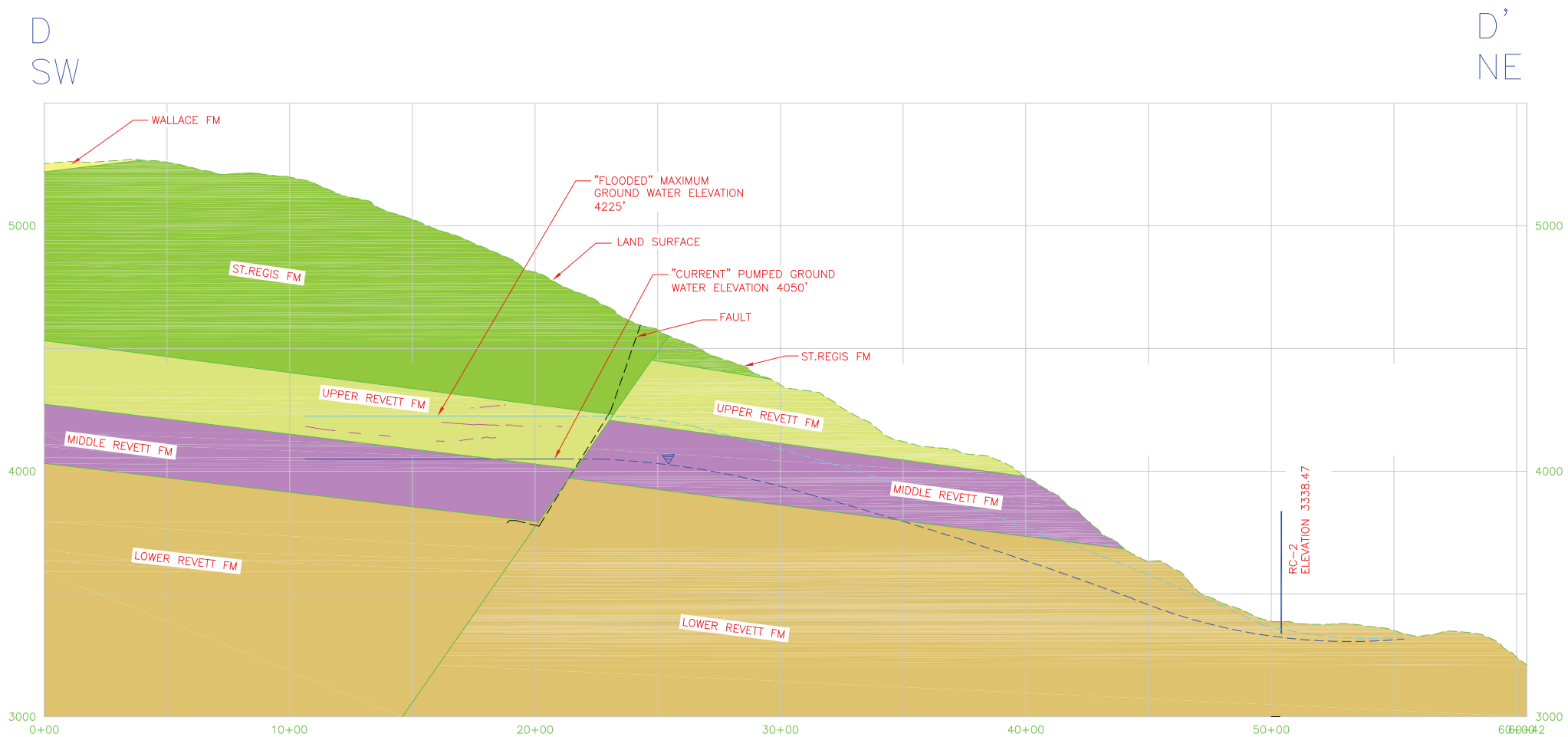
SECTION C





LEGEND

- LAND SURFACE
- TOP OF MINE WORKINGS
- CURRENT PUMPED ELEVATION
- MAXIMUM FLOODED ELEVATION
- FAULTS

NOTES:
1. THE GEOLOGICAL CROSS-SECTIONS AND WATER LEVELS ARE BASED ON AVAILABLE DATA. THESE SECTIONS PRESENT SIMPLIFIED CONCEPTUAL INTERPRETATIONS OF THIS DATA.
2. FLOODED GROUNDWATER ELEVATION CONTROLLED BY HIGH POINT OF SERVICE ADIT.

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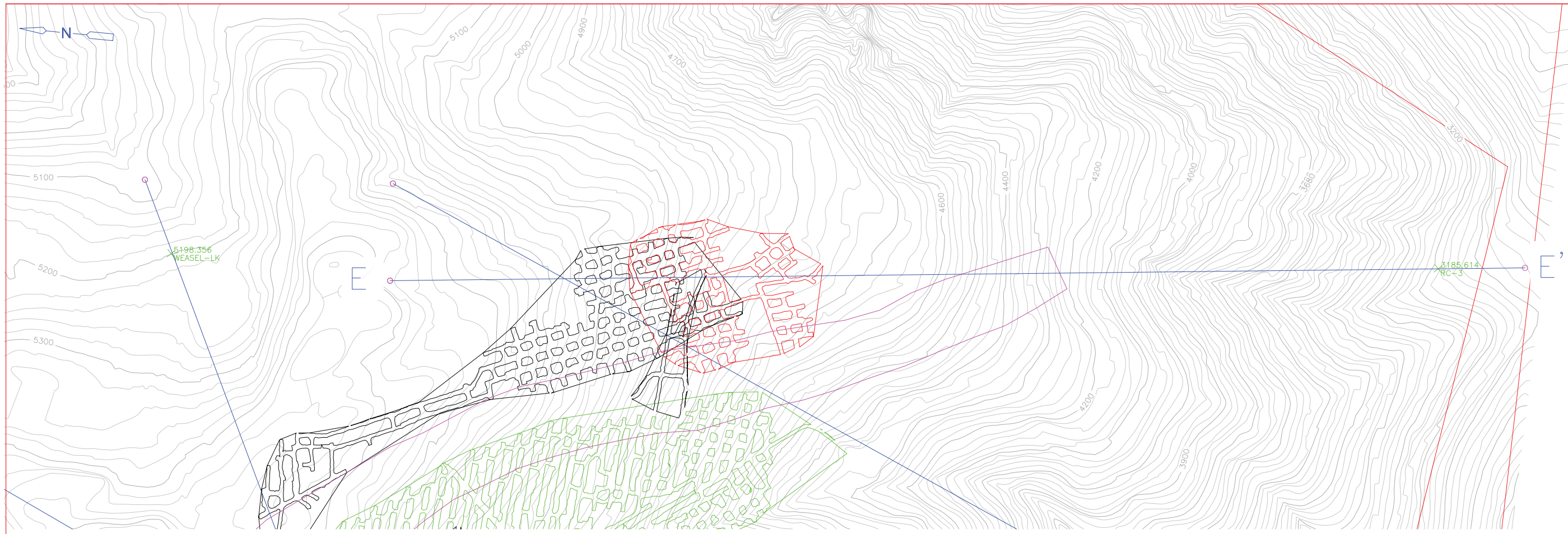
SECTION D



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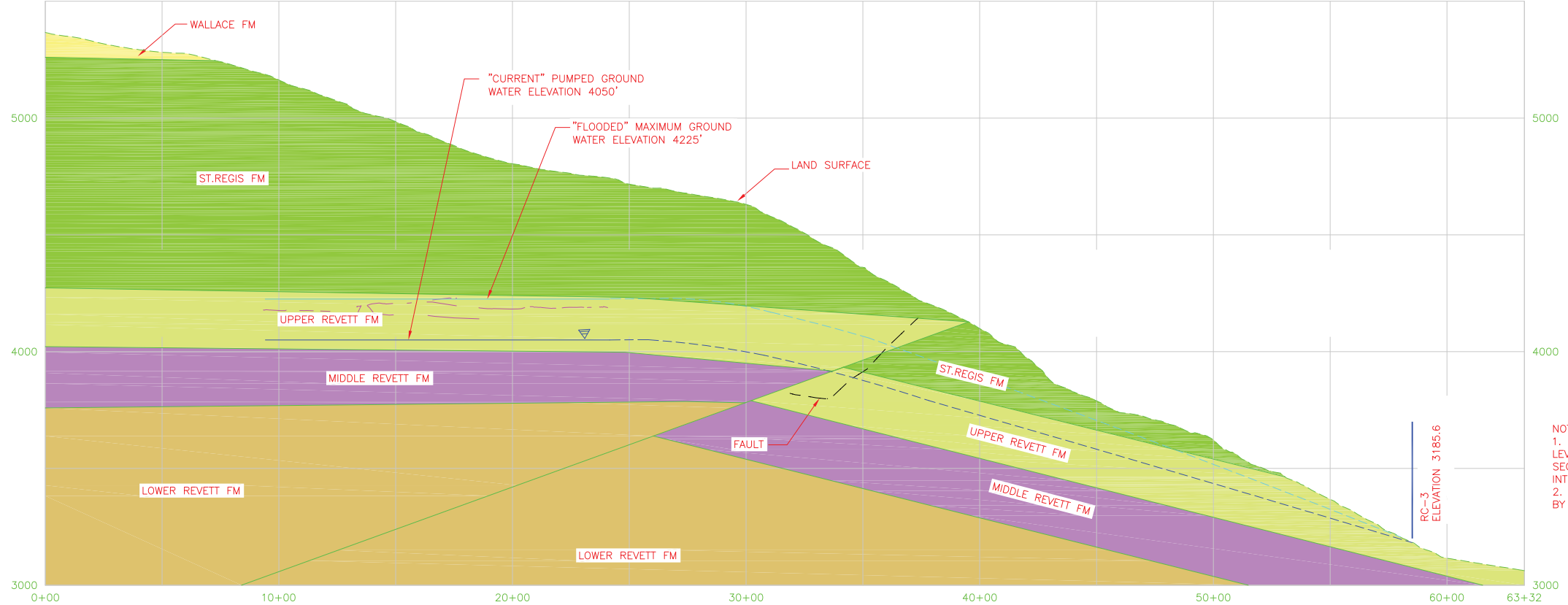

LEGEND

- LAND SURFACE
- TOP OF MINE WORKINGS
- CURRENT PUMPED ELEVATION
- MAXIMUM FLOODED ELEVATION
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SECTION E

Appendix G
Troy Mine Conceptual Design of New Water Line for Transport of Mine Water after Mine Closure

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tel: 406 441-1400
fax: 406 449-7725

Technical Memorandum

To: *Emily Corsi, Herb Rolfes – DEQ*
Bobbie Lacklen, John McKay - KNF

From: *Darrel Stordahl, P.E., Bill Bucher, P.E., Terry Cowan, P.E. - CDM*

Date: *December 3, 2010*

Subject: *Conceptual Design of New Water Line for Transport of Mine Water after Mine Closure – Troy Mine*

CDM has been retained by the Montana Department of Environmental Quality (DEQ) and the Kootenai National Forest (KNF) to prepare a conceptual design and cost estimate for a new pipeline and capture system at the Troy Mine. The pipeline will transport mine pool discharge through the service and conveyor adits to the infiltration pond located at the tailings impoundment via a new, buried pipeline. The purpose of this memorandum is to present the conceptual design and cost estimate to be used in decision making by the agencies.

The Troy Mine is an underground copper and silver mine located south of the town of Troy in Lincoln County, MT. ASARCO began operating the mine in 1982 and halted production in 1993 due to low metals prices. The mine was sold to Revett Silver Company and production resumed under Genesis, a subsidiary of Revett, in 2005. In 2006, Genesis submitted a Revised Reclamation Plan, for which an Environmental Assessment (EA) must be completed. In support of the EA, this memorandum analyzes a closure water management alternative presented in the EA.

Mine Discharge Data

It has been shown in the *Revised Mine Water Management Analysis – Troy Mine* and *Mine Water Balance Analysis – Troy Mine* Technical Memoranda (CDM, 2010a and CDM, 2010b) that the Troy Mine is expected to discharge mine pool water through the service and conveyor adits after closure. The *Revised Mine Water Management Analysis* memorandum estimates the maximum water discharge to be 6.9 cubic feet per second (cfs), and this rate is used in this memorandum for the conceptual design of the new closure water line. The discharge estimation is based on a limited amount of available data. However, it is consistent with observed maximum discharges measured by the mine over the period of operation. This

memorandum includes a backup system for the proposed design that should handle any reasonably foreseeable discharges.

Water Line Conceptual Design and Calculations

The water line was designed to follow the existing tailings/slurry pipes, approximate the land gradient, and have the hydraulic capacity to handle all of the estimated peak discharge of 6.9 cfs under gravity flow (no pressure flow). The land gradient is rather steep near the adit openings and flattens as it approaches the tailings impoundment. The upper quarter of the pipe run has slopes around 12%, the next quarter close to 3.5%, and the bottom half has slopes approximately 1.0% down to 0.3%. With the wide range of slopes, and their corresponding pipe capacities, multiple pipe sizes were used in the design to provide a cost savings. See the *Cost Estimate and Assumptions* portion of this report for a list of pipe sizes, lengths, and costs. The static capacity of the water line is about 250,000 cubic feet when full (see attached calculation sheet). This is the maximum amount of water that could drain from the pipeline should a break occur at the lowest point in the line. This amount could be reduced with the addition of automatically controlled valves along the length of the pipeline, but this design feature is not incorporated in this design.

Smooth HDPE was chosen as the pipe material for this conceptual design. The smooth interior of HDPE provides hydraulic efficiency, has a long service life (estimated at 75 years), is virtually chemically inert, is easy to install, is watertight, and provides an overall cost savings. Other materials such as iron, steel and concrete would not provide the equivalent performance at as low a cost.

FlowMaster software was used in the hydraulic calculations. Pipe lengths and slopes were estimated from *Exhibit A, Troy Mine Facilities Current Status* of Genesis' March 2006 *Troy Mine Revised Reclamation Plan*. FlowMaster calculations and a topographic map are shown in attached Appendix A.

Systems Control and Data Acquisition

Supervisory Control and Data Acquisition (SCADA) is included as part of the new water line. The SCADA can detect variability of flow in the pipe system and if a leak is present it will alert the proper personnel and divert mine adit discharge into the existing 10-12" tailings reclaim water line.

Leakage or breakage in the nearly six-mile pipe can be determined by using two flow meters, one placed close to the mine adit and the other placed close to the discharge end. The SCADA system would compare the two flow rates, with a time delay allotted to compensate for the length of pipe between the flowmeters. The flow rates should correspond within a small percentage range. If a leak or pipeline break occurs, the flow rate at the discharge would not correspond to the flow rate at the intake. The SCADA system alarm will be

activated, and a valve would reroute the water to another pipe. The existing pipe would be taken out of commission until repairs were made.

The flow meters would be powered using a solar-powered panel-mounted system with battery backup. The flow meter at the infiltration pond will transmit its flow rate to a compact programmable logic controller (PLC) located inside the solar power panel. The PLC will forward the flow rate by Ethernet radio to another compact PLC located in a panel close to the mine portal. The values will be compared, and, if the difference is outside a predetermined range, the PLC will close the pipe valve and reroute flow to the existing reclaim water line. The SCADA system will notify appropriate personnel of an alarm situation.

The existing reclaim water line will be used as a backup system. It is assumed that the existing reclaim water line consists of a 10″ steel pipe on the upper, steeper section of the pipe run and a 12″ steel pipe on the lower, flatter run. Assuming the pipeline follows the land gradient, it is estimated that the reclaim water line will handle approximately half of the estimated maximum of 6.9 cfs under gravity flow conditions. It is likely that the reclaim water line could handle the full estimated maximum flow if it is retrofitted with appropriate vacuum relief and pressure relief valves.

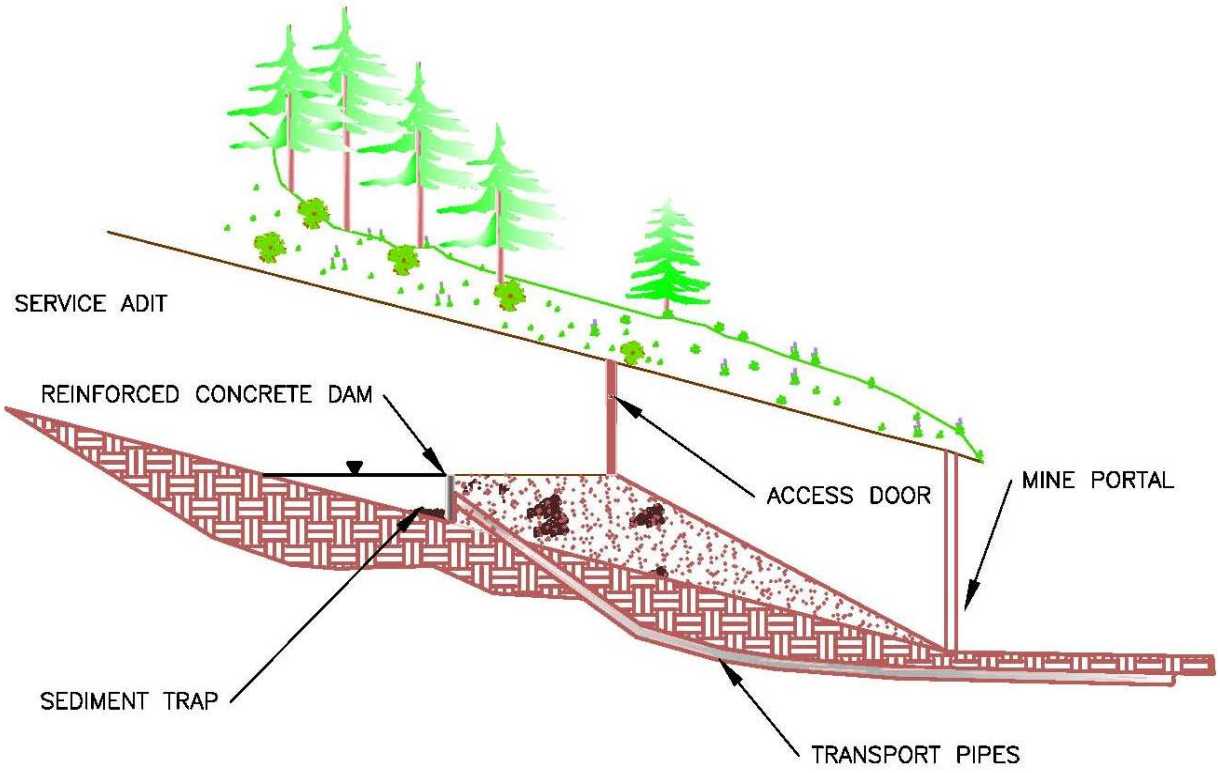
Mine Water Capture

Systems to capture the mine water and deliver it into the transport lines are needed at the service and conveyor adit portals. We propose to install these systems inside the adit to minimize freezing issues. As shown in Figure 1, the capture systems consist of concrete dams about six feet high constructed inside the adits about 50 feet back from the portal entrances. The entrance to the transport pipes would be set about two feet below the top of the dam so sediment transported by the mine discharge would be trapped below the pipe entrances. The 50-foot run of transport pipe between the dams and portals would be backfilled with material from the mine portal pads to bury the transport pipes and provide frost protection at the portals. To maintain access for maintenance of the sediment traps and transport pipe intakes, locking doors would be constructed at the portals. These doors will be sized to accommodate a small backhoe and truck to periodically clean out the sediment traps.

Small reservoirs would be created in the adits behind the concrete dams. The accumulated water could potentially infiltrate into fractures or unconsolidated material in the adit floors and walls and be released to the environment. Fractures and other leakage paths in the area below the elevation of the top of the concrete dam should be grouted to minimize any such releases.

The design has two transport pipes with their intake elevations staggered so the higher one would only come on line when flow into the mine increases. The lower intake would be for

Figure 1. Conceptual design of mine water capture system.



the new transport line described in this memorandum. The higher intake would tie to the existing reclaim water line. As the new transport line reaches capacity, flow would enter the reclaim water line without the need for a valve. With proper maintenance of the system, it is anticipated that any foreseeable discharge could be accommodated by the two lines flowing at full capacity.

In the unlikely event that the capacity of both these lines is exceeded, water would flow over the dam and pass through the rock backfill. At the mine portal it would drain to a constructed channel which would lead to Stanley Creek. This emergency channel would require a MPDES permit. Figure 2 is a conceptual design showing these water lines and the channel to Stanley Creek.

If, at some point in the future, the mine water quality improves to the point that it can be directly discharged to Stanley Creek, the capture system will be altered so the mine discharge

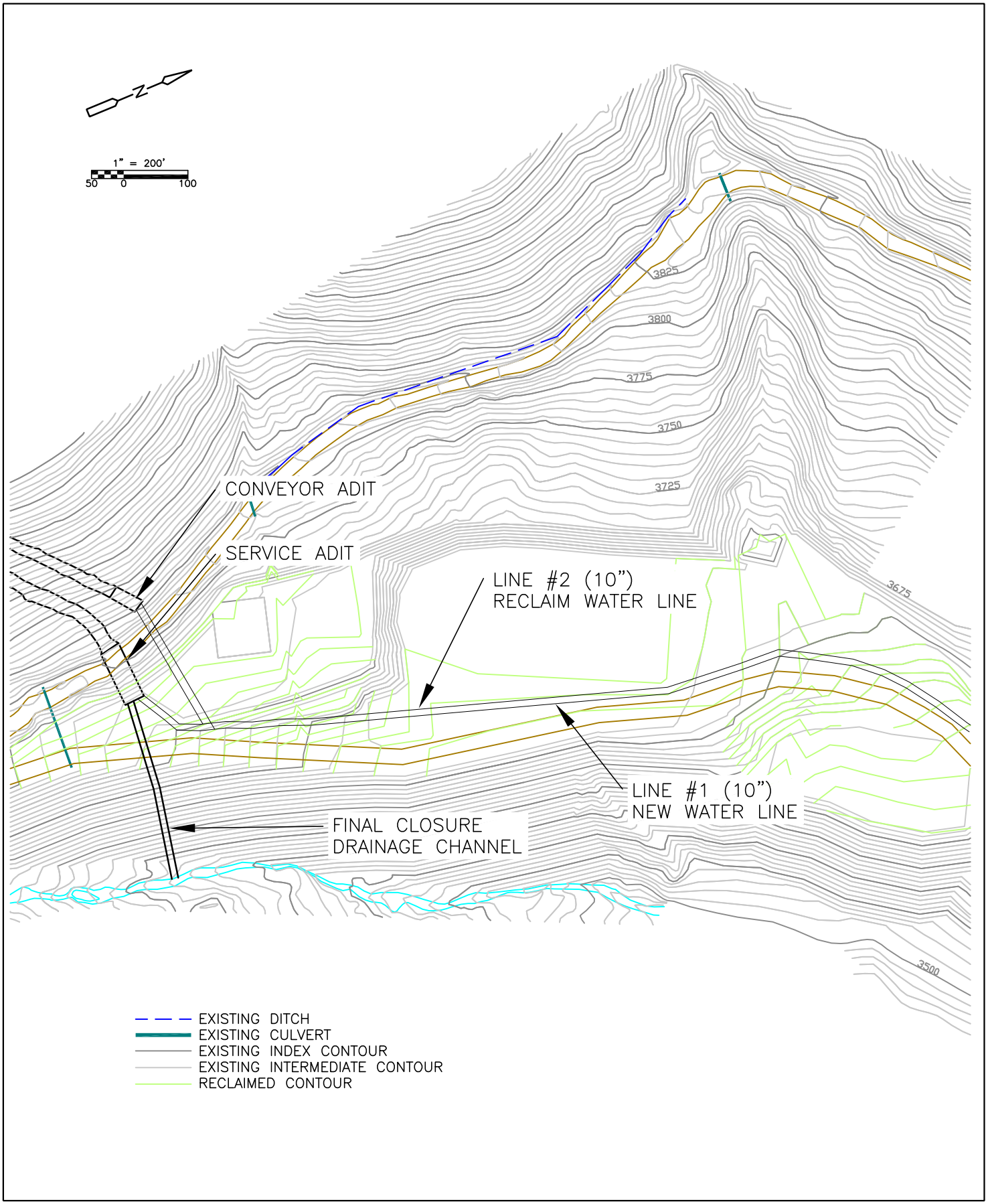


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FIGURE 2
TROY MINE RECLAMATION MINE WATER
DISCHARGE PIPELINES AND CHANNEL

is routed to a small channel that routes directly to Stanley Creek as shown on Figure 2. The transport lines will then be abandoned.

Cost Estimate and Assumptions

Table 1 is a preliminary cost estimate for construction of the capture system and new transport pipeline. Unit prices for the pipeline used in this cost estimate were taken from several contractors' bids for similar, prior work. The run of pipe would follow the existing tailings/slurry line as shown on *Exhibit A, Troy Mine Facilities Current Status* of Genesis's March 2006 *Troy Mine Revised Reclamation Plan* report (Genesis, 2006). Pipe slopes were estimated from topographic maps with the assumption that pipes will closely follow the land gradient. The pipe diameter was designed to correspond to the anticipated gradient of the pipe run. Pipe capture items were estimated using Means Costworks cost estimating software. The cost of installing buried power to the mine portal area for operation of the valves is included. The total cost estimate of about $2.9 million includes installation of all components, mobilization, erosion control, 10% engineering, and 15% contingencies. Operation and maintenance costs are not included. Details on the cost estimate are attached in Appendix B.

Table 1. Cost Estimate

			Engineer's Estimate	
Unit Description	**Quantity**	**Unit**	**Unit Price**	**Total Price**
10" Smooth HDPE	7,708	LF (installed)	$50	$385,400
12" Smooth HDPE	5,604	LF (installed)	$55	$308,220
15" Smooth HDPE	10,246	LF (installed)	$65	$665,990
18" Smooth HDPE	6,763	LF (installed)	$75	$507,225
Reinforced Concrete Dam	2	LS	$8,000	$16,000
Tunnel Grouting	2	LS	$9,900	$19,800
Door construction	2	LS	$10,000	$20,000
Adit Backfill	466	CY	$4	$1,864
Flowmeters	2	each	$10,500	$21,000
Solar Panel	2	each	$3,600	$7,200
PLC	2	each	$2,400	$4,800
Ethernet Radio	2	each	$2,100	$4,200
Buried power	15,000	LF (installed)	$0.50	$7,500
Mobilization (10%)	-	-	-	$196,170
Erosion Control (5%)	-	-	-	$98,085
Engineering (10%)	-	-	-	$226,345
Contingency (15%)	-	-	-	$373,470
			Total Estimate:	**$2,863,269**

Conclusion

This technical memorandum was prepared to provide a conceptual design of a new, buried water line to transport mine pool discharge through the service and conveyor adits to the infiltration pond located in the tailings impoundment. The design flow of 6.9 cfs is estimated to be the maximum discharge (CDM, 2010a). The new pipe system conceptual design consists of 10", 12", 15", and 18" smooth HDPE pipes operating under gravity flow. The smooth interior of HDPE provides hydraulic efficiency, has a long service life (estimated at 75 years), is virtually chemically inert, is easy to install, is watertight, and provides an overall cost savings as compared to other materials. SCADA would be incorporated to detect leaks in the pipe line, and, if needed, alert personnel and automatically divert flow into the existing water reclamation line while any leak is repaired. The existing reclaim water line will be kept as a backup transport pipe should the capacity of the new pipe be exceeded or the new pipe require repair. Water collection systems have been conceptually designed inside the adit entrances to capture the mine pool water and direct it into the transport pipes. The cost estimate to construct this project is about $2.8 million.

References

CDM, 2010a. Mine Water Management Analysis – Troy Mine. Prepared for Montana Department of Environmental Quality and Kootenai National Forest, December 3, 2010.

CDM, 2010b. Mine Water Balance Analysis - Troy Mine. Technical Memorandum to Emily Corsi and Herb Rolfes, Montana Department of Environmental Quality dated April 12, 2010.

Genesis, Inc., 2006. Troy Mine Revised Reclamation Plan. March, 2006. Troy, MT.

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Appendix A
FlowMaster Calculations and Topo Map

Worksheet for 10" Smooth HDPE

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Slope

Input Data

Roughness Coefficient	0.012	
Channel Slope	8.45157	%
Normal Depth	10.00	in
Diameter	10.00	in
Discharge	6.90	ft^3/s

Results

Channel Slope	8.45157	%
Normal Depth	10.00	in
Flow Area	0.55	ft^2
Wetted Perimeter	2.62	ft
Top Width	0.00	ft
Critical Depth	0.83	ft
Percent Full	100.0	%
Critical Slope	0.07994	ft/ft
Velocity	12.65	ft/s
Velocity Head	2.49	ft
Specific Energy	3.32	ft
Froude Number	0.00	
Maximum Discharge	7.42	ft^3/s
Discharge Full	6.90	ft^3/s
Slope Full	0.08452	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	in
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	in
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%

Worksheet for 10" Smooth HDPE

GVF Output Data

Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	10.00	in
Critical Depth	0.83	ft
Channel Slope	8.45157	%
Critical Slope	0.07994	ft/ft

Worksheet for 12" Smooth HDPE

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Slope

Input Data

Roughness Coefficient	0.012	
Channel Slope	3.19622	%
Normal Depth	12.00	in
Diameter	12.00	in
Discharge	6.90	ft^3/s

Results

Channel Slope	3.19622	%
Normal Depth	12.00	in
Flow Area	0.79	ft^2
Wetted Perimeter	3.14	ft
Top Width	0.00	ft
Critical Depth	0.97	ft
Percent Full	100.0	%
Critical Slope	0.02830	ft/ft
Velocity	8.79	ft/s
Velocity Head	1.20	ft
Specific Energy	2.20	ft
Froude Number	0.00	
Maximum Discharge	7.42	ft^3/s
Discharge Full	6.90	ft^3/s
Slope Full	0.03196	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	in
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	in
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%

Worksheet for 12" Smooth HDPE

GVF Output Data

Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	12.00	in
Critical Depth	0.97	ft
Channel Slope	3.19622	%
Critical Slope	0.02830	ft/ft

Worksheet for 15" Smooth HDPE

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Slope

Input Data

Roughness Coefficient	0.012	
Channel Slope	0.97226	%
Normal Depth	15.00	in
Diameter	15.00	in
Discharge	6.90	ft^3/s

Results

Channel Slope	0.97226	%
Normal Depth	15.00	in
Flow Area	1.23	ft^2
Wetted Perimeter	3.93	ft
Top Width	0.00	ft
Critical Depth	1.05	ft
Percent Full	100.0	%
Critical Slope	0.00927	ft/ft
Velocity	5.62	ft/s
Velocity Head	0.49	ft
Specific Energy	1.74	ft
Froude Number	0.00	
Maximum Discharge	7.42	ft^3/s
Discharge Full	6.90	ft^3/s
Slope Full	0.00972	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	in
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	in
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%

Worksheet for 15" Smooth HDPE

GVF Output Data

Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	15.00	in
Critical Depth	1.05	ft
Channel Slope	0.97226	%
Critical Slope	0.00927	ft/ft

Worksheet for 18" Smooth HDPE

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Slope

Input Data

Roughness Coefficient	0.012	
Channel Slope	0.36769	%
Normal Depth	18.00	in
Diameter	18.00	in
Discharge	6.90	ft^3/s

Results

Channel Slope	0.36769	%
Normal Depth	18.00	in
Flow Area	1.77	ft^2
Wetted Perimeter	4.71	ft
Top Width	0.00	ft
Critical Depth	1.02	ft
Percent Full	100.0	%
Critical Slope	0.00571	ft/ft
Velocity	3.90	ft/s
Velocity Head	0.24	ft
Specific Energy	1.74	ft
Froude Number	0.00	
Maximum Discharge	7.42	ft^3/s
Discharge Full	6.90	ft^3/s
Slope Full	0.00368	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	in
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	in
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%

Worksheet for 18" Smooth HDPE

GVF Output Data

Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	18.00	in
Critical Depth	1.02	ft
Channel Slope	0.36769	%
Critical Slope	0.00571	ft/ft

Worksheet for Existing 10" Steel

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data

Roughness Coefficient	0.012	
Channel Slope	3.60000	%
Normal Depth	10.00	in
Diameter	10.00	in
Discharge	4.50	ft^3/s

Results

Discharge	4.50	ft^3/s
Normal Depth	10.00	in
Flow Area	0.55	ft^2
Wetted Perimeter	2.62	ft
Top Width	0.00	ft
Critical Depth	0.81	ft
Percent Full	100.0	%
Critical Slope	0.03203	ft/ft
Velocity	8.26	ft/s
Velocity Head	1.06	ft
Specific Energy	1.89	ft
Froude Number	0.00	
Maximum Discharge	4.84	ft^3/s
Discharge Full	4.50	ft^3/s
Slope Full	0.03600	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	in
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	in
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%

Worksheet for Existing 10" Steel

GVF Output Data

Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	10.00	in
Critical Depth	0.81	ft
Channel Slope	3.60000	%
Critical Slope	0.03203	ft/ft

Worksheet for Existing 12" Steel

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data

Roughness Coefficient	0.012	
Channel Slope	1.03000	%
Normal Depth	12.00	in
Diameter	12.00	in
Discharge	3.92	ft^3/s

Results

Discharge	3.92	ft^3/s
Normal Depth	12.00	in
Flow Area	0.79	ft^2
Wetted Perimeter	3.14	ft
Top Width	0.00	ft
Critical Depth	0.84	ft
Percent Full	100.0	%
Critical Slope	0.00988	ft/ft
Velocity	4.99	ft/s
Velocity Head	0.39	ft
Specific Energy	1.39	ft
Froude Number	0.00	
Maximum Discharge	4.21	ft^3/s
Discharge Full	3.92	ft^3/s
Slope Full	0.01030	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	in
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	in
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%

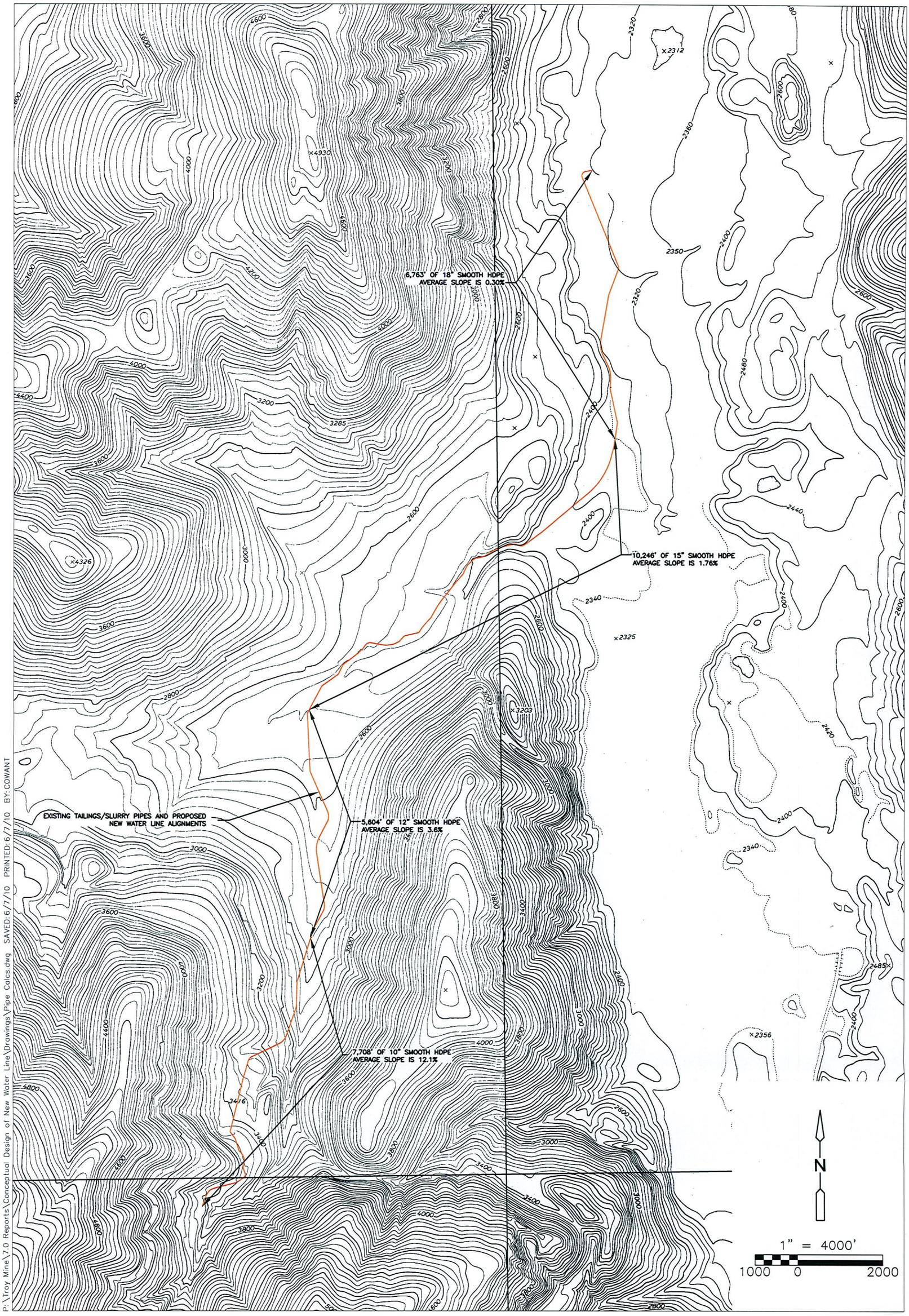
Worksheet for Existing 12" Steel

GVF Output Data

Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	12.00	in
Critical Depth	0.84	ft
Channel Slope	1.03000	%
Critical Slope	0.00988	ft/ft

TROY MINE - NEW WATER LINE VOLUME

Diam (in)	Length (ft)	Volume (cf)
10	7708	31430
12	5604	32906
15	10246	94004
18	6763	89350
Total:		247690



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CDM

Figure No. 1
Plan View

Appendix B
Cost Estimate

Troy Mine
Mine Pool Water Capture System
Cost Estimate - Single Adit
July 1, 2010

			Engineer's Estimate		
Unit Description	**Quantity**	**Unit**	**Unit Price**	**Total Price**	**Mean's Code**
Concrete Dam					
Forms	240	sq ft	$7.65	$1,836	03 11 13 85 2000
Rebar	0.2	ton	$2,126.25	$425	03 21 10 60 700 + 1000
Concrete	8.9	cy	$143.00	$1,273	03 31 05 35 0300
Place Concrete (pumped)	8.9	cy	$28.00	$249	
Subtotal - Dam				$3,783	
Given Location, double cost.				$8,000	
Tunnel Grouting					
Mobilization				$4,000	Engineer's Estimate
Grout	100	cu ft	$59.00	$5,900	31-73-13-10-0820
Subtotal - Dam				$9,900	
Door Construction	1	ea	$10,000.00	$10,000	Engineer's Estimate
Backfill	233	cu yd	$4.00	$932	Engineer's Estimate
Total Cost:				**$28,832**	

Transport pipe cost in pipeline cost estimate.

Appendix H
Mine Water Plume Location and Identification Phase I Results and Phase 2 & 3 Work Plan

Mine Water Plume Location and Identification

Phase 1 Results and Phase 2 & 3 Workplan
Sterling Troy Mine

Prepared for:

Genesis Inc./Sterling Mining Company
424 S. Sullivan Road
Veradale, WA 99037

Prepared by:

Hydrometrics, Inc.®
22 Second Ave West, Suite 1100
Kalispell, MT 59901

October 2001

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Mine Water Plume Location and Identification

Phase 1 Results and Phase 2 & 3 Workplan
Genesis Inc. Troy Mine

1.0 INTRODUCTION

This report summarizes results of investigations in 2000 and 2001 that were conducted to locate and identify the minewater flowpath from the decant pond at the Troy Mine tailings impoundment. Additionally, this report describes the workplan for continued investigation of the minewater flowpath in 2001 and 2002.

Phase 1 results continue to support the hypothesis that copper in minewater that is discharged to the decant ponds is strongly attenuated (immobilized) in the groundwater system, probably within a short distance of the decant ponds. Groundwater quality data suggests that the groundwater in deeper gravel/sand units near the decant ponds (e.g., units monitored by wells IW-1, MW-95-7, and MW-95-8) is derived primarily from minewater disposed in the decant ponds. This groundwater does not contained elevated copper concentrations (0.003 mg/L or less). However, tracer test results suggests that these gravel units are not the primary groundwater flowpath for decant pond water. Based on Phase 1 results and review of the local geology, it is hypothesized that a shallow gravel unit may provide the primary flowpath for transport of water from the decant ponds. While this shallow unit is believed to transport water primarily laterally away from the decant pond, some slow transport of water downward to the deeper gravels (i.e., leakage through the silts/fine sands that underlie the shallow gravel) is believed to also occur. The slow rate of the vertical transport of water to the deeper gravels is believed to account for the lack of detection of the tracer in the deeper gravels during the 2001 tracer test. Phases 2 and 3 of the evaluation include additional monitoring well drilling targeting the shallow gravel unit and an additional groundwater tracer test.

1.1 BACKGROUND

The Troy Mine was developed by Asarco in 1979 and went into production in 1981. The mine was operated by Asarco until 1993 when the mine was placed on temporary shutdown. In 1999, the mine was purchased by Genesis Inc., a subsidiary of Sterling Mining Company. Since 1993, Asarco and Genesis Inc. have disposed of water from the underground workings by discharge to the impoundment in one of three ways:

- Sprinkler irrigation over the impoundment (primarily during the growing season).
- Discharge to the decant pond (also known as the barge pond).
- Discharge to the Section III pond.

The primary chemical of concern in mine water is copper, which is typically present at concentrations of approximately 0.1 mg/L. For comparison, surface water in Lake Creek adjacent to the impoundment typically contains approximately 0.003 mg/L and the chronic aquatic life standard for copper is approximately 0.004 mg/L (assuming hardness of 35 mg/L). In spite of the higher copper concentrations discharged to the impoundment, copper concentrations in Lake Creek and in monitoring wells installed in the impoundment vicinity have not increased measurably as a result of the discharge (*see* Summit, 1999; Parametrix, 1999).

The observation that mine water has been discharged with little or no apparent effect on ambient water quality has led to the preliminary consideration of continued discharge of mine water to the decant pond as a potential long-term method of mine water disposal (see Revised Reclamation Plan, Sterling 2000). In order for impoundment discharge to be considered further, both the physical flow paths and the transport and attenuation mechanisms for copper in the impoundment/groundwater system must be understood. In particular, the flow paths must be identified so that an effective groundwater monitoring system can be installed. Transport and attenuation mechanisms must be understood to determine the long-term fate of constituents in mine water and the effects of long-term discharge on ambient groundwater and stream quality.

In September 2000, Hydrometrics prepared a "Minewater Fate and Transport Study Plan" (Hydrometrics, 2000a) to collect information needed to evaluate the fate and transport of mine water that is disposed at the decant pond. An initial obstacle to the study of fate and transport in the system is the absence of any evidence of a copper-bearing mine water discharge plume in the groundwater system. Therefore, the first phase of the fate and transport study is to locate and identify the groundwater flow paths for discharged mine water. Later phases of the study plan will identify probable fate and transport mechanisms, and evaluate potential implications under a long-term discharge scenario.

Plume location and identification is anticipated to consist of three phases as follows:

1. Sampling and evaluation of all available monitoring wells and further evaluation of water quality data.
2. Construction, sampling, and evaluation of additional excavations, borings, and wells to supplement the existing monitoring well network.
3. Tracer testing to verify plume location and flow paths

1.2 PHASE 1 SUMMARY

As initially proposed in the study plan, Phase 1 of plume location consisted of sampling and evaluation of all available monitoring wells and further evaluation of water quality data. Based on the water quality evaluation it was thought that one of the existing wells (IW-1, the "irrigation well") was effectively monitoring the mine water plume. Therefore, a preliminary tracer test was conducted in spring 2001 to test the hypothesis that well IW-1 is located in, and monitors, the minewater plume. Results of this tracer test (summarized in Section 3 of this report) indicate that none of the existing wells is located in the primary flowpath from the pond. Based on these Phase 1 results, it is determined that additional investigations as outlined in Phases 2 and 3 of the Fate and Transport Study are needed. Workplans for Phases 2 and 3 are described in Section 4 of this report.

2.0 METHODS

Monitoring and testing plans for Phase 1 work are included in Appendices A through D. The following sections provide an overview of the plans and methods. Locations of wells near the tailings impoundment are shown on Figure 1.

2.1 SAMPLING AND EVALUATION OF MONITORING WELLS

A proposed plan for groundwater monitoring in and near the tailings impoundment was submitted to MDEQ by Genesis Inc. in August 2000. This plan (see Appendix A) proposed sampling of 9 wells near the impoundment (MW-1, MW-2, MW-3, MW-4, MW-95-5, MW-95-7, MW-95-8, IW-1 or the Irrigation well, and the Quonset hut well). All of the wells were sampled on September 7, 2000 except for MW-95-7 which was dry. Wells MW-95-5 and MW-95-8 were sampled by bailing with disposable plastic bailers. The remaining wells were sampled with submersible pumps.

2.2 TRACER TEST

Tracer testing at the decant pond consisted of adding salt (NaCl or sodium chloride) to the mine water flowing to the decant pond to raise the TDS, specific conductivity, sodium, and chloride concentrations of water in the decant pond to levels much higher than ambient groundwater. At the same time, monitoring of groundwater in adjacent wells was conducted in order to identify increases in these chemical parameters in groundwater and thus locate the minewater flowpath in the groundwater system. Methods of conducting the tracer test were originally described in a December 4, 2001 letter from Sterling Mining Co. (Frank Duval) to MDEQ (Abe Horpestad) proposing the test and requesting permission from DEQ to run the test (see Appendix B). As originally proposed, the tracer test was to consist of adding salt to the minewater inflow to the decant pond at the rate of approximately 500 pounds per day for a period of about 18 days. MDEQ granted approval to conduct the tracer test on January 22, 2001 (see Appendix B).

FIGURE 1 MONITORING WELL LOCATIONS

In February 2001, it was recognized that minewater flows were sufficiently low that all minewater flows to the decant pond could be suspended for a period of about 2 weeks. Without minewater inflows to the pond, it was believed that it would be be easier to simply add the salt to the pond as a "slug" and eliminate the need for daily salt additions. Moreover, it was believed that slug addition of salt would result in more constant salt concentrations in the pond and overall a better tracer test. The testing protocol was revised in a February 2, 2001 letter to MDEQ (see Appendix C). The revised testing protocol also provided a monitoring schedule and analytical parameter list.

During preparation for the tracer test it was discovered that the system for remote monitoring of some wells in the tailings impoundment area were not functioning, perhaps as the result of snowplowing to access the wells. Therefore, the monitoring schedule for the tracer test was revised to eliminate remote monitoring (see Appendix D).

The tracer test was conducted during the period of March 8 to May 31, 2001. In general, monitoring during the test followed the schedule outlined in Table 1 of Appendix D. A timeline and summary of the tracer test is as follows:

- March 8 – All wells and decant ponds were sampled to collect baseline water quality data for major ions, nutrients, and metals prior to tracer (salt) addition. Decant pond cell #3 and well MW-97-14 were dry and could not be sampled.
- March 12 – Salt addition started at 8 am; 5 tons of salt were added by 9:50 am and 10 tons of salt were added by 11:45 am. Salt was added to the reclaim water pipeline at the mill pond. At 2:30 pm, monitoring of the decant pond specific conductivity was started.
- March 13 – Mine water flows to decant pond were shut off at 5 pm. Decant pond staff gage installed. Decant pond specific conductivity monitoring continued (3 times daily) and daily sampling of wells IW-1, MW-95-3, MW-95-7, and MW-95-8 was initiated.
- March 16 – Decant pond monitoring continued on a daily basis.

- March 14 through April 2 – Daily sampling of wells (IW-1, MW-95-3, MW-95-7, and MW-95-8) and decant ponds continued. (March 18 – Decant pond #3 dry and no longer sampled. March 30 – Well MW-95-8 dry and could not be sampled.)
- April 2 – All wells, including MW-1 through MW-4, MW-95-5, and MW-97-12 sampled prior to reduction in monitoring frequency to weekly.
- April 9 – Mine water flow to decant pond resumed; water from section 3 pond allowed to flow to decant pond.
- April 9 through May 31 – Weekly sampling of wells and decant ponds continued. (April 25, decant pond #2 dry and could no longer be sampled. May 31, well MW-95-8 again contained water and was sampled.)
- May 31 – Tracer test terminated.

3.0 PHASE 1 RESULTS

Phase 1 results continue to support the hypothesis that copper in minewater that is discharged to the decant ponds is strongly attenuated (immobilized) in the groundwater system, probably within a short distance of the decant ponds. Groundwater quality data suggests that the groundwater in deeper gravel/sand units near the decant ponds (e.g., units monitored by wells IW-1, MW-95-7, and MW-95-8) is derived primarily from minewater disposed in the decant ponds. This groundwater does not contained elevated copper concentrations (0.003 mg/L or less). However, tracer test results suggests that these gravel units are not the primary groundwater flowpath for decant pond water. Based on Phase 1 results and review of the local stratigraphy (see Section 4), it is hypothesized that a shallow gravel unit may provide the primary flowpath for transport of water from the decant ponds. While this shallow unit is believed to transport water primarily laterally away from the decant pond, some slow transport of water downward to the deeper gravels (i.e., leakage through the silts/fine sands that underlie the shallow gravel) is believed to also occur. The slow rate of the vertical transport of water to the deeper gravels is believed to account for the lack of detection of the tracer in the deeper gravels during the relatively short duration of the tracer test.

3.1 GROUNDWATER SAMPLING AND EVALUATION

Groundwater quality data for wells around the decant ponds was collected three times in the past year (September 2000, March 2001, April 2001). Comparisons of groundwater quality data and minewater/decant pond water are provided in Tables 1 through 3 and Piper diagrams in Appendix E. As these comparisons indicate, groundwater in wells near the decant pond (IW-1, MW-95-8, MW-95-7) has an overall chemical signature that is very similar to the decant pond with the exception of the lack of copper in groundwater. This is true not only of major ion chemistry as shown by the Piper diagrams, but also nitrate + nitrite concentration (see Tables 1-3). Of particular note on the Piper diagrams is the seasonal shift in decant water composition and corresponding shifts in groundwater composition between September 2000 and March 2001.

TABLE 1 SEPTEMBER 2000 WATER QUALITY DATA

	Service Adit Minewater	IW-1	QW-1	MW-4	MW-2	MW-3	MW-1	MW95-8	MW95-5
Alkalinity.	76	72	24	16	156	124	108	170	170
Arsenic	0.003	<0.003	<0.003	<0.003	0.027	0.01	0.007	<0.003	0.003
Calcium	23	26	7	4.3	29	36	33	62	47
Carbonate	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Copper	0.056	0.002	0.001	<0.001	<0.001	0.001	<0.001	0.003	0.003
Iron	<0.020	<0.020	0.16	<0.020	<0.020	7.8	7.7	<0.020	30
Hardness	81	86	24	15	109	106	103	184	171
Bicarb.	76	72	24	16	156	124	108	170	170
Potassium	<2	<2.0	<2.0	<2.0	2.7	1.1	1.5	2.1	10
Magnesium	5.5	5	1.7	1	8.7	4	5.3	6.9	13
Manganese	0.024	0.081	0.018	0.04	0.25	0.66	0.57	<0.005	4.8
Sodium	NA	3	<2.0	<2.0	21	5.1	4.9	2.5	7.7
Ammonia	0.1	0.061	<0.050	0.13	0.43	0.39	0.11	0.051	0.21
Nitrate+nitrite	0.69	0.69	<0.050	0.11	0.094	<0.050	0.12	1.2	0.075
Lead	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
pH	8.3	7.2	6.3	6.6	7.5	6.9	6.9	7.9	6.3
Antimony	0.009	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Silica	NA	9.3	8.4	7.5	11	28	22	11	65
Sulfate	15	19	3.9	2.6	<2.0	<2.0	9.1	15	7.3
TDS	112	115	52	36	197	166	159	235	361
Zinc	<0.010	<0.010	0.32	0.023	<0.010	<0.010	<0.010	0.19	0.35

Note: All units (mg/L) except pH (std. units), alkalinity, carbonate, bicarbonate and hardness (all mg/L as CaCO3), ammonia and nitrate + nitrite (mg/L as N). All metals are dissolved.

TABLE 2. MARCH 2001 WATER QUALITY DATA (BEFORE TRACER TEST)

	MW 95-5	MW 95-4	MW 95-3	MW 97-12	MW-1	MW-2	MW-3	MW-4	MW 95-7	MW 95-8	IW-1	DECANT POND 1	DECANT POND 2
Alkalinity.	154.	22.	89.	61.	114.	21.	113.	168.	71.	81.	75.	74.	76.
Arsenic	0.008	0.004	<0.002	<0.002	0.006	<0.002	0.019	0.029	0.002	<0.002	<0.002	<0.002	<0.002
Calcium	46.	38.	130.	12.	35.	4.6	32.	30.	30.	41.	28.	31.	30.
Chloride-	3.9	4.2	2.7	3.0	2.1	<1.0	1.1	<1.0	<1.0	1.1	<1.0	<1.0	<1.0
Carbonate	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Copper	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.049	0.043
Iron	36.	17.	0.22	0.20	6.9	<0.030	12.	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Hardness	171.	139.	503.	54.	111.	16.	97.	112.	92.	125.	98.	116.	113.
Bicarb.	154.	22.	89.	61.	114.	21.	113.	168.	71.	81.	75.	74.	76.
Potassium	11.	24.	74.	5.3	1.1	<1.0	<1.0	2.4	<1.0	<1.0	<1.0	<1.0	<1.0
Magnesium	13.	11.	43.	5.6	5.7	1.1	3.9	9.0	4.1	5.6	6.7	9.5	9.1
Manganese	5.8	3.0	0.99	0.10	0.55	0.14	0.59	0.24	<0.005	<0.005	<0.005	0.040	0.037
Sodium	9.0	35.	53.	5.8	5.6	<1.0	5.4	23.	1.3	1.3	2.0	1.6	1.5
Ammonia	0.60	4.2	10.	<0.10	<0.10	0.20	0.30	0.42	<0.10	<0.10	<0.10	<0.10	<0.10
Nitrate+nitrite	0.19	0.31	<0.10	<0.10	0.32	0.13	<0.10	<0.10	1.1	1.6	0.79	1.6	1.4
Lead	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
pH	8.0	6.6	7.9	6.7	8.0	6.9	7.2	8.2	8.1	8.4	8.1	8.3	8.2
Antimony	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.011	0.011
Silica	58.	43.	10.	54.	25.	10.	30.	13.	12.	9.8	9.8	8.1	8.3
Sulfate	9.2	292.	693.	14.	9.6	5.3	1.4	1.2	27.	41.	25.	39.	42.
TDS	284.	406.	1060.	150.	160.	31.	178.	197.	136.	164.	133.	171.	164.
Zinc	<0.010	<0.010	<0.010	<0.010	<0.010	0.013	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010

Note: All units (mg/L) except pH (std. units), alkalinity, carbonate, bicarbonate and hardness (all mg/L as CaCO3), ammonia and nitrate + nitrite (mg/L as N). All metals are dissolved.

TABLE 3. APRIL 2001 WATER QUALITY DATA (AFTER TRACER ADDITION PERIOD)

	DECANT POND-1	DECANT POND-2	MW-95-3	MW-95-7	IW-1
Alkalinity.	50.	76.	146.	220A	70.
Arsenic	<0.002	<0.002	0.002	<0.002	<0.002
Calcium	22.	30.	130.	32.	26.
Chloride-	96.	67.	2.6	1.3	<1.0
Carbonate	<1.0	<1.0	<1.0	<1.0	<1.0
Copper	0.040	0.036	<0.002	0.002	<0.002
Iron	<0.050	<0.050	<0.050	<0.050	<0.050
Hardness	82.	113.	502.	96.	90.
Bicarb.	50.	76.	146.	220A	70.
Potassium	1.6	1.9	79.	1.8	1.5
Magnesium	6.5	9.2	43.	4.2	6.2
Manganese	0.053	0.036	1.0	<0.005	<0.005
Sodium	51.	38.	56.	1.5	2.8
Ammonia	<0.10	<0.10	12.	0.12	<0.10
Nitrate+nitrite	0.80	1.5	<0.050	1.0	0.71
Lead	<0.002	<0.002	<0.002	<0.002	<0.002
pH	7.8	8.0	7.8	7.9	8.0
Antimony	0.007	0.010	<0.005	<0.005	<0.005
Silica	7.0	7.3	10.	11.	13.
Sulfate	33.	40.	730.	31.	24.
TDS	243.	246.	1051.	160.	135.
Zinc	<0.010	<0.010	<0.010	<0.010	<0.010

Note: All units (mg/L) except pH (std. units), alkalinity, carbonate, bicarbonate and hardness (all mg/L as CaCO3), ammonia and nitrate + nitrite (mg/L as N). All metals are dissolved. Alkalinity and bicarbonate values for MW-95-7 are suspected to be in error (cation/anion balance is significantly off); 70 mg/L assumed for Piper diagram in Appendix E.

3.2 TRACER TEST

The addition of salt to the decant ponds caused the following changes in decant pond water chemistry:

- increased the specific conductivity (SC) of the decant ponds to approximately 400 to 700 micromhos/cm (2 to 3 times higher than ambient groundwater, i.e. IW-1, MW-95-7 and MW-95-8);
- increased the sodium concentration to 40 to 90 mg/L (20 to 50 times higher than ambient groundwater); and
- increased the chloride concentration to 60 to 160 mg/L (60 to 160 times higher than ambient groundwater).

The premise of the tracer test is that because SC, sodium, and chloride were elevated in the decant pond by the salt addition, the presence of increased concentrations of these parameters in ambient groundwater would demonstrate a connection (i.e., a groundwater flowpath) between the decant ponds and the monitoring wells. Because of residual process water within the tailings, the specific conductivity and sodium concentrations in water in well MW-95-3 (completed in the tailings west of the decant ponds) were similar to, or higher than decant pond water prior to, during, and after the tracer test. Therefore, the presence of increased SC and sodium in well MW-95-3 is unrelated to the addition of salt to decant pond water.

3.2.1 Chemical Effects of the Tracer on Groundwater

Results of the groundwater tracer test are shown in the trend plots (SC, sodium, chloride versus time) in Appendix F. Overall, there was no meaningful increase in concentrations of the tracer (salt) in any monitoring wells during the test. Therefore, the tracer test indicates poor hydrologic connection (low or slow rate of flow) between the decant ponds and the units in which the monitoring wells are completed. As noted above, groundwater quality data suggests that the groundwater in deeper gravel/sand units near the decant ponds (e.g., units monitored by wells IW-1, MW-95-7, and MW-95-8) is derived primarily from

minewater disposed in the decant ponds. However, tracer test results suggests that these gravel units are not the primary groundwater flowpath for decant pond water.

3.2.2 Decant Pond Infiltration Rate

Water levels in the decant ponds were monitored over the course of the tracer addition period (24 days, from March 13 to April 6) while no water was discharged to the ponds. Based on the volume of water lost from the ponds over this period it is possible to calculate an infiltration rate for the ponds. Decant pond #1 and decant pond #2 have surface areas of approximately 3.2 and 1 acres, respectively and during the tracer addition period, water levels in the ponds dropped 10.7 and 8.8 feet, respectively. Total volume of water infiltrated through the ponds is therefore approximately 14 million gallons. Since the tracer addition period was 34,380 minutes, the average infiltration rate for the period was about 400 gpm or about 0.2 in/hr (0.4 ft/day).

The calculated infiltration rate is not particularly high and is in the range of what might be expected for a fine sand. However, this infiltration rate implies that the hydraulic conductivity of the groundwater aquifer that transports the minewater away from the decant pond is much larger, perhaps on the order of 500 ft/day or more, typical of coarse sands or gravel. The decant ponds have a large surface area for infiltration (about 180,000 ft^2) and the hydraulic gradient in the pond is 1 (vertical gradient). In the groundwater system near the pond it is likely that the gradient is much less than 1 (i.e. flow is not strictly vertical but likely has a large horizontal component) and the cross-sectional area of the aquifer is likely a fraction of the surface area of the ponds. Given the likely much lower gradient and smaller area of the aquifer in the flowpath, the aquifer would have to have a much higher hydraulic conductivity to transmit the flow from the decant ponds.

4.0 PHASE 2 AND 3 WORKPLAN

4.1 CONCEPTUAL MODEL OF HYDROGEOLOGIC SYSTEM

Groundwater in the Lake Creek Valley occurs in glaciolacustrine deposits and alluvium (Levings et al, 1984). Within the glaciolacustrine deposits groundwater occurs primarily in the sand, gravel, and cobble zones. Silt and clay zones within the glaciolacustrine deposits are confining beds that restrict vertical ground-water movement. Although the general directions of groundwater movement in the area are likely towards the north (in the general direction of flow in Lake Creek) and towards the west (toward Lake Creek), local groundwater flow directions are likely controlled primarily by the location and orientation of permeable water bearing zones within the glaciolacustrine and alluvial deposits.

Previous monitoring well drilling (see Summit and MF&G, 1996) and geotechnical boring investigations (see Woodward-Clyde, 1977) in the area have identified the presence of sand and gravel zones within the glaciolacustrine deposits in the general vicinity of the decant ponds. As summarized in the Draft EIS (p. 103),

> ”The surficial geology of the pond [tailing impoundment] site reflects the complex geology of the area and varies from fine-grained clayey silts to coarse rock and gravel. The coarser deposits tend to be nearer the edge of the valley and along the lower reaches of Camp Creek. Test wells and test holes also reflect the complex geology of the area with substantial vertical variations in materials encountered.”

The most notable sand and gravel occurrences in wells and test holes are summarized in Table 4. Data from wells and test holes suggest permeable gravels are located at or near the surface near the decant ponds and extending to the east and south of the ponds. Gravels are also present at depth near the decant ponds and to the west of the impoundment near Lake Creek. Groundwater sampling and

tracer testing in spring 2001 indicate that the groundwater in deeper gravel/sand units near the decant ponds (e.g., units monitored by wells IW-1, MW-95-7, and MW-95-8) is derived primarily from minewater disposed in the decant ponds. However, tracer test results suggests that these gravel units are not the primary groundwater flowpath for decant pond water. Based on Phase 1 results and review of the local stratigraphy (see Section 4), it is hypothesized that the shallow gravel unit may provide the primary flowpath for transport of water from the decant ponds. While this shallow unit is believed to transport water primarily laterally away from the decant pond, some slow transport of water downward to the deeper gravels (i.e., leakage through the silts/fine sands that underlie the shallow gravel) is believed to also occur. The slow rate of the vertical transport of water to the deeper gravels is believed to account for the lack of detection of the tracer in the deeper gravels during the relatively short tracer test.

TABLE 4. IDENTIFIED PERMEABLE ZONES IN THE VICINITY OF THE DECANT PONDS

Well/Boring	Location	Zone Description	Other
MW-95-7	Approx. 250 feet east southeast of decant pond #3	Gravel 0 to 18 ft bgs;	Well screened 79 to 89 ft bgs.
MW-95-8	Approx. 50 feet north of decant pond #1, north side of Section 2/3 divider dike.	Gravel, cobbles, sand 0 to 20 ft bgs;	Well screened 48 to 53 ft bgs.
IW-1	Approx. 20 feet north of decant pond #1.	No drilling logs can be found, Asarco internal memos refer to well as screened in "lower sand and gravel aquifer".	Well screened 190 to 210 ft bgs.
MW-1	Approx. 4,000' northwest of decant ponds between dike and Lake Creek	Clean sand and gravel 160 to 280 bgs	Well perforated 55' to 100' bgs in silt/clay and 160' to 280't bgs
MW-3	Approx. 3,000' west of decant ponds between dike and Lake Creek.	Sand and gravel 118 to 125' bgs	Open-ended casing
TH-10	Section 2 approx. 1,000' west of decant ponds	Very gravelly sand 8 to 40' bgs	Field permeability 4,400 ft/yr
TH-11	In section 1 approx. 800' south of decant ponds	Gravel 0 to 40' bgs	Field permeability 8,100 ft/yr
TH-12	Southeast portion section 2; approx. 1200 feet southwest decant ponds	Gravelly sand to gravel 5 to 40'bgs	Field permeability 1,100 ft/yr

*bgs = below ground surface.

4.2 PHASE 2 MONITORING WELL INSTALLATION AND TESTING

The primary target for additional borings and well construction is shallow gravel and cobble units similar to the shallow materials encountered in well MW-95-8 (located 50 feet north of the decant pond), well MW-95-7 (located approximately 250 feet east of the decant pond), and exposed in the terraces immediately to the northeast of the decant pond. The quantity of water disposed in the decant pond (greater than 1,000 gpm or more at times) requires that the pond must be underlain by a relatively permeable unit in order to percolate and transmit the disposed water. The presence of approximately 20 feet of "gravel, cobbles and sand" material at MW-95-8 and MW-95-7 (Appendix II in MFG and Summit, 1996) suggests that surficial gravel materials are a likely conduit for mine water flows.

In summer 2001, excavations were made adjacent to the decant pond in an attempt to locate the surficial gravel materials and install monitoring wells as proposed in the first step in Phase II of the Fate and Transport Study (Hydrometrics, 2000). Although the surface of the tailings near the ponds is stable and workable by heavy equipment, it was not possible to maintain an open excavation sufficient to reach the base of the tailings. Therefore, future work will require drill rigs.

The proposed drilling program to install monitoring wells is anticipated to require one or two phases, Phases 2a and 2b. Phase 2a will include initial well installation to find and identify the groundwater flow path(s) from the decant ponds. Phase 2a will be comprised of wells relatively close to the ponds. Proposed Phase 2a monitoring well locations are shown on Figure 1. Wells are proposed to the west of decant pond #1, south of decant pond #1, south of decant pond #2, north of decant ponds #1 and #2 near the pond divider dike, and east of decant pond #3. Anticipated depth of completion of the wells is 20 to 40 feet, within the shallow gravel zone. Typical monitoring well construction details are shown on Figure 2. Actual well locations and construction details will be selected in the field and may be modified based on field conditions. Wells will be

developed after well construction by pumping with a submersible pump, purging with rig air, bailing, or surging with a block.

Phase 2b of well installation will include wells completed further downgradient in the groundwater flowpath(s) identified in Phase 2a. The exact number and locations of Phase 2b wells will be determined based on Phase 2a results.

Monitoring wells completed in Phase 2 will be sampled after well development for the water quality parameters listed in Table 2.

4.3 PHASE 3 GROUNDWATER TRACER TEST

The need for another groundwater tracer test will be determined based on the results of monitoring well installation and sampling. If a chemical tracer from minewater (i.e., copper) can be found in the monitoring wells then tracer testing may not be needed. If it is believed that the minewater flowpath has been found but minewater can not be definitively identified in groundwater based on water quality analyses, then a tracer test will be conducted. Protocol for the tracer test would be developed at that time, similar to the protocol used in spring 2001 (e.g. see Appendix D).

TABLE 2 ANALYTICAL PARAMETERS FOR GROUNDWATER MONITORING AT THE TROY MINE

Analytical Parameter	Required Reporting Value * (mg/L)	Analytical Method **
Common Ions and Physical Parameters		
pH	0.1 S.U.	EPA 150.1
TDS	(10)	EPA 160.1
Calcium	(1)	EPA 6010
Magnesium	(1)	EPA 6010
Hardness	(1)	ASTM 2340B
Potassium	(2)	EPA 6010
Sodium	(1)	EPA 6010
Total Alkalinity as $CaCO_3$	(1)	EPA 310.1
Bicarbonate	(1)	EPA 310.1
Carbonate	(1)	EPA 310.1
Chloride	(1)	EPA 300.0
Sulfate	(1)	ASTM 9036
Silica	(0.1)	EPA 6010
Temperature (field)	0.1 °C	(field)
Specific Conductivity (field)		(field)
Static Water Level (field)		(field)
Nutrients		
Ammonia as N	0.05	EPA 350.1
Nitrate + Nitrite as N	0.01	EPA 353.2
Dissolved Metals (filtered sample)		
Antimony	0.003	EPA 6020M
Arsenic	0.003	EPA 6020M
Copper	0.001	EPA 6020M
Iron	0.01	EPA 6010/6020
Lead	0.003	EPA 6020M
Manganese	0.005	EPA 6020M
Zinc	0.01	EPA 6020M

* Values in parentheses are detection limit goals, no RRVs exist for these parameters.

** Dissolved metals will be analyzed by ICP-MS (methods 6010, 6020, or 6020M).

FIGURE 2 TYPICAL SHALLOW MONITORING WELL CONSTRUCTION

5.0 REFERENCES

Hydrometrics, 2000. Minewater Fate and Transport Study Plan – Draft. September, 2000

Levings, G. W., R.F. Ferreira and J.H. Lambing, 1984. Water Resources of Lake Creek Valley, Northwestern Montana

Sterling Mining Co., 2000. Genesis Inc. Troy Mine Revised Reclamation Plan.

Summit Envirosolutions and McCulley Frick & Gilman, Inc., 1996. Interim Report of Findings, Hydrologic and Hydrogeologic Assessment, Asarco Troy Mine, Troy Montana.

Summit Envirosolutions, 1999 Site Instrumentation Status Report Troy Tailings Impoundment, Lincoln County, Montana.

Woodward-Clyde Consultants, 1977. Phase II Geotechnical Services, Troy Pojectnear Troy Montana. Prepared for ASARCO, Inc. January 25, 1977.

APPENDIX A

GROUNDWATER MONITORING PROPOSAL

(August 16, 2000 letter from Genesis Inc. to MDEQ)

APPENDIX B

TRACER TEST PROPOSAL, REQUEST AND APPROVAL

(December 4, 2001 letter from Genesis Inc. to MDEQ)

(January 22, 2001 letter from MDEQ to Genesis Inc.)

APPENDIX C

TRACER TEST PROTOCOL REVISION 1

(February 2, 2001 letter from Hydrometrics to MDEQ)

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February 2, 2001

Mr. Joe Gurrieri
MT Dept. of Environmental Quality
PO Box 200901
Helena, MT 59620-0901

RE: Groundwater Tracer Test at the Troy Mine

Dear Joe:

Sterling Mining Companyreceived permission from MDEQ (Abe Horpestad) to proceed with the tracer test at the Genesis Inc. Troy Mine and was requested by Abe to inform you of our progress. Because minewater flows and conditions at the decant ponds have changed somewhat since the tracer test proposal was submitted in early December, we are planning to modify the test procedure. This letter describes the modifications to the tracer test and our final proposed monitoring schedule.

Schedule
We are tentatively planning to start the test the week of February 12, 2001 and would like you to observe the test, if possible. This schedule is contingent on our testing and identifying an appropriate method to add the salt to the ponds. As we have discussed, it will be important to make sure that all of the salt is dissolved quickly in the ponds. We will do some testing of salt additions prior to the start of the actual tracer test. We will inform you of any changes to this schedule.

Test Modification
Based on current conditions in the ponds and mine water flow rates, we now plan to add all of the salt to the ponds (approximately 10 tons) and cease all minewater flows to the ponds for the duration of the salt addition period (approximately 1 to 2 weeks).

As described in Sterling's tracer test proposal, in December the decant ponds contained approximately 12 million gallons of water and mine water inflows to the ponds were approximately 470 gpm. Based on these water volumes, we intended to add approximately 5 tons of salt to the ponds to achieve the desired initial TDS concentration in the ponds. Then approximately 500 pounds of salt would be added daily to maintain this TDS.

Currently, the volume of water in the ponds is much higher (21 million gallons) and minewater flows are much lower (around 200 gpm). At these flow rates, Sterling can divert all minewater flows to the thickener and mill water pond for storage and thereby eliminate minewater flows to the decant ponds for a period of approximately 1 to 2 weeks (actual duration of minewater storage will depend on precipitation runoff to mill water pond during this period). Given these conditions, we believe that it will be easier to simply add the salt to the pond as a "slug" and eliminate the need for daily salt additions. Moreover, this will result in more constant TDS concentrations in the pond. Therefore, we intend to add all of the salt to the pond over an approximately 8 hour period. We plan to add the salt into the tailings reclaim water line (the buried 10-inch line that goes from the mill water pond to the decant pond) at the mill water pond. At the end of the salt addition the reclaim water line will be turned off and minewater flow will be diverted to the thickener and/or mill water pond

Proposed Monitoring Schedule

The overall schedule for monitoring is described in attached Table 1. In this table, "tracer addition period" means the period after the salt has been added to the pond and during the period that mine water is not discharged to the pond.

Prior to tracer addition, the decant pond and adjacent monitoring wells (Irrigation Well, MW-95-3, MW-95-7, and MW-95-8) will be sampled and analyzed for major ion, nutrient, metals and physical parameters according to the schedule in the attached Table 2. Wells around the perimeter of the impoundment will also be sampled for the complete analytical schedule.

During tracer addition, the specific conductivity (SC) of the various waters will be measured daily to track TDS concentrations and waters will be sampled weekly for sodium and chloride. Waters to be monitored include the decant pond and adjacent monitoring wells and wells that can be remotely monitored. Specific conductivity will be measured at four points (1 point along each side) in each pond. To document mixing in the ponds, specific conductivity in the ponds will be measured three times per day during the first 3 days of the test.

If the tracer is detected at adjacent monitoring wells during the tracer addition period, then the decant pond and adjacent monitoring wells will be sampled and analyzed for major ion, nutrient, and metal parameters according to the schedule in Table 2.

At the end of the tracer addition period, the decant pond and adjacent monitoring wells will be sampled and analyzed for major ion, nutrient, and metal parameters (Table 2). Perimeter monitoring wells will be sampled and analyzed for specific conductivity, sodium, and chloride. If the specific conductivity of any perimeter well is more than 10 percent higher than pre-test baseline conductivity, then the well will be sampled for a full suite of analytical parameters (Table 2).

If the tracer has not been detected at adjacent monitoring wells by the end of the tracer addition period, monitoring of SC will be continued on a daily basis for an additional two weeks, then on a weekly basis thereafter. Sodium and chloride will also be monitored weekly in the adjacent wells until the test is terminated.

At the end of the tracer test, the decant pond and adjacent monitoring wells will be sampled and analyzed for major ion, nutrient, and metal parameters (Table 2). Perimeter monitoring wells will be sampled and analyzed for specific conductivity, sodium, and chloride. If the specific conductivity of any perimeter well is more than 10 percent higher than pre-test baseline conditions, then the well will be sampled for a full suite of analytical parameters (Table 2).

Water levels in the ponds will be monitored with staff gages throughout the test. Static water levels in the wells will be monitored at the time of sampling, or in instrumented wells, continuously throughout the test.

The decision of when to terminate the test will be based on monitoring results and will be coordinated with DEQ.

Please let me know if you would like any modifications to this test. I look forward to seeing you on Site for this tracer test.

Sincerely,

Scott Mason
Geochemist

c: Bruce Clark
Frank Duval

Table 1. Monitoring Schedule for Troy Tracer Test

	Pre-Test Baseline	Tracer Addition Period			End of Tracer Addition Period		Post Tracer Addition Period			End of Test	
Monitoring Location	Major Ions, Nutrients, & Metals (see Table 2)	Continuous Specific Conductivity	Daily Specific Conductivity & Water Level	Weekly Sodium and Chloride	Major Ions, Nutrients, & Metals (see Table 2)	Sodium, Chloride, & Specific Conductivity Only	Continuous Specific Conductivity	Daily Specific Conductivity & Water Level	Weekly Sodium and Chloride	Major Ions, Nutrients, & Metals (see Table 2)	Sodium, Chloride, & Specific Conductivity Only
Decant Pond 1 *	Yes		Yes **	Yes	Yes			Yes	Yes	Yes	
Decant Pond 2 *	Yes		Yes **	Yes	Yes			Yes	Yes	Yes	
Decant Pond 3 *	Yes		Yes **	Yes	Yes			Yes	Yes	Yes	
Irrigation Well	Yes		Yes	Yes	Yes			Yes	Yes	Yes	
MW-95-8	Yes	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes	
MW-95-7	Yes	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes	
MW-95-3	Yes	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes	
MW-95-4	Yes	Yes	Yes		?	Yes	Yes	Yes		?	Yes
MW-97-12	Yes	Yes	Yes		?	Yes	Yes	Yes		?	Yes
MW-97-14	Yes	Yes	Yes		?	Yes	Yes	Yes		?	Yes
MW-95-5	Yes	Yes	Yes		?	Yes	Yes	Yes		?	Yes
MW-1	Yes				?	Yes				?	Yes
MW-2	Yes				?	Yes				?	Yes
MW-3	Yes				?	Yes				?	Yes
MW-4	Yes				?	Yes				?	Yes

Notes:

? Well will be sampled for major ions, nutrients, and metals per Table 2 only if specific conductivity is 10% or more greater than pre-test result.

* Specific conductivity will be measured at four points (1 point along each side) in each pond.

** Specific conductivity will be measured three times per day during the first 3 days of the test to document mixing in the ponds.

TABLE 2 ANALYTICAL PARAMETERS FOR GROUNDWATER MONITORING AT THE TROY MINE

Analytical Parameter	Required Reporting Value * (mg/L)	Analytical Method **
Common Ions and Physical Parameters		
pH	0.1 S.U.	EPA 150.1
TDS	(10)	EPA 160.1
Calcium	(1)	EPA 6010
Magnesium	(1)	EPA 6010
Hardness	(1)	ASTM 2340B
Potassium	(2)	EPA 6010
Sodium	(1)	EPA 6010
Total Alkalinity as $CaCO_3$	(1)	EPA 310.1
Bicarbonate	(1)	EPA 310.1
Carbonate	(1)	EPA 310.1
Chloride	(1)	EPA 300.0
Sulfate	(1)	ASTM 9036
Silica	(0.1)	EPA 6010
Temperature (field)	0.1 °C	(field)
Specific Conductivity (field)		(field)
Static Water Level (field)		(field)
Nutrients		
Ammonia as N	0.05	EPA 350.1
Nitrate + Nitrite as N	0.01	EPA 353.2
Dissolved Metals (filtered sample)		
Antimony	0.003	EPA 6020M
Arsenic	0.003	EPA 6020M
Copper	0.001	EPA 6020M
Iron	0.01	EPA 6010/6020
Lead	0.003	EPA 6020M
Manganese	0.005	EPA 6020M
Zinc	0.01	EPA 6020M

* Values in parentheses are detection limit goals, no RRVs exist for these parameters.

** Dissolved metals will be analyzed by ICP-MS (methods 6010, 6020, or 6020M).

APPENDIX D

TRACER TEST PROTOCOL REVISION 2

(March 6, 2001 letter from Hydrometrics to MDEQ)

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March 6, 2001

Mr. Joe Gurrieri
MT Dept. of Environmental Quality
PO Box 200901
Helena, MT 59620-0901

RE: Groundwater Tracer Test at the Troy Mine

Dear Joe:

Sterling Mining Company received permission from MDEQ (Abe Horpestad) to proceed with the tracer test at the Genesis Inc. Troy Mine and was requested by Abe to inform you of our progress. Because the remote groundwater monitoring system was damaged and is no longer functioning, the planned monitoring schedule has changed somewhat since the tracer test proposal revision in early February. This letter describes the modifications to the proposed monitoring schedule. We plan to conduct pre-test sampling of the wells on March 8 and 9 and to start the tracer (salt) addition on March 12, 2001.

The revised schedule for monitoring is described in attached Table 1. In this table, "tracer addition period" means the period after the salt has been added to the pond and during the period that mine water is not discharged to the pond. Revisions to the Table have been done in "redline" mode (additions are italicized, deletions are strikeout) to clarify the changes that have been made. The primary change is that continuous monitoring of wells is not possible and will not be done. To offset the loss of continuous specific conductivity data, the frequency of sampling of wells near the decant pond for SC, sodium, and chloride has been increased from weekly to daily.

Please let me know if you would like any modifications to the planned monitoring schedule.

Sincerely,

Scott Mason
Geochemist

c: Abe Horpestad
Bruce Clark
Frank Duval

Table 1. Revised Monitoring Schedule for Troy Tracer Test

	Pre-Test Baseline	Tracer Addition Period			End of Tracer Addition Period		Post Tracer Addition Period			End of Test	
Monitoring Location	Major Ions, Nutrients, & Metals (see Table 2)		Daily Specific Conductivity, Sodium, Chloride & Water Level		Major Ions, Nutrients, & Metals (see Table 2)	Sodium, Chloride, Water Level & Specific Conductivity Only		Daily Specific Conductivity, Sodium, Chloride & Water Level		Major Ions, Nutrients, & Metals (see Table 2)	Sodium, Chloride, Water Level & Specific Conductivity Only
Decant Pond 1 *	Yes		Yes **		Yes			Yes		Yes	
Decant Pond 2 *	Yes		Yes **		Yes			Yes		Yes	
Decant Pond 3 *	Yes		Yes **		Yes			Yes		Yes	
Irrigation Well	Yes		Yes		Yes			Yes		Yes	
MW-95-8	Yes		Yes		Yes			Yes		Yes	
MW-95-7	Yes		Yes		Yes			Yes		Yes	
MW-95-3	Yes		Yes		Yes			Yes		Yes	
MW-95-4	Yes				?	Yes				?	Yes
MW-97-12	Yes				?	Yes				?	Yes
MW-97-14	Yes				?	Yes				?	Yes
MW-95-5	Yes				?	Yes				?	Yes
MW-1	Yes				?	Yes				?	Yes
MW-2	Yes				?	Yes				?	Yes
MW-3	Yes				?	Yes				?	Yes
MW-4	Yes				?	Yes				?	Yes

Notes:

? Well will be sampled for major ions, nutrients, and metals per Table 2 only if specific conductivity is 10% or more greater than pre-test result.

* Specific conductivity will be measured at four points (1 point along each side) in each pond.

** Specific conductivity will be measured three times per day during the first 3 days of the test to document mixing in the ponds.

TABLE 2 ANALYTICAL PARAMETERS FOR GROUNDWATER MONITORING AT THE TROY MINE

Analytical Parameter	Required Reporting Value * (mg/L)	Analytical Method **
Common Ions and Physical Parameters		
pH	0.1 S.U.	EPA 150.1
TDS	(10)	EPA 160.1
Calcium	(1)	EPA 6010
Magnesium	(1)	EPA 6010
Hardness	(1)	ASTM 2340B
Potassium	(2)	EPA 6010
Sodium	(1)	EPA 6010
Total Alkalinity as $CaCO_3$	(1)	EPA 310.1
Bicarbonate	(1)	EPA 310.1
Carbonate	(1)	EPA 310.1
Chloride	(1)	EPA 300.0
Sulfate	(1)	ASTM 9036
Silica	(0.1)	EPA 6010
Temperature (field)	0.1 °C	(field)
Specific Conductivity (field)		(field)
Static Water Level (field)		(field)
Nutrients		
Ammonia as N	0.05	EPA 350.1
Nitrate + Nitrite as N	0.01	EPA 353.2
Dissolved Metals (filtered sample)		
Antimony	0.003	EPA 6020M
Arsenic	0.003	EPA 6020M
Copper	0.001	EPA 6020M
Iron	0.01	EPA 6010/6020
Lead	0.003	EPA 6020M
Manganese	0.005	EPA 6020M
Zinc	0.01	EPA 6020M

* Values in parentheses are detection limit goals, no RRVs exist for these parameters.

** Dissolved metals will be analyzed by ICP-MS (methods 6010, 6020, or 6020M).

APPENDIX E

PIPER DIAGRAMS

APPENDIX F

TRACER TEST RESULTS – SC, Na, CL Trendplots

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Mg++	0.000322	0.000322	7.82
NH3(aq)	5.69e-005	5.69e-005	0.969
NO3-	0.00171	0.00171	106.
Na+	0.00106	0.00106	24.4
O2(aq)	4.25e-005	4.25e-005	1.36
SO4--	0.000366	0.000366	35.2
SiO2(aq)	0.000181	0.000181	10.8
UO2++	2.05e-009	2.05e-009	0.000554

Elemental composition		In fluid		Sorbed	
	total moles	moles	mg/kg	moles	mg/kg
Barium	1.061e-006	1.061e-006	0.1456		
Cadmium	2.575e-008	2.575e-008	0.002893		
Calcium	0.001659	0.001659	66.46		
Carbon	0.002612	0.002612	31.36		
Chlorine	0.0001103	0.0001103	3.909		
Copper	1.693e-007	1.693e-007	0.01075		
Fluorine	5.147e-006	5.147e-006	0.09774		
Hydrogen	111.0	111.0	1.118e+005		
Magnesium	0.0003218	0.0003218	7.819		
Nitrogen	0.001768	0.001768	24.75		
Oxygen	55.52	55.52	8.880e+005		
Potassium	0.0002251	0.0002251	8.796		
Silicon	0.0001806	0.0001806	5.071		
Sodium	0.001063	0.001063	24.43		
Sulfur	0.0003664	0.0003664	11.74		
Uranium	2.054e-009	2.054e-009	0.0004887		

Appendix I
Assessment of Natural Attenuation of Metals in a Decant Pond Disposal System

ASSESSMENT OF NATURAL ATTENUATION OF METALS IN A DECANT POND DISPOSAL SYSTEM

TROY MINE

Prepared for:

Genesis Inc. Troy Mine
P.O. Box 1660
Troy, MT 59935

Prepared by:

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May 2010

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EXECUTIVE SUMMARY

Mine and tailings water have been directed to the Troy Mine tailings impoundment for over 30 years without appreciable transport of metals in groundwater away from the infiltration pond (decant pond). This is due in part to natural attenuation of metals in the sediments beneath the infiltration pond and in the groundwater aquifer. Field evidence for natural attenuation of metals is provided by the sampling and analysis of water and soil samples in the vicinity of the tailings impoundment infiltration pond and from laboratory testing.

Water quality data shows that the concentrations of parameters that are not attenuated (e.g. chemically conservative parameters such as nitrate) are similar between the mine water/decant pond water and the underlying groundwater. This similarity in concentrations indicates that mine water is not appreciably diluted in the groundwater system in close proximity to the infiltration pond. In contrast, the concentrations of metal parameters are much lower in the groundwater than in the mine water/decant pond, indicating that metal parameters are attenuated (removed) in the groundwater system.

Analyses of sediments in the subsurface of the decant pond reveal that metals are enriched in the sediments, indicating that the metals attenuated/removed from groundwater are retained on the sediments. Microscopic and electron microprobe examination of sediments document the occurrence of secondary copper minerals (i.e., non-ore forming minerals) in the sediments. These secondary minerals form by precipitation of copper from mine water. Geochemical equilibrium modeling confirms that copper, iron, lead, and manganese minerals are oversaturated in mine water and are favored to form from mine water.

The longevity of the natural attenuation mechanisms is dependent on the duration of the geochemical conditions conducive to attenuation and to the capacity of the tailing impoundment/aquifer sediments to continue to uptake metals. **The mineral precipitation and co-precipitation mechanisms are expected to last indefinitely or in perpetuity as long as geochemical conditions remain similar to current conditions.** The adsorption mechanisms are conservatively estimated to last a minimum of 600 years.

Potential monitoring and management practices that would help ensure the continued effectiveness of metal attenuation by maintaining the geochemical conditions that are conducive to attenuation are described. The goal of monitoring and management practices would be to maintain the following current conditions at the tailing impoundment:

1. Neutral or alkaline pH;
2. Oxidizing redox conditions (moderate to high Eh);
3. Presence of moderate amounts of dissolved silica;
4. Presence of moderate amounts of bicarbonate; and
5. Presence of low to moderate amounts of organic material.

Management practices should be aimed at maintaining the existing geochemical conditions by:

1. Maintaining exposure of disposal water to atmospheric oxygen and carbon dioxide;
2. Avoiding excessive use of phosphate fertilizer for reclamation (high levels of dissolved phosphate may suppress arsenic adsorption and limit arsenic attenuation);
3. Maintaining pH by monitoring or mitigation; and
4. Maintaining the decant pond/infiltration site as an aerobic environment by monitoring and if necessary removing excessive organic material that may build up.

ASSESSMENT OF NATURAL ATTENUATION OF METALS IN DECANT POND DISPOSAL SYSTEM

TROY MINE

1.0 INTRODUCTION

This report summarizes an assessment of the natural attenuation of selected metals (antimony, cadmium, copper, lead, mercury, silver, and uranium) in post-closure mine water that is proposed to be disposed by infiltration into the reclaimed tailing impoundment at the Troy Mine in Lincoln County, Montana (Figure 1). Although there are several different sources or types of water associated with the Troy Mine, "mine water" for purposes of this evaluation, refers to water that is pumped or that flows from the underground mine workings via the mine adits. After mine closure, mine water would be piped to the tailings pond area for disposal (Genesis Inc., 2006).

Water that is used in the milling circuit and/or to transport tailings to the tailings impoundment is termed "tailings water." During operational periods, tailings water flows over the deposited tailings to the tailings decant pond where a portion of the water infiltrates to the subsurface and the remainder is pumped back to the mine for use in the mill. During times of excess mine water (especially during the mine dewatering phase of the mine restart in 2005), mine water may also flow to the decant pond directly via the tailings lines. Thus during operational periods, water in the decant pond ("decant pond water") is composed of a varying mix of tailings water, mine water, and natural rainfall and snowmelt. Since decant pond water is partially composed of mine water and is similar in metal content and overall chemistry to mine water, the fate of metals in decant pond water that infiltrates from the decant pond during operations is also considered in this report to provide additional evaluation of attenuation mechanisms.

FIGURE 1. LOCATION OF TROY MINE

LOCATION MAP	LOCATION MAP TROY MINE SANDERS COUNTY, MT	FIGURE 1

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location map.dwg

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Consulting Scientists and Engineers

1.1 BACKGROUND

The Troy Mine was developed by Asarco in 1979 and went into production in 1981. Asarco operated the mine until 1993 when the mine was placed on temporary shutdown. In 1999, the mine was purchased Sterling Mining Company (now Revett Minerals, Inc) and has been operated by Genesis Inc., a subsidiary of Revett. Mining restarted in 2005 with milling and tailings production beginning in November 2005 and continuing to this day.

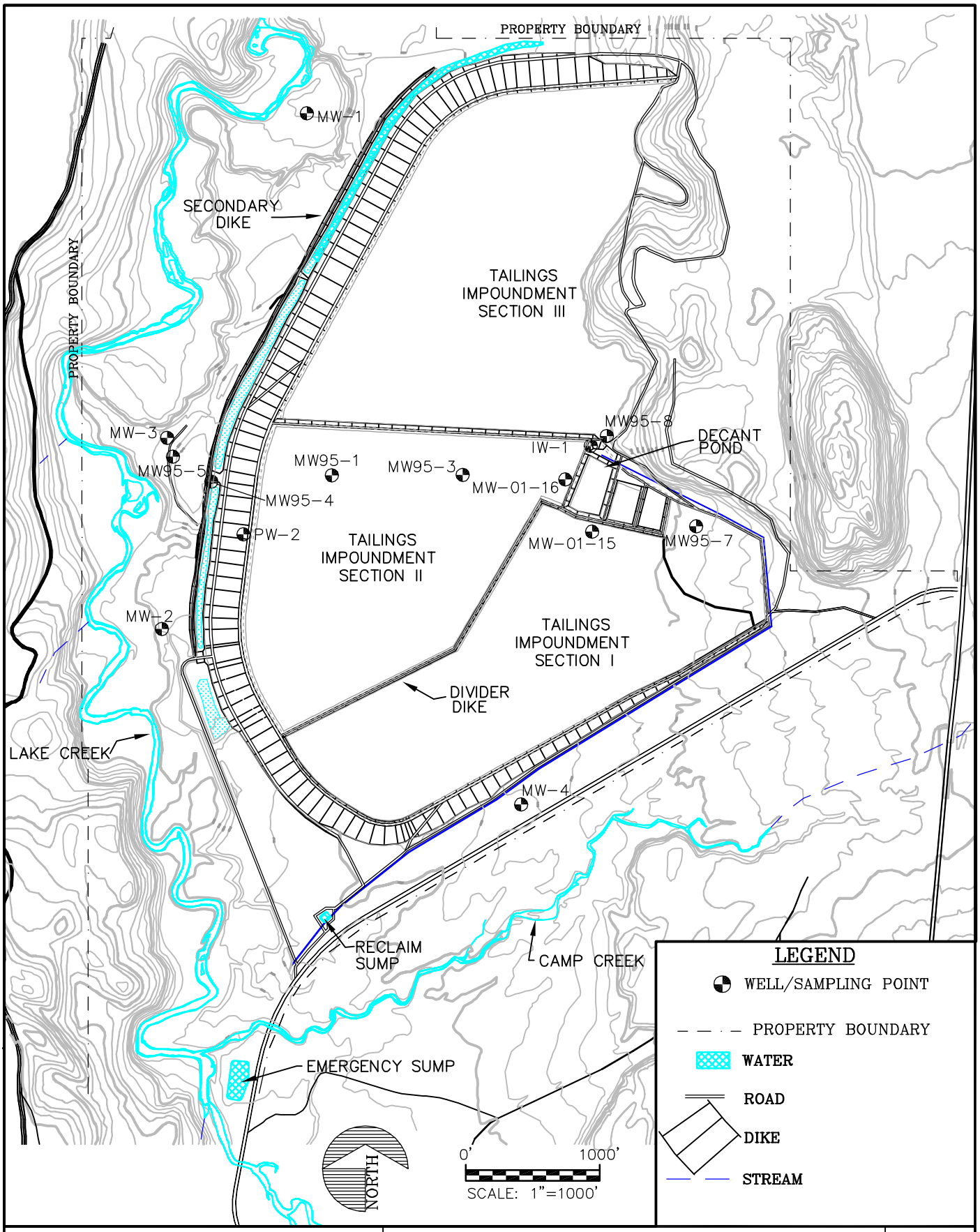
During the interim shutdown period of 1993 through 2004, Asarco and Genesis Inc. disposed of water from the underground workings by discharge to the tailings impoundment in one of three ways:

- Sprinkler irrigation over the impoundment (primarily during the growing season).
- Discharge to the decant pond (also known as the barge pond in some reports).
- Discharge to the Section III pond (an area in Section III of the impoundment where water ponds on the surface before flowing through a pipe to the decant pond).

The general layout of the tailings impoundment and associated ponds and monitoring wells is shown on Figure 2. Long-term disposal of mine water though the decant pond system after mine closure has been proposed as part of the Mine's final reclamation plan (Genesis, Inc., 2006) and is being evaluated by Montana Department of Environmental Quality (DEQ) as part of the ongoing environmental assessment of the final reclamation plan.

The primary constituent of concern is copper, which is typically present in mine water at concentrations of approximately 0.04 to 0.17 mg/L during shutdown periods. For comparison, copper concentrations in Lake Creek adjacent to the impoundment typically range from approximately <0.001 to 0.003 mg/L (higher values occur during high flow events), the chronic aquatic life standard for copper is approximately 0.004 mg/L (assuming hardness of 35 mg/L) and the Montana groundwater quality standard and Federal drinking water standard is 1.3 mg/L. In spite of the higher copper concentrations discharged to the impoundment, copper concentrations in Lake Creek and in groundwater monitoring wells installed in the impoundment vicinity have not increased measurably as a result of the

FIGURE 2. MAP OF TAILING IMPOUNDMENT SHOWING LOCATION OF DECANT POND AND MONITORING WELLS



TROY MINE	TAILINGS IMPOUNDMENT AND MONITORING WELLS	FIGURE 2

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discharge of mine waters (see Summit, 1999; Parametrix, 2008). Similar to copper, concentrations of other metals (arsenic, antimony, lead, and uranium) are significantly reduced as decant water infiltrates the sediments beneath the pond and flows in the groundwater system. Other metals of interest (cadmium, lead, mercury, silver) are present at very low concentrations and are rarely detected in mine water and decant pond water.

The observed natural attenuation of copper and other metals (i.e., the reduction in metal concentrations through natural geochemical processes) in the decant pond and groundwater system led to the consideration of the infiltration of mine water at the tailing impoundment as a potential long-term disposal and treatment method for mine water following mine closure. From 2000 through 2004, a series of field and laboratory investigations were conducted to identify the geochemical processes responsible for the natural attenuation of copper in the decant pond and groundwater system (Hydrometrics, 2000 and 2001; Land & Water Consulting, 2004). The primary findings of these studies are:

1. Permeable sand and gravel layers beneath the decant pond provide the primary pathway for transport of mine water in the subsurface;
2. Copper concentrations are quickly attenuated (reduced) to levels below human health and aquatic life standards during groundwater transport within a short distance (ten to one hundred feet) of the decant ponds; and
3. Geochemical mechanisms responsible for copper attenuation include primarily the formation of copper minerals and secondarily adsorption by organic matter in soils and sediment beneath the decant pond.

The copper minerals forming in the pond sediments and groundwater are identical to the secondary copper minerals that form within the underground workings as the primary sulfide minerals are exposed to oxygen, become thermodynamically unstable, and oxidize to form new (i.e., secondary) minerals. Thus, the copper attenuation mechanism occurring in the decant pond sediments and groundwater is the completion of a chemical reaction started in the underground mine.

Subsequent to the 2000-2004 studies (that focused on copper), the natural attenuation of arsenic, antimony, cadmium, lead, mercury, silver, and uranium from mine water and decant pond water have been evaluated by additional investigations. CDM (2010) conducted geochemical modeling and lab experiments to demonstrate the natural attenuation provided by the precipitation of iron from mixing of mine water and decant pond water with natural ambient groundwater. These studies demonstrated that precipitation of naturally-occurring iron and manganese in groundwater can significantly reduce the concentrations of arsenic, antimony, copper, lead, and uranium in mine water and decant pond water.

1.2 PURPOSE AND SCOPE OF EVALUATION

The purpose and scope of this evaluation is to further evaluate the natural attenuation of copper as well as other metals in mine water and groundwater beneath the decant pond. The purpose and scope is based on addressing issues identified in the following communications/ interactions with Montana DEQ and Kootenai National Forest:

- March 27, 2008 DEQ Task Order to CDM on copper attenuation;
- May 8, 2008 letter from DEQ to Doug Miller (Genesis);
- December 3, 2008 conference call with Wayne Jepson and Jim Castro (DEQ), Kent Whiting (CDM), Fess Foster (consultant to Genesis), Doug Parker and Scott Mason (Hydrometrics);
- December 10 meeting in Helena with DEQ, KNF (by phone), Genesis, Fess Foster, and Hydrometrics; and
- January 8, 2009 conference call with Wayne Jepson, Jim Castro, Lisa Boettcher, and Pat Plantenberg (DEQ), Kent Whiting (CDM), and Scott Mason (Hydrometrics).

The metal attenuation issues identified in these meetings and communications are:

- Evaluation of metals (antimony, cadmium, lead, mercury, silver, and uranium) in addition to copper that are present in mine water;
- Evaluation of the longevity of the natural metal attenuation mechanisms; and

- Identification of management practices and monitoring to ensure continued effectiveness of metal attenuation.

The Scope of Work for this evaluation was further clarified in the *Proposed Scope of Work for Copper Attenuation Study Addendum* (Hydrometrics, 2009). The proposed project is organized in a phased or tiered manner that follows the Tiered Analysis Approach recommended by EPA in *Monitored Natural Attenuation of Inorganic Contaminants in Groundwater, Volumes 1 and 2* (EPA, 2007a). EPA's tiered approach addresses four primary issues:

1. Demonstration of active contaminant removal from ground water;
2. Determination of the mechanism(s) and rate of attenuation;
3. Determination of the long-term capacity for attenuation and stability of immobilized contaminants; and
4. Design of performance monitoring program.

Some metal parameters that were initially identified for evaluation (mercury and silver) are not present at measurable concentrations in mine water and decant pond water. Moreover, potential concentrations (i.e., detection limit concentrations) in mine water and decant pond water are better than (below) applicable water quality standards. Therefore, this evaluation of the fate of these metals does not include a detailed evaluation of their attenuation behavior based on field evidence or geochemical modeling. For these parameters, the evaluation is limited to a summary of the available literature.

1.3 LIMITATIONS AND UNCERTAINTIES

As with all predictive studies, this study has certain limitations and uncertainties. They are listed below, and discussed in the following paragraphs. In spite of these uncertainties, it is felt that this study is a reliable prediction of post-mine closure water quality and the behavior

of metals in the infiltration pond and groundwater system. The reliability of these predictions is bolstered by the empirical evidence of attenuation that has occurred for over thirty years.

Limitations and uncertainties in this evaluation include:

1. The lack of actual post-closure mine water for evaluation;
2. The lack of the analysis of several metals in some previous investigations;
3. The very low or non-detectable concentrations of some metals;
4. The assumption of chemical equilibria or disequilibria in geochemical modeling; and
5. Uncertainties in the thermodynamic data upon which geochemical calculations and modeling is based.

After mine closure, disposal water would be composed exclusively of mine water plus rainfall and snowmelt that enters the disposal pond. Because the mine is not yet permanently closed, post-closure mine water does not yet exist and post-closure mine water quality cannot be directly measured. Therefore, it is necessary to base the evaluation of natural attenuation on the behavior of metals in analogous waters, namely interim shutdown mine water, operational mine water, and decant pond water. Although this adds some uncertainty to this analysis, the Troy Mine has been operating for over 30 years and there is an extensive record of mine water quality data that indicates that mine water quality is consistent over time. In addition, mine water quality data for the interim closure period (1995 through 2004) is believed to be a very good predictor of future post-closure water quality.

Concentrations of some metals (in particular arsenic, cadmium, lead, and uranium) in mine water, decant pond water, and groundwater are frequently below or just above the analytical reporting limit. The inability to determine actual concentrations in waters with reported “nondetect” results limits the extent of the evaluation of the attenuation behavior of these metals because known concentrations are required in order to quantify the amount of attenuation and to conduct geochemical models. In addition, detected results that are near the limits of analytical detection have a relatively high amount of uncertainty or imprecision.

However, because concentrations of these metals are very low and near or below detection limits, they also tend to be below applicable water quality standards and are of less environmental concern.

Extensive field and laboratory studies were conducted in 2000 through 2004 on the mechanisms of the natural attenuation of copper in mine water disposed at the decant pond (Land and Water Consulting, 2004). Metals in addition to copper were not identified as potential problems at the time and little data concerning the mechanisms of attenuation of other metals were collected. Although the evidence for natural attenuation of these other metals is strong (i.e., concentrations of arsenic, antimony, lead, and uranium in groundwater are demonstrated to be significantly reduced through natural geochemical processes), field evidence of the specific mechanisms of attenuation (e.g. adsorption, mineral precipitation, etc.) for metals other than copper is limited. In this report, the nature of attenuation mechanisms for copper and other metals is evaluated and demonstrated by additional site-specific laboratory testing and geochemical modeling of attenuation mechanisms. In addition, natural attenuation has been studied and demonstrated extensively at many other sites and a review of natural attenuation mechanisms based on scientific literature is also provided.

Virtually all geochemical modeling software including the geochemical model and software (Geochemist's Workbench; RockWare, 2010) used in this assessment are equilibrium models. Although complete chemical equilibrium is relatively rare in nature, equilibrium-based models remain powerful tools as they help to define geochemical conditions and indicate the types of geochemical changes that are likely to occur. In addition, if parts of the geochemical system are known to be in disequilibrium or partial equilibrium, the equilibrium models can be forced to maintain disequilibrium or partial equilibrium in portions of the modeled system. Instances where partial disequilibrium as assumed for modeling purposes are described in Section 5.

The thermodynamic data used for geochemical calculations and modeling in this report are from recognized sources (e.g. Lawrence Livermore National Laboratory, 2006) and are

generally considered to be valid. However, all measurements contain uncertainties and in the case of thermodynamic data such as equilibrium or solubility product constants, many of the numbers are extremely large or small (e.g. 10^{-50}) and small relative uncertainties in the data can yield relatively large uncertainties in the results of calculations (such as mineral saturation indices). To reduce the uncertainty in conclusions based on geochemical modeling, the model results are "field truthed" or corroborated with empirical evidence from field and laboratory studies to the extent possible.

2.0 OCCURRENCE OF METALS IN TROY MINE WATER

2.1 SOURCE OF METALS

The source of metals in the Troy mine water and decant pond water are the metal-bearing minerals present in and around the ore body and associated mineralized zones. As rainwater and snowmelt percolate through rock to the underground workings, the water contacts metal-bearing minerals and dissolves small amounts of copper and other trace metals. As described in the Rock Creek EIS (MDEQ and USFS, 2001):

> "Sulfide mineral oxidation is a process that may occur in pH-neutral conditions, and is the probable source of the elevated copper in the water that is in the underground workings in the Troy mine. The Troy mine has developed and exposed the bornite-digenite-native silver ore zone. Bornite is a copper-iron-sulfur mineral and digenite is a copper-sulfur mineral. The underground pillars that support the overlying sedimentary rocks are composed of ore grade bornite-digenite-native silver. In a pH-neutral oxidizing environment, the bornite-digenite-native silver minerals that occur on fracture and joint surfaces in the rock are oxidized in place to a mixture of various copper oxide minerals. These copper oxide minerals are exposed in the outcrops of the Troy orebody on the south side of Mt. Vernon and underground in the mine workings. The oxide minerals include tenorite, chrysocolla, brochantite, malachite, and cupriferous goethite, Hayes and Balla, (1986). These are all secondary copper oxide minerals which occur in areas of low acidity. The bornite and digenite minerals that occur between the individual sand grains and that comprise the main ore zone are not leached, as they are encapsulated by the quartz overgrowths that occurred during diagenesis and burial metamorphism.
>
> Subsequent melting snow water, percolating down through the various sedimentary rocks along these same fracture and joint surfaces, partially dissolve the oxidized copper oxide minerals, and the dissolved copper is seen and detected in the underground mine waters. It should be noted that in the Troy mine, the overlying galena halo zone and the pyrite halo zone were not mined and are not exposed in the Troy mine.
>
> It should also be noted that the melting snow water, percolating down through the overlying galena and pyrite halo zones, is not creating acid rock conditions, as the sampling of the underground mine waters consistently show that the pH of the mine waters is 7.2 to 7.4, a near-

neutral to alkaline condition. These conditions are what is expected be similar at the Rock Creek project site." (pg 3-29 Rock Creek FEIS Vol. 1. September 2001)

The source of other metals is similar to that of copper. Arsenic, antimony, cadmium, lead and mercury either form sulfide minerals or are present in sulfide minerals as substituting ions for sulfur or other metals. Oxidation of these sulfides leads to the release of trace amounts of these metals. Silver occurs as native silver and argentiferous sulfides in the ore body and is very slightly soluble (silver concentrations in mine water are below the analytical detection limit).

As described by Land and Water Consulting (2004) and summarized below, the copper attenuation mechanism operating in the decant pond and groundwater system today results in the formation of copper minerals that are identical to the secondary copper minerals that form within the underground workings as described in the Rock Creek EIS. Thus, the copper attenuation mechanism occurring in the decant pond sediments and groundwater is the continuation and completion of chemical reactions started in the underground mine.

2.2 CONCENTRATIONS OF METALS IN WATER

Mine water quality is routinely monitored by the collection of mine water from the mine adit at two locations: the Adit Ditch which includes wash down water from the Transfer Point and the Adit Pipe which is excess water pumped from the back of the mine. Over the course of the mine's life the analytical detection limits attainable from laboratories has continually improved (minimum detection limits have decreased) and much of the mine water quality data collected in the early years of mining was reported at elevated detection limits, relative to current limits. Inclusion of this early data skews statistical calculations and misrepresents actual concentrations. Therefore, in this evaluation only more recent data (2000 through 2009) is considered.

The concentration of metals in recent mine water (2000 through 2009) for both the interim shutdown period (2000 though November 2004 data) and the recent operational period

TABLE 1. METALS AND BICARBONATE CONCENTRATIONS IN TROY MINE WATER

Parameter (Dissolved)	Minimum (mg/L)	Maximum (mg/L)	Average* (mg/L)	Montana Groundwater Quality Standard** (mg/L)	Montana Surface Water Quality Standard** (mg/L)
Mine Water - Interim Shutdown Period 2000 through November 2004					
Arsenic	0.001	0.004	0.0021	0.010	0.010
Antimony	<0.003	0.016	0.0072	0.006	0.0056
Cadmium	No data	No data	No data	0.005	0.000097
Copper	0.044	0.17	0.076	1.3	0.00285
Iron	0.01	0.03	0.02	0.3	1
Lead	<0.002	0.003	0.0013	0.015	0.000545
Manganese	0.011	0.22	0.099	0.05	none
Mercury	No data	No data	No data	0.002	0.00005
Silver	No data	No data	No data	0.100	0.00037
Uranium	No data	No data	No data	0.03	0.03
Bicarbonate	20	113	60	none	None
Mine Water - Operational Period – December 2004 through 2009					
Arsenic	0.001	0.008	0.0026	0.010	0.010
Antimony	<0.003	0.015	0.0081	0.006	0.0056
Cadmium	0.00087	0.0022	0.0015	0.005	0.000097
Copper	0.041	0.986	0.339	1.3	0.00285
Iron	0.01	0.81	0.20	0.3	1
Lead	0.002	0.059	0.0204	0.015	0.000545
Manganese	0.025	0.312	0.177	0.05	None
Mercury	<0.000005	0.000005***	0.0000025	0.002	0.00005
Silver	<0.0005	<0.003	NC	0.100	0.00037
Uranium	<0.0003	0.0013	0.000091	0.03	0.03
Bicarbonate	49	112	84	none	none
Decant Pond Water – Operational Period – December 2004 through 2009					
Arsenic	<0.0005	0.005	0.0019	0.010	0.010
Antimony	0.008	0.062	0.028	0.006	0.0056
Cadmium	<0.0001	0.00126	0.00062	0.005	0.000097
Copper	0.006	0.20	0.0238	1.3	0.00285
Iron	0.008	0.38	0.082	0.3	1
Lead	<0.0005	0.0016	0.0013	0.015	0.000545
Manganese	0.101	0.791	0.4927	0.05	none
Mercury	<0.000005	<0.000005	<0.000005	0.002	0.00005
Silver	<0.0005	<0.003	NC	0.100	0.00037
Uranium	0.0029	0.0033	0.0031	0.03	0.03
Bicarbonate	52	121	93	none	none

Period of Record = 2000 through 2009 Data. Mine water includes Adit Ditch and Adit Pipe sampling locations.
NC = average not calculated as all values are less than analytical detection limit.
* One half of the detection limit value used for nondetect results in calculation of average.
**Circular DEQ-7 Montana Numeric Water Quality Standards, February 2008. Values for surface water standards are the lower of the human health standard or the chronic aquatic life criteria. Hardness dependent criteria based on hardness of 25 mg/L. Values for iron and manganese in groundwater is the Federal Secondary Drinking Water Standard. For silver there is no chronic aquatic life criterion, value shown is acute criterion.
***Laboratory QC results indicate that this result is biased high.

(December 2004 through 2009 data) are given in Table 1. Both the Adit Ditch and Adit Pipe are representative of mine water and therefore data from both sites is combined in Table 1. For comparison, metal concentrations in decant pond water and Montana water quality standards are also shown. Graphs in Appendix B show the concentrations of selected chemical constituents in mine water and decant pond water for the period of 2000 through 2009 and for nitrogen species for the course of mine life.

There are several key observations regarding mine water and decant pond water quality:

1. Mercury and silver are not detected, or if detected, are present at concentrations below relevant Montana water quality standards.
2. On average, metal concentrations are generally higher in mine water during the operational period (e.g. copper average concentration of 0.076 mg/L during shutdown versus 0.339 mg/L during operations; lead average concentration of 0.0013 mg/L during shutdown versus 0.0204 mg/L during operations). However, more recent (2009) operational data indicates that copper and lead concentrations have returned to near interim shutdown levels.
3. During the shutdown period, antimony is the only metal parameter that exceeds the groundwater standard (average concentration of 0.0072 mg/L in mine water compared to the standard of 0.006 mg/L). Antimony concentrations are similar in operational period mine water (average of 0.0081 mg/L). Antimony concentrations are steady in operational period mine water and in decant pond water through 2007 (about 0.02 mg/L) but increased in decant pond water in 2009 to about 0.06 mg/L. After the cessation of mining, mine disposal water is expected to be similar to current mine water (<0.003 to 0.016 mg/L).

2.3 CONCENTRATION OF COMMON ION PARAMETERS IN WATER

Graphs in Appendix B show the concentrations of selected common chemical constituents in mine water and decant pond water over the course of mine life. Notable observations regarding common ion concentrations include:

1. Much lower nitrogen concentrations during interim shutdown. The source of nitrogen in mine water is predominantly from the residues of explosives used in blasting and mining. After mining (blasting) ceases, nitrogen levels quickly fall to low levels.
2. Sulfate concentrations and pH levels in mine water are somewhat variable, probably from seasonal variations in rain and snowmelt, but relatively steady exhibiting no overall trends. The lack of trend suggests that sulfide oxidation rates within the mine are relatively steady as well, and therefore no significant change in sulfide oxidation rate and mine water pH is expected after final mine closure.
3. Common cation (calcium, potassium, sodium) concentrations are steady in mine water but exhibit some variation in decant pond water due to the addition of potassium and sodium-bearing milling reagents. Potassium and sodium concentrations in decant pond water are similar to mine water during the interim shutdown period, but are increased during active mining phases. Calcium concentrations are higher during the recent mining phase and correlate with increases in bicarbonate concentrations.
4. Bicarbonate (the principle contributor to alkalinity) concentrations during the interim mine closure typically varied between 20 and 80 mg/L and typically were about double calcium concentrations, suggesting some control of bicarbonate levels by calcite (CaCO3) solubility. Since the mine re-start in 2005, bicarbonate levels have increased and in 2009 ranged from approximately 80 to 120 mg/L (Table 1). This increase is believed to reflect the geology of the current mining area where the ore body is higher in carbonate minerals.

3.0 REVIEW OF METAL ATTENUATION LITERATURE

This Section describes the environmental chemistry and behavior of selected metals in the natural environment. This information is summarized from the following EPA publications:

- Water-related Environmental Fate of 129 Priority Pollutants, Volume 1 and 2. (EPA, 1979);
- Monitored Natural Attenuation of Inorganic Contaminants in Ground Water, Volume 1 and 2, (EPA, 2007a);
- Metal Attenuation Processes at Mining Sites (EPA, 2007b);
- Issue Paper on the Environmental Chemistry of Metals (Langmuir et al., 2004); and
- Understanding Variation in Partition Coefficient, K_d, Values, Volumes II and III (EPA, 1999 and 2004).

3.1 NATURAL ATTENUATION MECHANISMS

Natural attenuation is typically defined as the removal or immobilization of dissolved chemical constituents (e.g. metals such as copper) from groundwater by interactions with natural aquifer materials such as soil, rock and organic matter. For inorganic constituents such as metals, the primary attenuation mechanisms are:

1. Sorption to aquifer solids;
2. Mineral precipitation; and
3. Co-precipitation.

These mechanisms may work independently or combined. For instance a metal may initially be primarily sorbed to a substrate at low surface concentrations and then form a surface precipitate as the surface concentration reaches a level where mineral nucleation and growth can occur. Langmuir et al (2004) describe this combined adsorption/precipitation as follows:

> "Except for Al and sometimes Mn, concentrations of trace metals in the environment are generally too low for those metals to exceed the solubility products of their pure metal solids and thus to precipitate. Instead, toxic metal concentrations are generally limited by sorption onto the

> surfaces of minerals, and onto organic matter including microbial cell wall surfaces. For aluminosilicate-rich soils, however, surface precipitation of Zn, Ni, and Co as layered double hydroxides was reported (e.g. Ford and Sparks, 2000). As metal concentrations further increase and fill available sorption sites, most metals tend to be incorporated in the structures of major mineral precipitates as "coprecipitates" in which they substitute for major metal cations, forming so-called solid solutions (Langmuir, 1997a). At higher metal concentrations, the metals may be precipitated in pure metal phases, limiting further increases in metal concentration."

The extent of sorption of trace metals in groundwater is largely controlled by the following factors:

1. Groundwater pH;
2. Metal concentration in solution;
3. The quantity of sorbent material (principally hydrous ferric and manganese oxides, organic matter, and clays) within the aquifer; and
4. The concentration of competing ions in solution.

The extent of co-precipitation and precipitation of metals in groundwater is largely controlled by the following factors:

1. Groundwater pH;
2. Groundwater redox (e.g. Eh or pe) conditions;
3. Metal concentrations in solution;
4. The concentrations of common ions (e.g. sulfate, bicarbonate/carbonate, hydroxide) that can form minerals with the metal ions;
5. The solubility and stability of metal-bearing minerals; and
6. The concentrations of common ions that form soluble metal complexes in solution.

Summaries of the attenuation mechanisms that have been identified in the scientific literature as controlling factors for the metals of interest are provided in Tables 2 and 3.

TABLE 2. SUMMARY OF ATTENUATION PROCESSES FOR ANTIMONY, MERCURY AND SILVER

Metal	Attenuation Mechanisms
Antimony	Sorption by iron, manganese, and aluminum oxides and clay
Mercury	Sorption by organic matter, iron and manganese oxides and clays
Silver	Sorption by iron and manganese oxides and organic matter

TABLE 3. SUMMARY OF ATTENUATION PROCESSES FOR ARSENIC, CADMIUM, COPPER, LEAD, URANIUM, AND ZINC

Contaminant	Possible Attenuation Reactions	Relevant parameters
As	Sorption in aerobic environments Sorption/Precipitation in anaerobic environments	• Abundance/stability of hosts; typically Fe and Al (hydr)oxides • Solid-phase sulfide accumulation; redox buffer capacity, sulfate reducing activity
Cd	Sorption in aerobic environments Sorption/Coprecipitation carbonates Sorption/Precipitation in anaerobic environments	• Abundance/stability of hosts; typically Fe and Al (hydr)oxides • Abundance/stability of hosts; may require consideration of pH buffer capacity • Solid-phase sulfide accumulation; redox buffer capacity, sulfate reducing activity
Cu	Sorption in aerobic environments Sorption/Coprecipitation carbonates Sorption/Precipitation in anaerobic environments	• Abundance/stability of hosts; typically Fe and Al (hydr)oxides • Abundance/stability of hosts; may require consideration of pH buffer capacity • Solid-phase sulfide accumulation; redox buffer capacity, sulfate reducing activity
Pb	Sorption/Coprecipitation in aerobic environments Precipitation as hydroxycarbonate or sulfate Sorption/Precipitation in anaerobic environments	• Abundance/stability of hosts; typically Fe and Al (hydr)oxides • Aquifer pH buffer capacity • Solid-phase sulfide accumulation; redox buffer capacity, sulfate reducing activity
U	Reductive Precipitation Sorption	• Abundance/reactivity of electron donors • Abundance of hosts; typically metal (hydr)oxides
Ni	Sorption in aerobic environments Sorption Sorption/Precipitation in anaerobic environments	• Abundance/stability of hosts; typically Fe and Al (hydr)oxides • Abundance of hosts (clays) • Solid-phase sulfide accumulation; redox buffer capacity, sulfate reducing activity

Note: *Measurement objectives and methodologies to support MNA investigations are documented in U.S. Environmental Protection Agency (2007). MNA assessments focus on both the aqueous phase and the solid phase in order to identify attenuation pathways.*

Source: Table 2 in Metal Attenuation Processes at Mining Sites (EPA, 2007b).

3.2 ANTIMONY

The attenuation of antimony is primarily controlled by adsorption mechanisms as described by Langmuir et al (2004):

> "[Antimony occurs] chiefly as oxyanions in oxidizing environments. As such they are relatively mobile, although they are adsorbed by ferrihydrite under acid to neutral conditions." (p. 60)

> "[A]ntimony may be too soluble for its concentration to be limited by mineral precipitation. The least soluble Sb phase is probably $Sb(OH)_3$, which does not precipitate until Sb concentrations exceed about $10^{-6.67}$ mol/kg, or 26 ug/L (Barnes and Langmuir, 1978). Antimony is a weak complex former, except for its reaction with sulfur at low Eh to form sulfide complexes." (p. 60)

As described by USEPA (1979):

> "The extent to which sorption reduces the aqueous transport of antimony is unknown, but it is clear that sorption processes are normally the most important mechanisms resulting in the removal of antimony from solution. Antimony apparently has an affinity for clay and other mineral surfaces. Coprecipitation of antimony with hydrous iron, manganese, and aluminum oxides may exert a significant control on antimony mobility in areas where there is active precipitation of these metals."(p. 5-3)

3.3 ARSENIC

The attenuation of arsenic in groundwater is primarily controlled by adsorption onto iron oxides and clays. As described by EPA (2004):

> "Arsenic is a known carcinogen, and occurs in natural systems in the +5 (arsenate) and +3 (arsenite) valence states. Arsenic(III) (As(III)) is more mobile (adsorbs less) and is many times more toxic than As(V). The pH and redox conditions are the two most important geochemical factors affecting the mobility of arsenic in the environment. Sorption studies indicate that the concentrations of dissolved As(V) and As(III) are controlled by adsorption on iron and aluminum oxides and clays. The adsorption of As(V) is high and independent of pH at acidic pH values, and decreases with increasing pH in the range of 7 to 9. Arsenic(V) adsorption will be decreased in soils with high phosphate concentrations because of anion competition." (EPA, 2004, p. 5.14)

"Sorption studies have also been conducted to determine the effect on arsenic sorption by the presence of other anions, such as dissolve phosphate, sulfate, nitrate, and chloride (Reynolds et al., 1999; Livesey and Huang, 1981). The results of these studies indicate that dissolved phosphate competes with arsenic for adsorption sites, and thus suppressing arsenic adsorption and enhancing the mobility of arsenic. Livesey and Huang (1981) found that dissolved sulfate, nitrate, and chloride present at concentrations present in saline soils had little effect on arsenic adsorption." (EPA, 2004, p. 5.14)

As described by USEPA (1979):

"Cycling of arsenic in the aquatic environment is dominated by adsorption and desorption to sediments. Arsenic may be sorbed onto clays, aluminum hydroxide, iron oxides, and organic material. … Under most conditions, coprecipitation or sorption of arsenic with hydrous oxides of iron is probably the prevalent process in the removal of dissolved arsenic." (p. 6-6)

3.4 CADMIUM

The attenuation of cadmium is primarily controlled by mineral precipitation and adsorption mechanisms as described by EPA (1999):

"The dominant cadmium aqueous species in groundwater at pH values less than 8.2 and containing moderate to low concentrations of sulfate ($<10^{-2.5}$ M SO_4^{2-}) is the uncomplexed Cd^{2+} species. The dominant cadmium solution species in groundwater at pH values greater than 8.2 are $CdCO_3$ (aq) and to a smaller extent $CdCl^+$. Both precipitation/coprecipitation/dissolution and adsorption/desorption reactions control cadmium concentrations. Several researchers report that otavite ($CdCO_3$) limits cadmium solution concentrations in alkaline soils. The solid $Cd_3(PO_4)_2$ has also been reported to be a solubility-controlling solid for dissolved cadmium. Under low redox conditions, sulfide concentrations and the formation of Cd precipitates may play an important role in controlling the concentrations of dissolved cadmium. At high concentrations of dissolved cadmium ($>10^{-7}$ M Cd), either cation exchange or (co)precipitation are likely to control dissolved cadmium concentrations. Precipitation with carbonate is increasingly important in systems with a pH greater than 8, and cation exchange is more important in lower pH systems. At lower environmental concentrations of dissolved cadmium, surface complexation with calcite and aluminum- and iron-oxide minerals may be the primary process influencing retardation. Transition metals (e.g. copper, lead, zinc) and alkaline earth (e.g. calcium, magnesium) cations

reduce cadmium adsorption by competition for available specific adsorption and cation exchange sites. In conclusion, the key aqueous- and solid-phase parameters influencing cadmium adsorption include pH, cadmium concentration, competing cation concentrations, redox, cation exchange capacity (CEC), and mineral oxide concentrations." (EPA, 1999)

Competition between cations for adsorption sites strongly influences the adsorption behavior of cadmium. The presence of calcium, magnesium, and trace metal cations reduce cadmium adsorption by soils (Cavallaro and McBride, 1978; Singh, 1979), iron oxides (Balistrieri and Murray, 1982), manganese oxides (Gadde and Laitinen, 1974), and aluminum oxides (Benjamin and Leckie, 1980). … The addition of copper or lead, which are more strongly adsorbed, slightly reduces cadmium adsorption by iron and aluminum oxides … In contrast, zinc almost completely displaces cadmium, indicating that cadmium and zinc compete for the same group of binding sites. (EPA, 1999, p.5.11)

Langmuir et al (2004) summarize cadmium mobility in the environment as follows:

"[Cadmium] sulfides are quite insoluble at low Eh, even at low metal and sulfide concentrations (Figures 18 through 23). … Other important Cd and Zn minerals include their carbonates, although the carbonates are relatively soluble at pH values below 8. Pure metal-containing mineral phases generally do not control the dissolved concentrations of Cd, Ni, or Zn in aerobic soils. These metals are more often controlled through adsorption or coprecipitation by oxyhydroxides of iron, manganese, and aluminum."

3.5 COPPER

Langmuir et al (2004) summarize copper mobility in the environment as follows:

"Silver, copper, and mercury are highly insoluble in reduced environments, where they precipitate as metals or as sulfides. In the absence of ligands other than OH-and depending on the copper concentration, the solubility of copper above pH 7–8 can be very low, due to the precipitation of tenorite (CuO). Moreover, in the presence of abundant carbonate, relatively insoluble Cu2+ carbonate minerals can precipitate. (p. 49)

Mercury and copper are strongly adsorbed by organic matter. All three metals are also strongly adsorbed by Fe(III) and Mn oxides, and secondarily by clays. Sorption of mercury is very fast

and practically irreversible (Bodek et al., 1988). By inhibiting mercury sorption, Hg-Cl complexing helps to mobilize the metal. Dimethyl mercury is very insoluble in water and tends to be volatilized from soils." (p. 60)

As described by USEPA (1979):

"Sorption of copper by precipitating hydrous iron and manganese oxides is an effective control on dissolved copper concentrations where these metals are being actively weathered or otherwise introduced into unpolluted aquatic environments." (p. 11-1)

"Copper has a strong affinity for hydrous iron and manganese oxides, clays, carbonate mineral, and organic matter. Sorption to these materials, both suspended in the water column and in the bed sediment, results in relative enrichment of the solid phase and reduction in dissolved levels. Hem and Skougstrad (1960) demonstrated that coprecipitation of copper with the hydrous oxides or iron effectively scavenges copper from solution." (p. 11-6)

"Copper is adsorbed to clay and mineral surfaces and organic materials. … The addition of various anions significantly increased adsorption. Humic acid was particularly effective in this regard." (p 11-9)

3.6 LEAD

The mobility and attenuation of lead is primarily controlled by mineral precipitation and adsorption mechanisms as described by EPA (1999):

"Lead has 3 known oxidation states, 0, +2, and +4, and the most common redox state encountered in the environment is the divalent form. Total dissolved lead concentrations in natural waters are very low (~10^{-8} M). Dissolved lead in natural systems may exist in free ionic form and also as hydrolytic and complex species. Speciation calculations show that at pH values exceeding 7, aqueous lead exists mainly as carbonate complexes [PbCO3 (aq), and $Pb(CO3)2^{2-}$]. Important factors that control aqueous speciation of lead include pH, the types and concentrations of complexing ligands and major cationic constituents, and the magnitude of stability constants for lead-ligand aqueous complexes.

A number of studies and calculations show that under oxidizing conditions depending on pH and ligand concentrations, pure-phase lead solids, such as PbCO3, Pb3(OH)2(CO3)2, PbSO4,

Pb5(PO4)3(Cl), and Pb4SO4(CO3)2(OH)2, may control aqueous lead concentrations. Under reducing conditions, galena (PbS) may regulate the concentrations of dissolved lead. It is also possible that lead concentrations in some natural systems are being controlled by solid solution phases such as barite (Ba(1-x)PbxSO4), apatite [Ca(1-x)Pbx(PO4)3OH], calcite (Ca (1-x)PbxCO3), and iron sulfides (Fe(1-x)PbxS).

Lead is known to adsorb onto soil constituent surfaces such as clay, oxides, hydroxides, oxyhydroxides, and organic matter. In the absence of a distinct lead solid phase, natural lead concentrations would be controlled by adsorption/desorption reactions. Adsorption data show that lead has very strong adsorption affinity for soils as compared to a number of first transition metals. Lead adsorption studies on bulk soils indicate that the adsorption is strongly correlated with pH and the CEC values of soils. Properties that affect CEC of soils, such as organic matter content, clay content, and surface area, have greater affect on lead adsorption than soil pH." (EPA, 1999)

Langmuir et al (2004) summarize lead mobility in the environment as follows:

"Lead is relatively immobile in soils, sediments, and ground waters. This reflects its strong tendency to be adsorbed by Fe and Mn oxides, but also the insolubility of a number of lead minerals including lead hydroxycarbonate, which limits lead concentrations in some public water systems, and pyromorphite, which controls lead concentrations in some soils adjacent to highways affected by road salt and leaded gasoline exhaust."

3.7 MERCURY

Mercury is not present at measurable concentrations in mine water and decant pond water. USEPA (1979) summarize the fate and mobility of mercury in the environment as follows:

> "Mercury's major removal mechanism from a natural water system is adsorption on the surfaces of particulate phases and subsequent settling to the bed sediment. The overwhelming majority of any dissolved mercury is removed in this manner with a relatively short time, generally in the immediate vicinity of the source." (p. 14-1)
>
> "Mercury is strongly sorbed to inorganic and organic particulates. Deposition of mercury-laden sediments in reducing zones can result in precipitation of the sulfide."
>
> "In summary, it is evident from environmental studies and theoretical considerations, that mercury adsorption onto the sediments is probably the most important process for determining the fate of mercury in the aquatic environment." (p. 14-8.)

Langmuir et al (2004) summarize mercury mobility in the environment as follows:

> "Bodek et al. (1988) offer a useful summary of the behavior of mercury. Hg(II) is usually complexed—in pure water as $Hg(OH)_2^o$, and at chloride concentrations typical of fresh waters (<10-2 mol/kg) as $HgCl_2^o$. Both Hg(II) and Cu(II) form strong humate complexes, so that in soils >99.9% of the metals may be complexed." (p. 49)
>
> "Mercury and copper are strongly adsorbed by organic matter. All three metals are also strongly adsorbed by Fe(III) and Mn oxides, and secondarily by clays. Sorption of mercury is very fast and practically irreversible (Bodek et al., 1988). By inhibiting mercury sorption, Hg-Cl complexing helps to mobilize the metal. Dimethyl mercury is very insoluble in water and tends to be volatilized from soils." (p. 60)

3.8 SILVER

Silver is not present at measurable concentrations in mine water and decant pond water. USEPA (1979) summarize the fate and mobility of silver in the environment as follows:

> "Sorption by manganese dioxide and precipitation with halides are probably the dominant controls on the mobility of silver in the aquatic environment." (p. 17-1)

> "Sorption appears to be the dominant process leading to partitioning of silver into the sediments. …. It appears that manganese dioxide has a strong affinity for [silver], followed by ferric hydroxide and clay minerals. … Organic materials also adsorb silver." (p. 17-3.)

Langmuir et al (2004) summarize silver mobility in the environment as follows:

> "As soft metals, silver and mercury form strong complexes with borderline soft Cl ion, which may dominate the solution chemistry of these metals. Silver and mercury form even stronger complexes with the soft halogens bromide and iodide. Silver, copper, and mercury are highly insoluble in reduced environments, where they precipitate as metals or as sulfides." (p. 49)

> "All three metals [copper, mercury, silver] are also strongly adsorbed by Fe(III) and Mn oxides, and secondarily by clays." (p. 60)

3.9 URANIUM

Uranium attenuation is primarily controlled by adsorption. As described by EPA (1999):

> "Uranium (VI) species dominate in oxidizing environments. Uranium(VI) retention by soils and rocks in alkaline conditions is poor because of the predominance of neutral or negatively charged species. An increase in CO2 pressure in soil solutions reduces U(VI) adsorption by promoting the formation of poorly sorbing carbonate complexes." (p. 5.66)

> "Some of the sorption processes to which uranyl ion is subjected are not completely reversible. Sorption onto iron and manganese oxides can be a major process for extraction of uranium from solution (Hsi and Langmuir, 1985; Waite *et al.*, 1994). These oxide phases act as a somewhat irreversible sink for uranium in soils. … Naturally occurring organic matter is another possible sink for U(VI) in soils and sediments. … Uranium sorption to iron oxide minerals and smectite clay has been shown to be extensive in the absence of dissolved carbonate (Ames *et al.*, 1982; Hsi

and Langmuir, 1985; Kent *et al.*, 1988). However, in the presence of carbonate and organic complexants, sorption has been shown to be substantially reduced or severely inhibited (Hsi and Langmuir, 1985; Kent *et al.*, 1988)." (p. 5-73)

4.0 FIELD EVIDENCE FOR NATURAL ATTENUATION

As described in Section 3, natural attenuation of metals is well established in the scientific literature based on numerous field and laboratory investigations. This section presents the site-specific field evidence for natural attenuation of metals from decant water in the groundwater system at the Troy Mine. Field evidence for natural attenuation is provided by the sampling and analysis of water and soil samples in the vicinity of the decant pond and from laboratory testing. Water quality data shows that the concentrations of chemical parameters that are not attenuated (e.g. chemically conservative parameters such as nitrate) are similar between the mine water/decant pond water and the underlying groundwater. This similarity in concentrations indicates that mine water is not appreciably diluted in the groundwater system. In contrast, the concentrations of metal parameters are much lower in the groundwater than in the mine water/decant pond, indicating that metal parameters are attenuated (removed) in the groundwater system. Analyses of sediments in the subsurface of the decant pond reveal that the metals are enriched in the sediments, indicating that the metals attenuated/removed from groundwater are retained on the sediments. Geochemical modeling described in Section 5 corroborates the field evidence.

4.1 FIELD EVIDENCE OF ACTIVE METALS REMOVAL

Water and soil sampling demonstrates that metals are removed from water and retained on solid phases on the sediment matrix as water infiltrates the decant pond and moves through the groundwater system.

4.1.1 Changes in Metal Concentrations in Groundwater

Decreases in metal concentrations in water (absent dilution) as decant pond/mine water moves through the groundwater system is evidence of active metals removal/attenuation. Since the changes in metal concentrations are rapid and dramatic, the effects of the infiltration of mine water at the decant pond can only be observed in close proximity to the pond. As described by Parametrix (2008), no changes in metal concentrations are detectable in Lake Creek adjacent the tailings impoundment or in groundwater monitoring wells near the toe of the impoundment. Changes in metal concentration (but not conservative species)

are apparent by comparison of decant pond and mine water with the three wells adjacent the pond: IW-1 (screened at 65 to 150 and 165 to 280 feet bgs), MW-95-8 (screened at 48 to 53 feet bgs), and MW-01-15 (screened at 30 to 40 feet bgs). Locations of these wells are shown on Figure 2.

Graphs comparing nitrogen and metal concentrations over time for decant pond, mine water and groundwater in the wells are provided in Appendix B. During active mine operations, mine water and decant pond water are typically elevated in nitrogen compounds (ammonia and nitrate) due the use of nitrogen-based explosives for mining purposes. Because nitrate is commonly a conservative species that is not attenuated in groundwater systems, a comparison of nitrogen concentrations between mine water/decant pond water and groundwater in the wells can be used to determine the extent of dilution in the groundwater system. As shown by the graphs in Appendix B, ammonia and nitrate + nitrite concentrations in groundwater in the monitoring wells match the concentrations in mine water and decant pond very closely, demonstrating that there is no appreciable dilution of the decant pond/mine water by ambient groundwater. In other words, groundwater near the decant pond is composed of mine water/decant pond that infiltrates the decant pond.

Because there is no appreciable dilution of mine water/decant pond water in the groundwater system monitored by the wells, any difference in metal concentration between the mine water/decant pond water and groundwater in the monitoring wells must be caused by removal (attenuation) of metals from the groundwater. As shown by the graphs in Appendix B, significant attenuation of arsenic, antimony, copper, and uranium is demonstrated to occur:

- Arsenic concentrations in decant pond water are very low (0.001 to 0.008 mg/L) and are reduced further such that arsenic is not detectable in groundwater in the monitoring wells (<0.001 to <0.003 mg/L).
- Antimony concentrations are low in mine water but range up to 0.062 mg/L in decant pond water. Concentrations are reduced to about 50 percent of the decant pond water

in the shallowest groundwater (0.032 mg/L in well MW-01-15) and further reduced to 0.005 mg/L in deeper groundwater (well MW-95-8).

- Copper concentrations were attenuated strongly, by approximately an order of magnitude in the mine shutdown phase, and to a slightly lesser extent in the current mining phase.
- Lead concentrations in mine water were very low (<0.002 to 0.003 mg/L) during the interim shutdown period and slightly higher (0.002 to 0.008 mg/L in 2009) during the current active mining phase with the exception of the mine re-start period in 2005 (up to 0.059 mg/Lin 2005). Lead concentrations range from <0.0005 to 0.0016 mg/L in decant pond water during the current active mining phase. Lead concentrations are attenuated and reduced in groundwater adjacent the decant pond as the highest groundwater concentration is 0.0011 mg/L.
- Uranium concentrations are reduced by approximately a third between the decant pond (0.003 mg/L) compared to groundwater in the closest, shallowest monitoring well (0.002 mg/L in well MW-01-15, located approximately 100 feet from the pond) and further reduced by approximately 85 percent in the deeper well (0.0005 mg/L in well MW-95-8, located approximately 150 feet from the decant pond).

Cadmium concentrations in decant pond water and mine water are low, typically <0.001 to 0.002 mg/L. Cadmium concentrations in nearby groundwater are similar to decant pond indicating that little attenuation occurs over short transport distances.

4.1.2 Changes in Metal Concentrations in Mixed Water Samples

CDM (2010) conducted geochemical modeling and a series of jar tests where mine water and decant pond water were mixed with natural groundwater from well MW-95-4 in varying ratios. The purpose of the test was to test the hypothesis that mixing of decant pond water with ambient groundwater with naturally high iron concentrations would result in the precipitation of iron oxyhydroxides and attenuation of metals by co-precipitation and adsorption mechanisms. Well MW-95-4 is located below the toe of the tailing impoundment, between the impoundment and Lake Creek as shown on Figure 2. Groundwater with naturally high dissolved iron concentrations is known to exist in the area, along, and on both

sides of Lake Creek (EPA, 1991). If water from the decant pond were to flow toward Lake Creek, it is likely that decant water would become mixed with ambient groundwater in the area, such as that monitored by well MW-95-4.

Geochemical modeling of the mixing of decant pond water with groundwater in MW-95-4 by CDM (2010) suggests that upon mixing, large amounts of iron and manganese oxyhydroxides would precipitate. The formation of iron oxyhydroxides is known to result in strong attenuation of other metals (see for instance, Langmuir, et al 2004). CDM conducted a series of mixing tests in jars to further test this effect. In these tests, samples of decant pond water and mine water were mixed with samples of groundwater from well MW-95-4, allowed to sit and react for a period of 22 days, and then were analyzed for metal concentrations. Results of the jar tests are summarized in Table 4, Section 4.1.2. In all of the jar tests, the mixing of the more oxidized decant pond and mine water caused large amounts of iron to precipitate in the groundwater resulting in strong decreases in antimony, copper, lead and uranium concentrations.

TABLE 4. RESULTS OF LABORATORY TESTING OF METAL ATTENUATION BY MIXING WITH AMBIENT GROUNDWATER

Sample	Arsenic (mg/L)	Antimony (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Manganese (mg/L)	Uranium (mg/L)
Groundwater MW-95-4	<0.003	<0.003	0.006	15.5	<0.0005	5.34	0.0005
Decant Pond Water	<0.003	0.068	0.032	<0.05	0.0008	0.862	0.0033
Mine Water (7 East Dam)	<0.003	0.015	0.114	0.114	0.001	0.105	0.0011
25% groundwater 75% decant	<0.001	0.046	0.007	0.008	<0.0005	2.17	0.0017
50% groundwater 50% decant	<0.001	0.026	0.005	0.009	<0.0005	3.49	0.0009
75% groundwater 25% decant	<0.001	0.010	0.003	0.008	<0.0005	4.86	0.0004
25% groundwater 75% mine water	<0.001	0.010	0.012	<0.005	<0.0005	1.52	0.0007
50% groundwater 50% mine water	<0.001	0.006	0.005	0.007	<0.0005	2.74	0.0004
75% groundwater 25% mine water	<0.001	0.002	0.003	<0.005	<0.0005	4.47	<0.0005

Source: Table 4-1. CDM (2010). Mine water was collected within the mine behind the 7 East Dam.

4.1.3 Metals Enrichment of Decant Pond Sediment

Geochemical testing of aquifer materials was conducted in 2003 during the interim shutdown period (Land & Water Consulting, 2004). Testing was conducted on sediment materials collected from pits dug in the bottom of the decant pond while the pond was nearly dry. Laboratory testing consisted of total metal analyses, sequential extraction analyses, microscopic examination and electron microprobe analyses.

Total metal analyses were performed to determine the overall metal content of sediments in order to identify areas of metal enrichment. Comparison of copper concentration in decant pond sediment with copper concentrations in Troy tailings and native soils indicates that all of the sediment samples collected at depths of less than four inches are strongly enriched in copper relative to native soils and tailings (Table 5 and Figure 3). Some soil/sediment samples (DP-1 3 ¾ "and DP-1 4") are enriched to the extent that they contain nearly twice the copper content as ore from the Troy mine. Total copper concentrations in decant pond sediments are evidence that copper is attenuated in surficial soil/sediments in the decant pond.

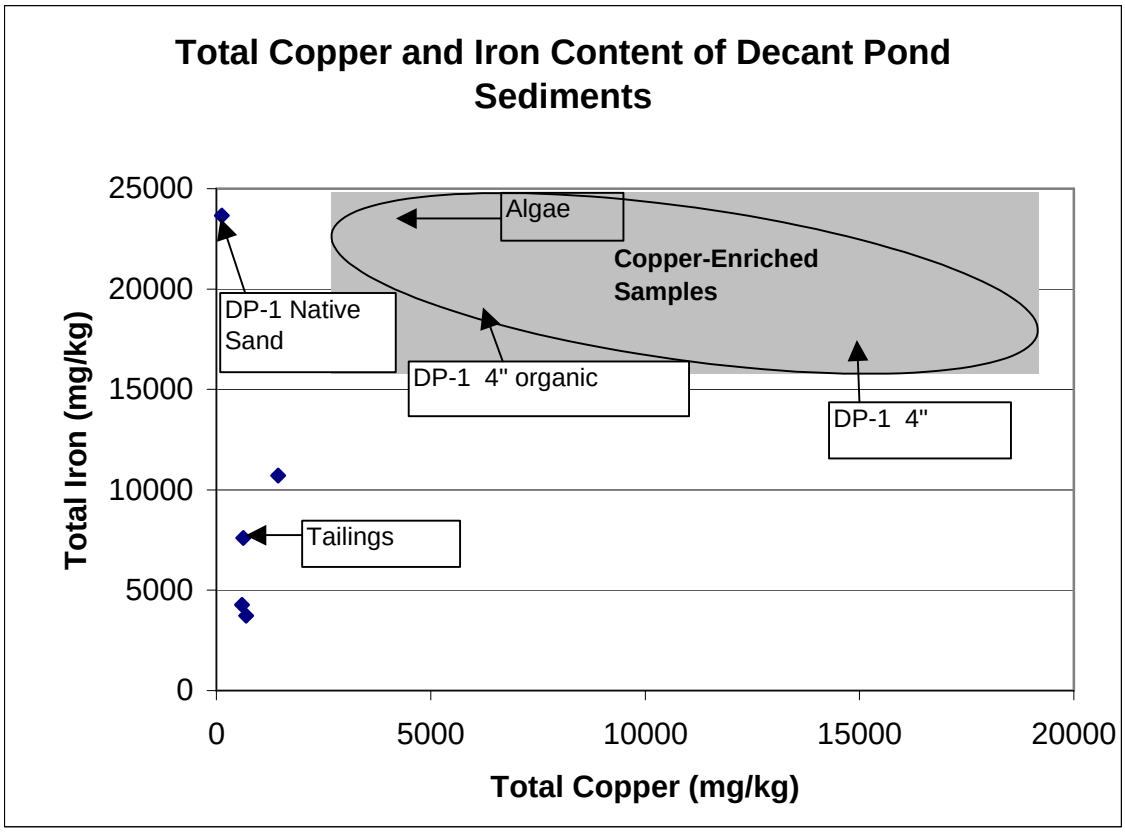
TABLE 5. TOTAL COPPER AND IRON CONTENT OF DECANT POND SOIL SAMPLES

Sample Designation	Total Copper (mg/kg or ppm)	Total Iron (mg/kg or ppm)
DP-1 algae	3,881	23,380
DP-1 0-1"	5,672	21,520
DP-1 3 ¾"	14,010	18,170
DP-1 4"	14,850	17,580
DP-1 4" organic	5,987	19,450
DP-1 2-4" slime tails	1,441	10,720
DP-1 4-8" sand tails	698	3,724
DP-1 1-4' sand tails	594	4,269
DP-1 native sand	127	23,660
Troy tailings (1)	630	7,600
Troy ore (2)	7,600	--
Native soil (3)	10 to 30	

(1) Data source: Table 4-23, Rock Creek Final EIS, September 2001.
(2) Data source: Table 3-2, Rock Creek Final EIS, September 2001.
(3) Data source: Appendix D, Troy Unit Revised Reclamation Plan, (Hydrometrics et al, December 2000).

Source of Table: (Land and Water Consulting, 2004)

FIGURE 3. COPPER AND IRON CONTENT OF DECANT POND SEDIMENTS



4.2 FIELD EVIDENCE OF ATTENUATION MECHANISMS

Evidence of attenuation mechanisms and rates of attenuation comes from the sampling and analysis of water and soil samples in the vicinity of the decant pond, laboratory mixing and testing of waters, and correlations between metal concentrations and water chemical indicators. Field evidence is corroborated by geochemical modeling as illustrated by Eh-pH and activity diagrams in Section 5. A summary of the identified attenuation mechanisms and the evidence supporting these mechanisms is provided in Table 6.

TABLE 6. SUMMARY OF FIELD EVIDENCE OF ATTENUATION MECHANISMS

Mechanism	Metals Attenuated by Mechanism	Field Evidence
Carbonate Mineral Formation	Cu	Sequential extraction Visual identification Electron microprobe analysis
Ion Exchange/Adsorption	As, Cu, Sb, Pb and U	Sequential extraction Jar mixing tests
Organic Matter	Cu	Sequential extraction Visual identification
Silicate Mineral Formation	Cu	Sequential extraction Visual identification Electron microprobe analysis
Co-precipitation with Iron oxides	As, Cu, Sb, Pb and U	Sequential extraction Visual identification Electron microprobe Jar mixing tests

4.2.1 Identification of Metal Phases in Sediment

As decant pond water infiltrates sediments beneath the pond, metals are removed from the water and incorporated into the sediments as evidenced by the decrease in groundwater metal concentrations and the corresponding increase in sediment metal concentrations. The forms of occurrence or phases of metals in decant pond sediments are indicative of the mechanisms of attenuation that cause the forms or phases to occur. Thus, the attenuation mechanisms can be identified by identifying the forms of occurrence of metals in decant pond sediments. Corroboration of these mechanisms is also provided by geochemical modeling that indicates that mine water and decant pond are oversaturated with copper, iron, lead, and manganese minerals, thus metals are expected to precipitate and to be removed from these waters.

Geochemical testing of decant pond sediments was conducted in 2003 during the interim shutdown period (Land & Water Consulting, 2004). Testing was conducted on sediment materials collected from pits dug in the bottom of the decant pond while the pond was nearly dry. Laboratory testing consisted of total metal analyses, sequential extraction analyses, and

visual reflected light microscopy and electron microprobe analyses. As described in Section 4.1.3, total metal analyses demonstrated that sediment beneath the decant pond is highly enriched in copper due to the attenuation of copper as decant infiltrates the sediments. Sediments were also analyzed by sequential extraction and electron microprobe to identify the forms of copper in the sediments.

Sequential extraction analyses were performed to identify the sediment solid phases enriched in copper. These analyses determined the trace metal contents of six phases: water soluble, exchangeable and carbonate, manganese oxides, organic matter, amorphous iron oxides, silicates and crystalline oxides (see Gatehouse et al, 1977). Sequential extraction results indicate that the dominant copper-bearing phases in the decant pond soils are exchangeable ions and carbonates, organic matter and sulfides, and silicates. It should be noted that the sulfide minerals are believed to be ore minerals that were not captured during the milling and metal concentration process and are not believed to represent attenuation of metals by sulfide formation.

Visual (stereo microscope) and electron microprobe analyses of sediment samples were performed to identify mineral phases enriched in copper (Cannon Microprobe, 2003). Copper phases identified in the samples included:

1. Copper silicates (likely the blue-green mineral chrysocolla);
2. Copper carbonates (likely the green mineral malachite);
3. Copper manganese silicates;
4. Copper iron oxides; and
5. Copper iron sulfides (likely chalcopyrite and bornite).

4.2.2 Decant Pond/Mine Water and Groundwater Mixing Tests

Geochemical modeling of the mixing of decant pond water with groundwater in MW-95-4 by CDM (2010) indicates that upon mixing, large amounts of iron oxyhydroxides would precipitate. The formation of iron oxyhydroxides is known to result in strong attenuation of other metals (see for instance, Langmuir, 2004). To further test this adsorption/co-

precipitation effect, a series of water mixing tests were conducted in jars. In these tests, samples of decant pond water and mine water were mixed with samples of groundwater from well MW-95-4, allowed to sit and react for a period of 22 days and then were analyzed for metal concentrations. Results of the jar tests are summarized in Table 4, Section 4.1.2. In all of the jar tests, the mixing of the more oxidized decant pond and mine water caused large amounts of iron to precipitate in the groundwater resulting in strong decreases in antimony, copper, lead and uranium.

5.0 GEOCHEMICAL EQUILIBRIUM MODELING

The geochemical system considered in this report includes mine water, decant pond water, and groundwater and associated minerals (e.g. in sediments beneath the decant pond) and gases (e.g. oxygen and carbon dioxide in the atmosphere) that comprise the decant pond and adjacent groundwater system. In this assessment of natural attenuation mechanisms, the purpose of constructing thermodynamic equilibrium models of the geochemical system is to:

1. Determine the geochemical conditions of disposal water including redox conditions, the activities of metals and other ions in water, and the saturation indices of metal-bearing minerals that may be important in attenuation of metals;
2. Identify the geochemical controls on metal attenuation mechanisms and water quality;
3. Identify geochemical changes that are likely to occur to the water as water approaches geochemical equilibrium in the disposal pond and groundwater system; and
4. Identify the potential geochemical changes that could impede or preclude the attenuation of metals and potential mitigation methods.

The overall approach to geochemical modeling in this assessment is as follows:

1. Define the framework and goals of modeling;
2. Select the geochemical software and thermodynamic database;
3. Select the representative waters to be modeled and the system constraints;
4. Calculate the activities of the important aqueous metal species and the saturation indices of solid metal phases (i.e., minerals); and
5. Construct stability and solubility diagrams to graphically show the relationships between aqueous metal species, minerals, and the geochemical parameters (e.g. Eh and pH) controlling the relationships between the aqueous species and mineral phases.

5.1 PROCESS MODEL FOR GEOCHEMICAL EQUILIBRIUM MODELING

The first and most critical step in developing a geochemical model is conceptualizing the system or process of interest in a useful manner (Bethke, 2008). As described by EPA (2007a):

> "The modeling effort begins with the careful identification of the processes that play significant roles in contaminant migration and attenuation at the site. In this way a conceptual model emerges that will eventually be coded into the input streams of the software packages that will produce the modeling results." (p. 10)

The process model of the Troy Mine water disposal cycle is a description of the processes affecting water quality and forms a guide or general framework for formulating the computer-based geochemical model. In most cases, it is not necessary or practical to construct a geochemical model that includes all aspects of the process model. For this assessment of natural attenuation the primary area of interest is the water in the decant pond and groundwater system. Therefore, this portion of the water disposal cycle model is examined in detail using computer-based geochemical equilibrium models as described in this section.

The process model for geochemical equilibrium modeling is summarized in Table 7. In this model, water is initially formed in the atmosphere and falls as rain or snow. It then interacts with a variety of different phases (atmospheric gases, minerals, organic matter, etc.) present in soil, groundwater systems, and the tailings impoundment and disposal pond. Several trends or cycles in the major element composition of water are observed as water moves through the hydrologic system of the mine:

1. Oxygen – Meteoric water is fully oxygenated but as the water moves through the soil profile oxygen is consumed by microbes and the decomposition of organic matter. In the bedrock aquifer, oxygen is further consumed by sulfide minerals. Upon entering the mine voids water is once again exposed to atmospheric oxygen and becomes more oxygenated; this process of oxygenation continues as water is transported to the decant pond and infiltrates to the groundwater system. The formation of oxide

TABLE 7. PRINCIPLE COMPONENTS OF THE PROCESS MODEL FOR GEOCHEMICAL EQUILIBRIUM MODELING

Water Type	General Water Quality	Principle Phases in Contact with Water	Principle Changes/Reactions Occurring
Meteoric Water	Dilute, slightly acidic, oxygenated rainwater	Atmospheric gases (O_2, CO_2, SOx, NOx) and particulates	Equilibrium with atmospheric gases
Soil Water	Less dilute, less oxygenated, high pCO_2	Soil gases, minerals, organic matter	Equilibrium with soil gases Consumption of oxygen by microbes/organic matter Dissolution of soil minerals Ion exchange
Groundwater	Less dilute, less oxygenated, high pCO_2, some metals	Aquifer minerals (primarily bedrock)	Partial equilibrium with minerals Sulfide mineral oxidation
Mine Water	More oxygenated, higher metals	Atmospheric gases Waste rock and ore including sulfide minerals Explosive residues (temporary)	Partial equilibrium with atmospheric gases Partial equilibrium with waste rock and ore Sulfide mineral oxidation Dissolution of explosive residues (temporary)
Water Disposed to Impoundment surface	More oxygenated, higher silica	Atmospheric gases Tailings Soil (after reclamation) Organic material	Partial equilibrium with atmospheric gases Evaporation Dilution by rain/snowmelt Partial equilibrium with tailings
Decant/Disposal Pond Water	More oxygenated, decreased metals	Atmospheric gases Sediments Tailings	Partial equilibrium with atmospheric gases Evaporation Dilution by rain/snowmelt Partial equilibrium with tailings/sediment Precipitation of metallic minerals
Groundwater	More oxygenated, decreased metals	Aquifer minerals (primarily unconsolidated glacial and fluvial deposits)	Precipitation of metallic minerals Adsorption of metals to aquifer sediments

minerals is favored by the oxidizing nature of the water. Isolated from the atmosphere once again, the water becomes less oxygenated as it infiltrates to groundwater.

2. Carbon dioxide/carbonate – Meteoric water is in equilibrium with atmospheric CO_2 but contains relatively low amounts of carbonate. As water moves through the soil profile, microbes and the decomposition of organic matter generate CO_2 and reduce pH, water dissolves carbonate from rocks and soil particles and the partial pressure of CO_2 (pCO_2) and carbonate content rise. In the bedrock aquifer, carbonate content may increase further as carbonate minerals are contacted and dissolved. Upon entering the mine voids, water is once again exposed to the lower atmospheric pressure of CO_2, some degassing of CO_2 and reduction in carbonate alkalinity occurs, and pH may rise (depending on how much acid is contributed by sulfide mineral oxidation). As water is disposed at the decant pond and infiltrates sediments, carbonate content may rise again from contact with additional carbonate minerals in tailings and sediments and from decomposition of organic matter in sediments.
3. Silica – Silicate minerals are the major rock forming minerals. Silicate minerals generally have low solubilities and in addition the rate of silicate dissolution is slow. The silica content of meteoric water is initially low. As water moves through the soil, bedrock aquifer, and mine voids, the silica concentration slowly increases due to the dissolution of silicate minerals. This process continues as water contacts the tailings (predominately finely ground quartz silica) and moves through the decant pond sediments and groundwater system.

5.2 GEOCHEMICAL MODELING SOFTWARE AND THERMODYNAMIC DATABASE

Several computer software packages are available that are accepted and approved by the scientific community and that are commonly used for geochemical modeling (e.g. PHREEQC, WATEQ, and Geochemist's Workbench). Each of these software packages has its own nuances, strengths and weaknesses of use and the choice of the most appropriate software depends on the purpose of the model and to some extent personal preference of the modeler. For the purposes of this assessment, Geochemist's Workbench was selected due to

its ease of use and ability to generate a variety of visual aids (e.g. activity diagrams, solubility diagrams, Eh – pH diagrams) that are useful in interpreting and describing geochemical conditions.

Geochemist's Workbench includes several thermodynamic databases that can be employed, including Lawrence Livermore National Laboratory (LLNL) database, the PHREEQC database, the WATEQF database, and an updated version 8, release 6 LLNL database. All of these databases are generally accepted and approved by the scientific community and are commonly used for geochemical modeling. The choice of database for this assessment was based on the inclusion of data for the constituents of concern (arsenic, antimony, cadmium, copper, lead, uranium, and zinc) in the databases. The updated version 8, release 6 LLNL database (LLNL, 2006) is found to be the most complete and therefore is used in all modeling described in this report.

5.3 REPRESENTATIVE DISPOSAL WATER (MINE WATER AND DECANT POND WATER)

After mine closure, disposal water would be composed exclusively of mine water plus rainfall and snowmelt that enters the reclaimed tailing impoundment infiltration area. Because the mine is not yet permanently closed, post-closure mine water quality can not be directly measured but instead must be estimated based on past and present quality of mine water and decant pond water. Waters that are believed to be most representative of post-closure are mine water and decant pond during the interim shutdown period of 1993 through 2004 and recent (2009) mine and decant pond water, with some exceptions (i.e., nitrogen levels after closure will be much lower than during operations). However, the majority of water quality analyses conducted on mine water, decant pond water and groundwater did not contain a complete list of analytes sufficient to support geochemical modeling. Therefore, water samples used for geochemical modeling are limited to samples collected in 2003 during the investigation of attenuation mechanisms described in Land and Water Consulting (2004) and samples collected in 2009 specifically for geochemical modeling. Sampling summaries and lab reports for these samples are included in Appendix A.

5.4 REPRESENTATIVE REDUCTION-OXIDATION CONDITIONS

Reduction-oxidation conditions (commonly referred to as "redox") control many of the primary equilibria or relationships that characterize water and affect the attenuation of metals. For instance, redox conditions control whether an aqueous species (such as Fe^{++} or Cu^{+}) is stable and soluble in water or whether the aqueous species is unstable and will react to form a different aqueous species (e.g. Fe^{+++} or Cu^{++}) or a solid mineral phase (such as hematite or cuprite). Some metals, such as arsenic, may exhibit different adsorption behavior depending on whether the aqueous species is more or less oxidized. Redox conditions are typically defined in terms of potential (i.e., Eh measured in millivolts). Redox relationships involve at least two aqueous species or phases (e.g. a gas or mineral) in which one species is more reduced, one species is more oxidized, and electrons are exchanged. The two related species are termed a "redox pair." Common redox relationships or pairs in water include:

- Ammonia (NH_3^o)and nitrate (NO_3^{-2});
- Ferrous iron (Fe^{++}) and ferric hydroxide ($Fe(OH)_3$) iron; and
- Sulfide (S^-) and sulfate (SO_4^{-2}).

Unfortunately redox conditions in water are difficult to assess or define and difficult to model as very few waters are actually in complete redox equilibrium where all redox pairs demonstrate equilibria with the same redox condition or Eh value. Lindberg and Runnels (1984) recommend evaluating all of the redox couples within a solution to determine if the system is in redox equilibrium. The definition of redox conditions for geochemical modeling in this assessment used a weight-of-evidence approach as follows:

- Step 1 – Field measurements of ORP (oxidation-reduction potential made with a platinum electrode) were made at the time of sample collection and converted to Eh values (adjustment of potential to be relative to the standard hydrogen electrode and corrected for temperature).
- Step 2 – Eh values were calculated based on measured concentrations of all available redox pairs:

    - Assume measured concentration defines overall or bulk concentration of redox pair species.
    - Calculate activities of redox pair species using Geochemist's Workbench software.
    - Calculate Eh values for redox pairs using Geochemist's Workbench software.
- Step 3 – Consider chemical indicators of redox conditions and processes.
- Step 4 – Select Eh value for modeling:
    - Select system Eh value based on weight-of-evidence from Steps 1 through 3.
    - Allow selected redox pairs to remain in disequilibria.
- Step 5 – Construct Eh –pH diagrams to show metal solubility under a range of redox conditions.

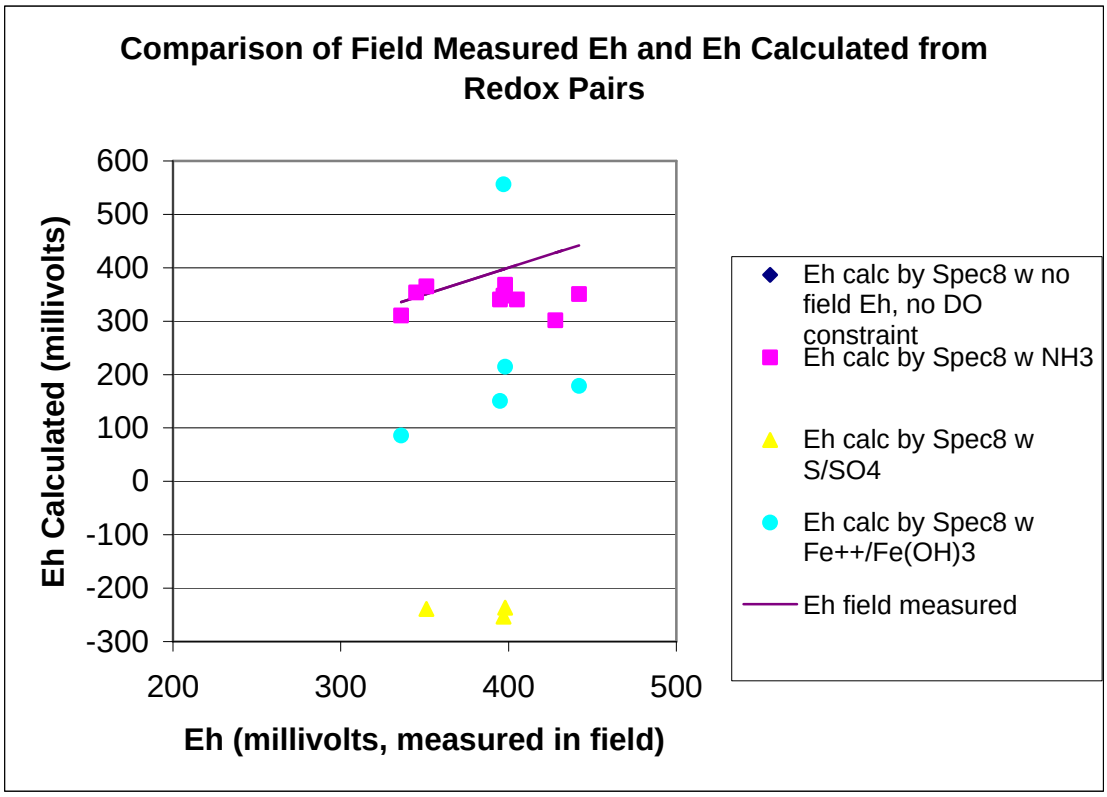
Table 8 summarizes field measurements and calculated Eh values for the ammonia/nitrate, sulfide/sulfate, and ferrous iron/ferric hydroxide redox pairs for the various water samples. As shown in Figure 3, field measured Eh and calculated Eh for sulfide/sulfate and ferrous/ferric hydroxide do not correlate well, indicating that the redox pairs are in disequilibrium. Field measured Eh values correlate fairly well with Eh calculated based on total ammonia and nitrate+nitrite concentrations. Although it is tempting to view this correlation as proof that field and ammonia/nitrate Eh values are the most correct, this correlation may simply reflect the fact that the platinum electrode used in the field measurements is more responsive to nitrogen species than to iron and sulfur species (perhaps due to the relatively high concentrations of the nitrogen species compared to sulfur and iron species). It should also be noted that the concentrations of iron and sulfide are generally low, just slightly higher than the analytical detection limits and may be subject to a relatively high degree of uncertainty; thus Eh calculated from iron and sulfur redox pairs may also be subject to a relatively high degree of uncertainty.

TABLE 8. COMPARISON OF FIELD MEASURED EH AND EH CALCULATED FROM REDOX PAIRS

	Ferrous Iron (mg/L)	Diss. Oxygen (mg/L)	Sulfide (mg/L)	Nitrate (mg/L)	Eh field (milliV)	Eh calc. from redox pairs (millivolts)		
						NH_3/NO_3	S^-/SO_4	$Fe^{2+}/Fe(OH)_3$
Mine Water Adit Ditch May 2009	ND	10.75	ND	14.25	405	340.4		
Mine Water Adit Pipe May 2009	0.05	11.11	ND	35.37	395	340.6		150.7
MW-01-15 May 2009	0.06	5.17	0.05	74.37	398	368.4	-236.2	214.6
Decant Pond May 2009	0.06	8.19	0.04	77.91	397	348	-253.1	556
MW-01-15 June 2009	ND	4.35	0.04	64.19	351	365	-238.7	
Decant Pond June 2009	0.05	6.86	ND	64.19	336	310.8		85.7
MW-95-8 June 2009		4.52	ND	108.5	345	354		
MW-95-8 July 2009		5.37	ND	97.83	432			
Decant Pond July 2009		6.26	ND	60.2	428	301.6		
MW-01-15 July 2009	0.06	3.34		62.42	442	350.6		178.8
Mine Water Pipe April 2003			Na	4.869				
Mine Water Ditch April 2003			Na	0.5755				
Transfer Point April 2003			Na					
Mine Water 9 East April 2003			Na	1.726		353.8		
Mine Water UQ-1 April 2003			Na	1.815		347		

ND = not detected.

FIGURE 3. COMPARISON OF FIELD MEASURED EH AND EH CALCULATED FROM REDOX PAIRS



Chemical indicators of redox conditions (Table 8) include dissolved oxygen concentrations, presence/absence of sulfide, ammonia, and dissolved iron. McMahon and Chappelle (2008) propose that the dominant redox processes in groundwater can be classified based on dissolved oxygen (DO), ferrous iron, manganese, nitrate, sulfate, and sulfide concentrations. In this classification, all waters containing greater than 0.5 mg/L DO and less than 0.1 mg/L iron are considered to be oxic, with oxygen as the principle electron acceptor. Classification as oxic is also supported by comparison of the low concentrations of the reduced species sulfide, ammonia and ferrous iron. Westall (2002) notes that in the presence of dissolved oxygen, field Pt electrode measured Eh is typically high, in the range of 300 to 400 millivolts.

Although the data are not conclusive given the redox disequilibrium, the redox evidence points to a fairly high Eh indicative of an oxic environment. The field Eh measurements and ammonia/nitrate redox pairs both satisfy this requirement and are in good agreement. However, some water samples did not contain measurable amounts of ammonia. Therefore, field Eh was selected to define system Eh for purposes of modeling. For samples from 2003 in which field Eh is not available, Eh calculated from the ammonia/nitrate redox pair is assumed.

Given that none of the redox pairs exactly match the field Eh, the imposition of this Eh condition during modeling has the potential effect of causing chemical concentrations (and activities) to shift away from the measured concentrations toward the concentrations that are calculated to be in equilibrium with the imposed Eh. For instance, if a water sample has a field Eh of 400 millivolts and a calculated Eh based on the ammonia/nitrate pair of 300 millivolts then the ratio of ammonia and nitrate concentrations is not in equilibrium with the Eh of the system as defined in the model. If the model is configured to equilibrate aqueous redox species, then the activities (and concentrations) of ammonia and nitrate will be adjusted according to the redox reaction so that a portion of the ammonia is converted to nitrate and the calculated Eh of the ammonia/nitrate redox pair matches that of the system Eh, in this case field Eh. If this adjustment is not desired, the model may be configured to "decouple" the ammonia/nitrate redox pair from the system Eh and the redox disequilibria of the pair as compared to the system Eh will be retained.

The choice of whether to allow redox pairs to be "coupled" to the system Eh so that concentrations are in equilibria with system Eh or whether to decouple redox pairs to maintain the measured species concentrations depends on both the available data and the purpose of the modeling exercise. In this assessment, all metal redox pairs were coupled to system Eh (as defined by field Eh) for the following reasons:

- All metal concentrations are for bulk concentrations of the elements (e.g. iron as Fe, copper as Cu) and the concentrations of the aqueous ions (e.g. Fe^{2+}, Fe^{3+}, Cu^{+}, Cu^{++}) are unknown. Coupling of the redox pairs is necessary to allow calculation of the

concentrations (and activities) of aqueous metal species and the saturation indices of metallic minerals (see discussion in Section 5.5) below.

- One of the purposes of modeling is to identify attenuation reactions that are occurring or are likely to occur in the groundwater. To do this it is necessary to identify the saturation state of the various metallic minerals and in many cases mineral stabilities are dependent on redox conditions.

Other redox pairs, such as ammonia/nitrate and sulfide/sulfate were not coupled with system Eh. The potential or Eh of ammonia/nitrate pair is in close agreement with the selected system Eh (field Eh) (see Figure 5) and so little would be gained by this coupling. The sulfide/sulfate redox pair was not coupled because given the high system Eh, essentially all of the sulfide would be converted to sulfate. Although this would have little effect on sulfate concentrations since sulfide concentrations are several orders of magnitude less than sulfate, it would greatly affect the potential stability of sulfide minerals. In order to allow the assessment of the potential for sulfide minerals to precipitate from waters, the sulfide/sulfate pair was not coupled, allowing sulfide to remain in solution in the model runs.

5.5 AQUEOUS SPECIATION AND MINERAL SATURATION INDICES

All laboratory water analyses report constituent concentrations in terms of the bulk concentrations (mass/unit volume) of the constituent element (e.g. 1 mg/L copper as copper). In actuality, elements are present in water in a variety of ionic forms or " aqueous species" (e.g. Cu^{++}, Cu^{+}) and ion complexes (e.g. $Cu_2(OH)_2^{2+}$). Moreover, the equilibria of chemical reactions such as mineral precipitation, and therefore mineral saturation indices, are dependent on the activity of constituents rather than on concentration. Activity is defined as:

$$\text{Activity} = [\text{concentration} / \text{molecular weight}] \times \text{activity coefficient}$$

Where the activity coefficient is dependent on the amounts and types of other ionic species in water (i.e., the ionic strength of the solution).

The speciation of the various chemical constituents, the activities of all aqueous species, and mineral saturation indices for all mine water, decant pond, and groundwater samples were calculated using the Spec8 module of the Geochemist's Workbench program as follows:

- All model runs were constrained by field Eh or Eh calculated from the ammonia/nitrate redox pair if field Eh was not available.
- All redox pairs that include metals of interest (i.e., arsenic, copper, iron, manganese[DP1]) were coupled to system Eh.
- No minerals or gases were allowed to dissolve, precipitate, or exsolve (i.e., the system is closed).
- The original charge imbalance in the water analysis was retained (not balanced).

The primary aqueous species for the metals of concern are summarized in Table 9. Mineral saturation indices for saturated phases and select unsaturated phases containing metals of concern are summarized in Table 10. Complete outputs of the model runs are included in Appendix C.

Aqueous metal speciation is similar for all water types and is summarized as follows:

- Divalent metals cadmium, copper, lead, iron and manganese are predominately present as simple divalent cations (Cd^{+2}, Cu^{+2}, Pb^{+2}, Fe^{+2}, Mn^{+2}) and are not complexed to any significant extent by anionic species.
- Arsenic is present predominately as an oxide (monoprotic arsenic acid).
- Antimony is present predominately as a hydroxide complex.
- Uranium is present as a carbonate complex.

A "saturated" mineral phase is a mineral that is in equilibrium with water where the mineral ion activity product (IAP) is equal to the mineral solubility equilibrium constant (K). Mineral saturation index (SI) is defined as log IAP/K. Oversaturated minerals are favored to precipitate or form from solution and have positive SI values (SI greater than zero). Undersaturated minerals are favored to be dissolved into solution, and have negative SI

TABLE 9. PRIMARY AQUEOUS SPECIES OF METALS

	Arsenic	Antimony	Cadmium	Copper	Lead	Iron	Manganese	Uranium
Mine Water Adit Ditch May 2009	$HAsO_4^{-2}$	$Sb(OH)_3$	Cd^{++}	Cu^{++}	Pb^{++}	Not detected	Mn^{++}	$UO_2(CO_3)_2^{-2}$
Mine Water Adit Pipe May 2009	$HAsO_4^{-2}$	$Sb(OH)_3$	Cd^{++}	Cu^{++}	Pb^{++}	Fe^{+2}	Mn^{++}	$UO_2(CO_3)_3^{-4}$
MW-01-15 May 2009	Not detected	$Sb(OH)_3$	Cd^{++}	Cu^{++}	Pb^{++}	Fe^{+2}	Mn^{++}	$UO_2(CO_3)_2^{-2}$
Decant Pond May 2009	$HAsO_4^{-2}$	$Sb(OH)_3$	Cd^{++}	Cu^{++}	Pb^{++}	Fe^{+2}	Mn^{++}	$UO_2(CO_3)_2^{-2}$
MW-01-15 June 2009	Not detected	$Sb(OH)_3$	Not detected		Not detected	Not detected	Mn^{++}	$UO_2(CO_3)_2^{-2}$
Decant Pond June 2009	$HAsO_4^{-2}$	$Sb(OH)_3$	Cd^{++}	Cu^{++}	Pb^{++}	Fe^{+2}	Mn^{++}	$UO_2(CO_3)_3^{-4}$
MW-95-8 June 2009	Not detected	Not detected	Cd^{++}	Cu^{++}	Not detected	Not detected	Not detected	$UO_2(CO_3)_3^{-4}$
MW-95-8 July 2009	Not detected	Not detected	Not detected	Cu^{++}	Not detected	Not detected	Not detected	$UO_2(CO_3)_3^{-4}$
Decant Pond July 2009	$HAsO_4^{-2}$	$Sb(OH)_3$	Cd^{++}	Cu^{++}	Not detected	Not detected	Mn^{++}	$UO_2(CO_3)_2^{-2}$
MW-01-15 July 2009	Not detected	$Sb(OH)_3$	Not detected	Cu^{++}	Not detected	Fe^{+2}	Mn^{++}	$UO_2(CO_3)_2^{-2}$
Mine Water 9 East April 2003	$HAsO_4^{-2}$	Not detected	Not analyzed	CuCO3(aq)	Not detected	Not detected	Mn^{++}	Not analyzed
Mine Water UQ-1 April 2003	Not detected	Not detected	Not analyzed	CuCO3(aq)	Not detected	Not detected	Mn^{++}	Not analyzed

TABLE 10. MINERALS SATURATED IN MINE WATER AND GROUNDWATER

	Antimony Cadmium	Copper	Lead	Iron	Manganese
Mine Water Adit Ditch May 2009	None	Brochantite Malachite Tenorite (Dioptase)	Cerussite	None	(Rhodochrosite)
Mine Water Adit Pipe May 2009	None	Ferrite-Cu Malachite Tenorite Delafossite Brochantite (Dioptase)	Cerussite	Hematite Ferrite-Cu Magnetite Delafossite Goethite Jarosite $Fe(OH)_3$	(Rhodochrosite)
MW-01-15 May 2009	None	Ferrite-Cu Malachite Tenorite Delafossite	(Cerussite)	Hematite Ferrite-Cu Magnetite Delafossite Goethite Jarosite $Fe(OH)_3$	(Rhodochrosite)
Decant Pond May 2009	None	Ferrite-Cu Malachite Tenorite Delafossite (Brochantite)	Cerussite	Hematite Ferrite-Cu Magnetite Delafossite Goethite Jarosite $Fe(OH)_3$	Rhodochrosite
MW-01-15 June 2009	None	(Tenorite) (Malachite)	None	None	(Rhodochrosite)
Decant Pond June 2009		Brochantite Ferrite-Cu Malachite Tenorite Delafossite (Dioptase)	Cerussite	Hematite Ferrite-Cu Magnetite Delafossite Goethite Jarosite $Fe(OH)_3$	Rhodochrosite
MW-95-8 June 2009	None	Tenorite (Malachite)	None	None	None
MW-95-8 July 2009	None	Tenorite (Malachite)	None	None	None
Decant Pond July 2009	None	Brochantite Malachite Tenorite (Dioptase)	None	None	Rhodochrosite (Hausmannite) (Pyrolusite)
MW-01-15 July 2009	None	(Tenorite) (Malachite)	None	None	(Rhodochrosite)
Mine Water 9 East April 2003	None	(Tenorite) (Malachite)	None	None	None
Mine Water UQ-1 April 2003	None	(Tenorite)	None	None	None

*Minerals in parentheses are near saturation (SI > approximately -1).

values. However, it is important to note that the calculated mineral saturation indices incorporate all of the uncertainties or errors associated with field collection of water samples and measurement of redox conditions, laboratory measurement of chemical concentrations of the metals and other elements, and thermodynamic data. Thus, the interpretation of saturation indices should consider the likelihood that some truly saturated minerals may have a calculated SI of <0 and conversely some truly unsaturated minerals may have a calculated SI of >0.

Mineral phases that are calculated by Geochemists Workbench to be saturated (SI>0) are summarized in Table 10 and described as follows:

- Arsenic, antimony, cadmium, uranium - no phases saturated.
- Copper – oxide, hydroxysulfate, and hydroxycarbonate minerals saturated:
    - Brochantite: $Cu_4SO_4(OH)_6$
    - Malachite: $Cu_2(OH)_2(CO_3)_2$; presence of this mineral in decant pond sediments was confirmed by microscopic examination (Cannon Microprobe, 2003)
    - Tenorite: CuO
    - Delafossite: $CuFeO_2$; presence of this mineral in decant pond sediments was confirmed by microscopic examination (Cannon Microprobe, 2003)
    - Ferrite-Cu: $CuFe_2O_4$
- Iron – oxide minerals saturated:
    - Hematite: Fe_2O_3
    - Ferrite-Cu: $CuFe_2O_4$
    - Magnetite: Fe_3O_4
    - Delafossite: $CuFeO_2$
    - Jarosite: $KFe^{3+}{}_3(OH)_6(SO_4)_2$
    - Iron hydroxide: $Fe(OH)_3$
    - Goethite: $FeO(OH)$

- Lead – carbonate mineral saturated:
    - Cerussite: $PbCO_3$
- Manganese – carbonate mineral saturated:
    - Rhodochrosite: $MnCO_3$

In addition to these phases that are calculated to be saturated, other important phases that are calculated to be undersaturated but near saturation (SI greater than approximately –1) include:

- Copper:
    - Dioptase: CuSiO2(OH)2; the occurrence of a hydrated copper silicate mineral in decant pond sediments was confirmed by microscopic and microprobe examination by (Cannon Microprobe, 2003). The phase was tentatively identified as chrysocolla ($CuSiO_3(H2O)_n$), a similar hydrated copper silicate.
- Manganese:
    - Hausmannite: Mn_3O_4
    - Pyrolusite: MnO_2

5.6 STABILITY AND SOLUBILITY DIAGRAMS

One of the goals of this evaluation is to identify attenuation mechanisms and to assess the long-term reliability of the mechanisms. For metals that are attenuated by mineral precipitation mechanisms or are adsorbed to freshly precipitated mineral surfaces, the effectiveness of the attenuation mechanisms are controlled by the stability of the associated minerals. As described in Section 5.5, mine water, decant pond water and groundwater are calculated to be near saturation or oversaturation with respect to copper, iron, lead, and manganese mineral phases and therefore the formation or precipitation of these minerals from these waters is favored. In the case of copper and lead, the precipitation of copper and lead minerals is a direct form of attenuation (i.e., copper and lead are removed from solution by the mineral precipitation). For other metals of interest (arsenic, antimony, cadmium, and uranium), the precipitation of iron or manganese minerals provides fresh mineral surfaces upon which the metals of interest may be adsorbed. Iron and manganese oxides and

hydroxide minerals have a strong affinity for adsorption of many metals (see discussion in Section 3).

Stability and solubility diagrams provide a visual method of showing the conditions under which minerals are likely to form, the factors controlling the stability of the mineral phases, and the changes in water chemical conditions that could limit mineral precipitation or lead to dissolution of existing mineral phases. Stability diagrams and solubility diagrams in this assessment were developed for copper, iron, lead, and manganese using the Act2 module of the Geochemist's Workbench software (RockWare, 2010).

For some metals, there are multiple minerals that are oversaturated or nearly saturated in solution. Theoretically, only the most stable (most saturated) mineral would be formed if the solution were allowed to come to chemical equilibrium. However, chemical equilibrium is rare in nature and formation of the most stable phases may not be kinetically favored. Moreover, given the uncertainties in the water chemical analyses and thermodynamic data, it is possible that minerals that are not quite saturated may in actuality be stable and perhaps even favored. In order to evaluate the stability of minerals in addition to those thought to be most thermodynamically stable, some minerals were "suppressed" or purposely omitted from some stability and solubility diagrams. In these cases, the suppressed minerals are identified in the notes on the diagrams and the rationales for suppression of the minerals are discussed in the text below.

All diagrams except those containing the copper silicate mineral chrysocolla are for the average temperature (11.4 C^o) in the mine water, decant pond water, and groundwater. For the copper silicate mineral chrysocolla, the only thermodynamic data available is for 25^oC and the information needed to extrapolate to lower temperatures is not available; therefore the copper silicate diagrams are for 25^oC.

Interpretation of the stability diagrams is illustrated by Figures 6 and 7 as follows:

- The diagrams show the Eh-pH conditions or aqueous species-pH conditions where mineral phases and aqueous species predominate for the given conditions.
- Solid mineral phases are yellow/tan in color and are labeled with the name of the mineral (e.g. tenorite).
- Aqueous phases are blue in color and are labeled with the name of the aqueous species (e.g. Cu^{++}).
- Lines on the diagrams denote phase boundaries where two or more distinct phases are in equilibrium. Lines may denote equilibrium between solid phases (e.g. the minerals tenorite and cuprite), between a solid phase and an aqueous phase (e.g. tenorite and the Cu^{++} ion at the specified aqueous activity), or between two or more aqueous phases (e.g. the redox equilibrium boundary between Cu^{+} and Cu^{++}).

As an example of the interpretation of activity diagrams, consider Figures 4 and 5 that show the Eh and pH for copper at copper activities of 10^{-6} (a concentration of about 0.08 mg/L, slightly less than measured in the Adit Ditch in May 2009) and $10^{-7.5}$ (a concentration of about 0.006 mg/L, similar to the concentration routinely measured in groundwater near the decant pond). Plotted on the diagrams are the Eh-pH conditions for mine water and decant pond water as measured in May 2009. From these diagrams it is possible to make a number of important observations regarding the changes in copper activities (and concentrations) that are likely to occur to attenuate copper and conversely the geochemical conditions that might impair or preclude copper attenuation:

1. At a copper activity of 10^{-6} (Figure 4), the waters are not at equilibrium with tenorite (equilibrium is on the boundary line between tenorite and aqueous copper) but rather are oversaturated with respect to tenorite. Therefore, under these conditions tenorite would be expected to precipitate, reducing the copper activity in the water until equilibrium is achieved. If the copper activity were reduced to $10^{-7.5}$ (a concentration of about 0.006 mg/L) then the diagram would look like Figure 5. At this lower copper activity, the waters plot near the equilibrium line and no further tenorite

precipitation is predicted. From these diagrams we would conclude that under current conditions of Eh and pH, copper is expected to be attenuated from mine and decant pond water until the copper concentration is approximately 0.006 mg/L, an observation confirmed by the concentration of copper in groundwater near the decant pond and the identification of copper oxide minerals in the decant pond sediments.

2. At the Eh typical of mine and decant pond waters (about 400 millivolts), there are only two dominant phases – the Cu^{++} ion and the mineral tenorite. The equilibrium relationship between these two phases is dependent on pH.
   - Higher pH conditions increase the stability of the solid phase (tenorite), therefore higher pH conditions will lead to more copper attenuation (lower copper concentration in water). Conversely, if conditions were to become more acidic (lower pH), copper attenuation would be less effective.
   - Therefore, the continuation or longevity of the copper attenuation mechanism is dependent on continued neutral pH conditions. If water were to become acidic, the attenuation of copper would be reduced. If this condition were to occur, an effective mitigation would be to take actions (e.g. addition of a base such as lime or limestone) to raise the pH of the water and restore the attenuation mechanism.

FIGURE 4. EH-PH DIAGRAM FOR COPPER (ACTIVITY = 10^{-6})

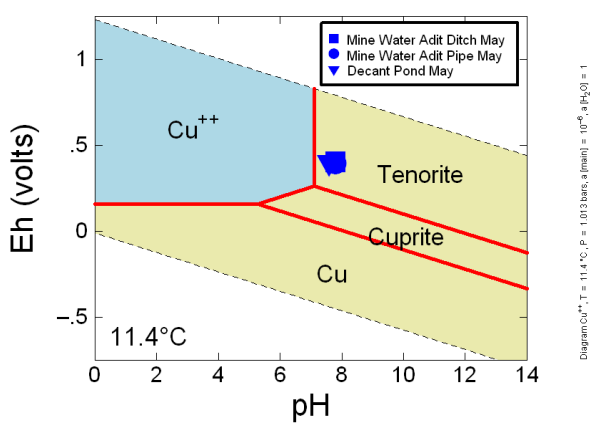
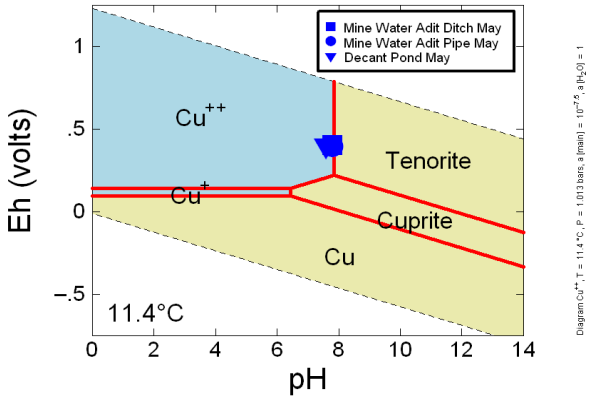


FIGURE 5. EH-PH DIAGRAM FOR COPPER ACTIVITY = $10^{-7.5}$



5.6.1 Copper Oxides and Copper Iron Oxides

Copper oxide minerals that are saturated or nearly saturated in mine water, decant water, and groundwater include tenorite (CuO), delafossite (CuFeO2), and copper ferrite ($CuFe_2O_4$). These minerals are defined by a system containing copper, iron, oxygen (Eh) and hydrogen (pH). The stability and solubility of the minerals are constrained by copper and iron activity and the Eh and pH of the solution.

Eh-pH diagrams for copper for the range of copper concentrations (and activities) present in water at the Troy Mine (activity of 10^{-6} to $10^{-7.5}$) are shown in Figures 4 and 5 (above). The Eh-pH of mine water, decant pond water, and groundwater are plotted on the diagrams for reference. The majority of the mine water, decant pond water, and groundwater samples plot in the tenorite mineral stability field. If allowed to come to chemical equilibrium, tenorite would be expected to precipitate from these waters, reducing the concentration of copper in the waters. Further, these diagrams illustrate that formation of copper oxide minerals is favored by:

1. Higher pH;
2. Higher copper concentrations; and
3. Higher Eh (more oxidizing conditions).

At the neutral pH typical of mine water, decant pond water and groundwater near the decant pond, the solubility of minerals is low, regardless of Eh conditions.

Some water samples are found to contain measurable amounts of iron. The effects of the addition of iron to the copper oxide system are shown in Figures 6 and 7. In the presence of iron, the copper oxide stability fields are diminished and copper iron oxides (delafossite and ferrite copper) are the most stable mineral phases at neutral to alkaline pH conditions. As noted above, there is field evidence corroborating the precipitation of delafossite in decant pond sediments as this mineral was identified in pond sediments by microscopic and electron microprobe analyses. The majority of the mine water, decant pond water, and groundwater samples plot in the delafossite mineral stability field. If allowed to come to chemical equilibrium, delafossite would be expected to precipitate from these waters, reducing the concentration of copper in the waters. Further, these diagrams illustrate that attenuation of copper by the formation of copper iron oxide minerals is favored by:

1. Higher pH;
2. Higher iron and copper concentrations; and
3. Higher Eh (more oxidizing conditions).

FIGURE 6. EH-PH DIAGRAM FOR COPPER (ACTIVITY = 10^{-6}) WITH IRON

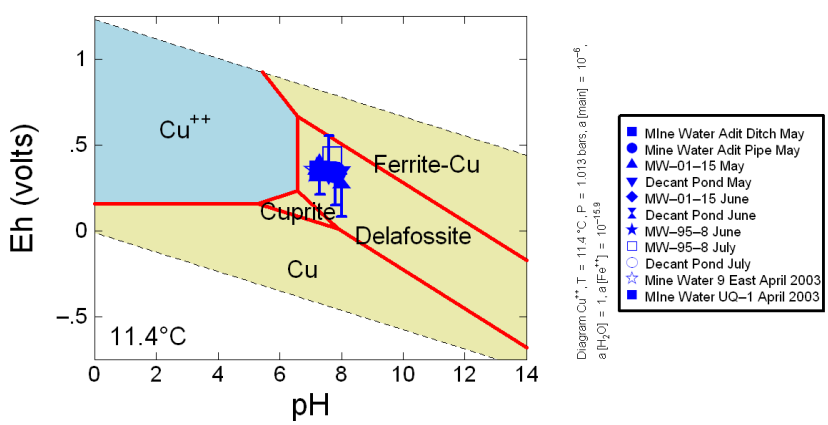
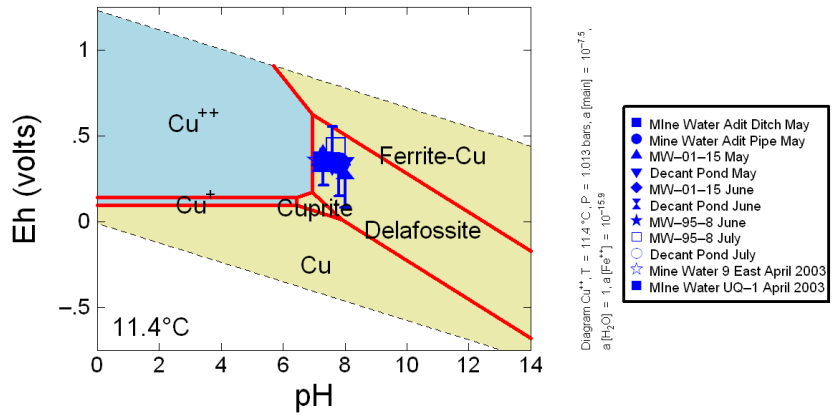


FIGURE 7. EH-PH DIAGRAM FOR COPPER (ACTIVITY = $10^{-7.5}$) WITH IRON



At the neutral pH typical of mine water, decant pond water and groundwater near the decant pond, the solubility of copper iron oxide minerals is low, regardless of Eh conditions. If waters were to become acidic, the attenuation of copper by the formation of copper iron oxide minerals would be reduced. If this condition were to occur, an effective mitigation would be to take actions (e.g. addition of a base such as lime or limestone) to raise the pH of the water and restore the attenuation mechanism.

5.6.2 Copper Carbonates

Copper carbonate mineral (e.g. malachite $Cu_2(OH)_2(CO_3)_2$) stability and solubility are constrained by copper and bicarbonate and pH of the solution. The presence of malachite in decant pond sediments was confirmed by microscopic examination (Cannon Microprobe, 2003). Stability diagrams for the copper bicarbonate system for the range of copper concentrations (and activities) present in water at the Troy Mine (activity of 10^{-6} to $10^{-7.5}$), average field Eh (393 millivolts) are shown in Figures 8 and 9. Because the stability and solubility of malachite is not directly dependent on Eh for the Eh range of interest, bicarbonate activity is shown on the y-axis instead of Eh. The bicarbonate activity and pH of mine water, decant pond water, and groundwater are plotted on the diagrams for reference.

These diagrams illustrate that formation of copper bicarbonate minerals is favored by:

1. Higher dissolved bicarbonate concentrations (at lower bicarbonate levels the copper oxide tenorite is stable);
2. Higher pH; and
3. Higher copper concentrations.

Attenuation of copper by the mechanism of copper carbonate mineral formation would be impaired by acidic (low pH) conditions or low dissolved bicarbonate concentrations. If waters were to become acidic, the attenuation of copper by the formation of copper carbonate minerals would be reduced. If this condition were to occur, an effective mitigation would be to take actions (e.g. addition of a base such as lime or limestone) to raise the pH and bicarbonate of the water and restore the attenuation mechanism.

FIGURE 8. BICARBONATE-PH DIAGRAM FOR COPPER (ACTIVITY = 10^{-6})

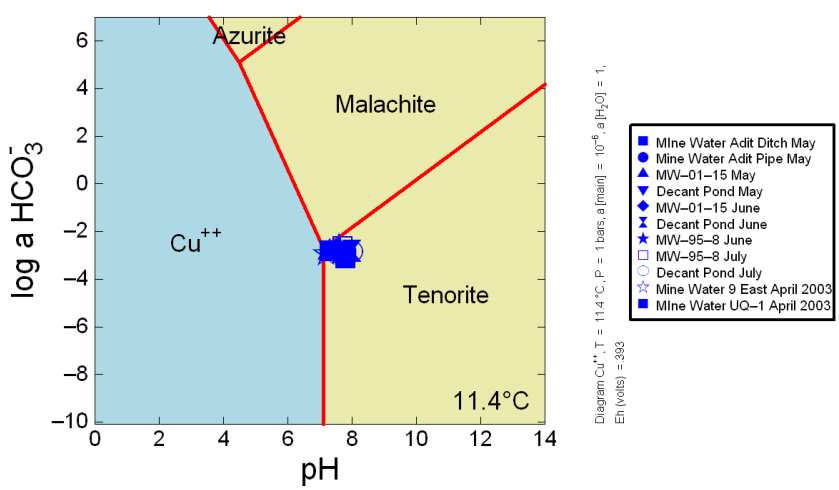
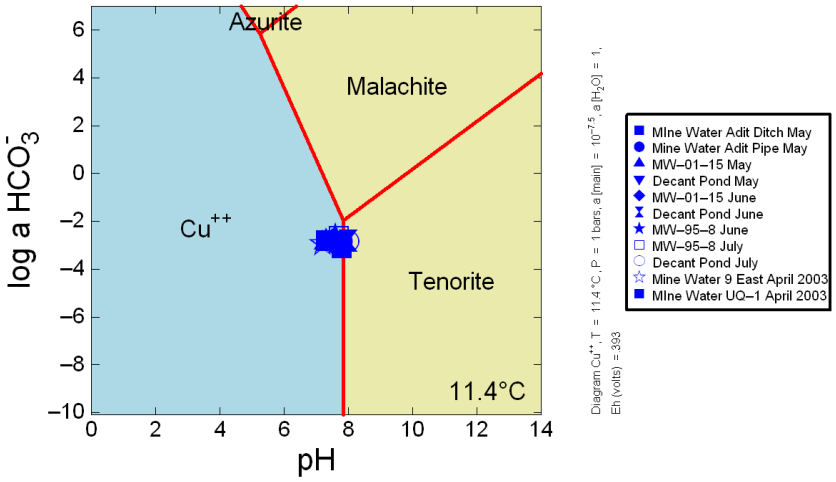


FIGURE 9. BICARBONATE-PH DIAGRAM FOR COPPER (ACTIVITY = $10^{-7.5}$)



5.6.3 Copper Hydroxysulfate

Copper hydroxysulfate (brochantite) mineral stability and solubility are constrained by copper activity, sulfate activity and the Eh-pH of the solution. Eh-pH diagrams for copper for the range of copper activities (10^{-6} to $10^{-7.5}$) and sulfate activities ($10^{-3.49}$ to $10^{-4.25}$) present in water at the Troy Mine are shown in Figures 10 through 13. The Eh-pH of mine water, decant pond water, and groundwater are plotted on the diagrams for reference. The copper oxide minerals tenorite and cuprite are suppressed in these diagrams in order to show brochantite stability. The majority of the mine water, decant pond water, and groundwater samples plot near or in the brochantite mineral stability field. If allowed to come to chemical equilibrium, brochantite would be expected to precipitate from these waters, reducing the concentration of copper in the waters. Further, these diagrams illustrate that formation of brochantite minerals is favored by:

1. Higher pH;
2. Higher sulfate and copper concentrations; and
3. Higher Eh (more oxidizing conditions).

FIGURE 10. EH-PH DIAGRAM FOR COPPER (ACTIVITY = 10^{-6}) WITH SULFATE (ACTIVITY = $10^{-3.5}$)

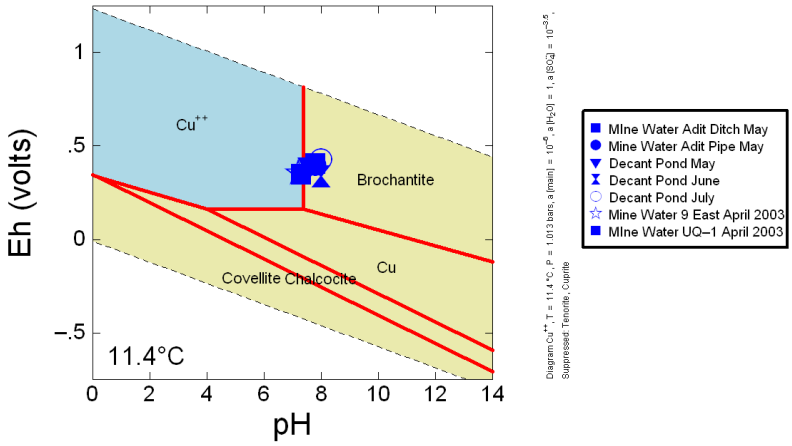


FIGURE 11. EH-PH DIAGRAM FOR COPPER (ACTIVITY = 10^{-6}) WITH SULFATE (ACTIVITY = $10^{-4.25}$)

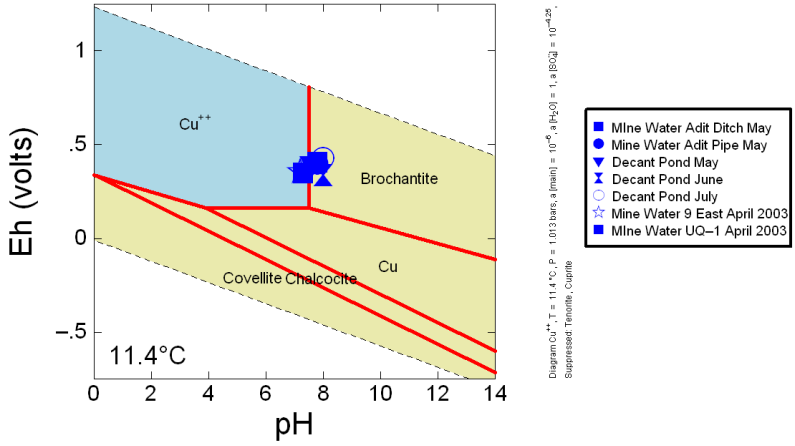


FIGURE 12. EH-PH DIAGRAM FOR COPPER (ACTIVITY = $10^{-7.5}$) WITH SULFATE (ACTIVITY = $10^{-3.5}$)

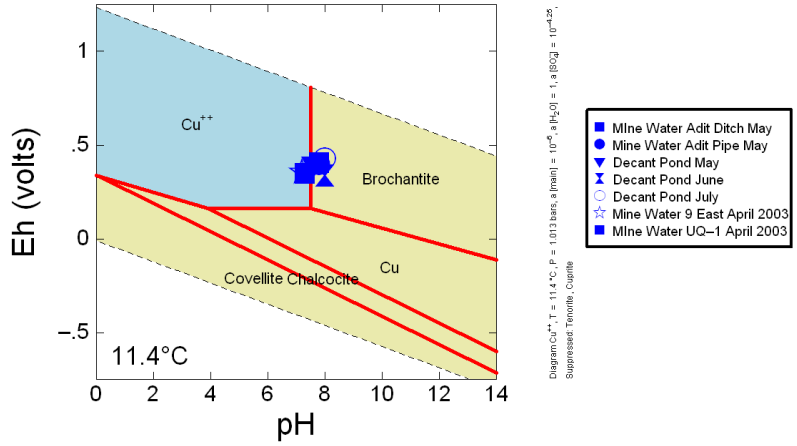
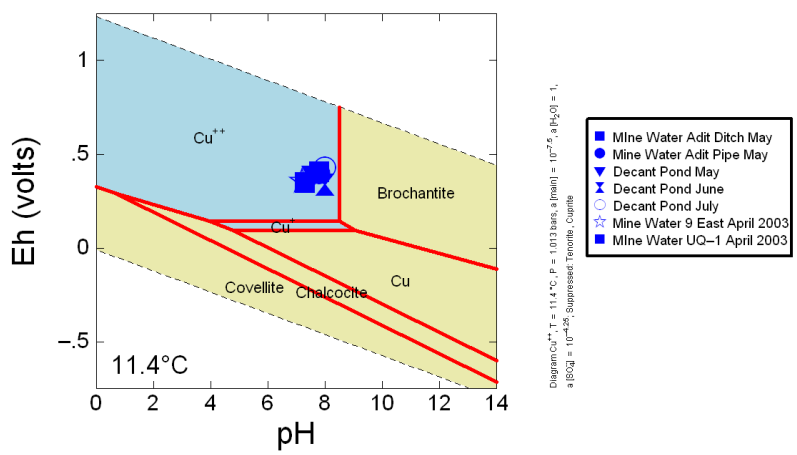


FIGURE 13. EH-PH DIAGRAM FOR COPPER (ACTIVITY = $10^{-7.5}$) WITH SULFATE (ACTIVITY = $10^{-4.25}$)



5.6.4 Copper Silicates

Copper silicate mineral stability and solubility are constrained by copper and silicate activity and pH of the solution. Although the copper silicate mineral dioptase appears to be more saturated than chrysocolla in waters at the Troy Mine, dioptase was "suppressed" and was omitted from the copper silicate stability diagrams so that the stability/solubility of

chrysocolla could be shown instead. The suppression of dioptase was done for the following reasons. Field evidence (microscopic and electron microprobe evaluation of sediment pond samples, Land and Water (2004); Cannon Microprobe (2003)) indicates that the copper silicate mineral chrysocolla has precipitated from decant pond water and is a stable mineral phase whereas dioptase was not found in the decant pond. Dioptase is a relatively rare mineral. Some investigators have proposed that chrysocolla formation is kinetically favored over dioptase and that dioptase may be formed by aging of cryptocrystalline chrysocolla (Crane et al, 2001). Omission of dioptase from the stability diagrams allows the stability and solubility of chrysocolla to be illustrated.

Stability diagrams for the copper-silica system for the range of copper concentrations (and activities) present in water at the Troy Mine (activity of 10^{-6} to $10^{-7.5}$), average field Eh (393 millivolts), and temperature of 25°C are shown in Figures 14 and 15. Because the stability and solubility of chrysocolla is not directly dependent on Eh, silica activity is shown on the y-axis instead of Eh. The silica activity and pH of mine water, decant pond water, and groundwater are plotted on the diagrams for reference. These diagrams illustrate that formation of copper silicate minerals is favored by:

1. Higher dissolved silica concentrations;
2. Higher pH; and
3. Higher copper concentrations.

Attenuation of copper by the mechanism of copper silicate mineral formation would be impaired by acidic (low pH) conditions or low dissolved silica conditions.

FIGURE 14. SILICA-PH DIAGRAM FOR COPPER (ACTIVITY = 10^{-6})

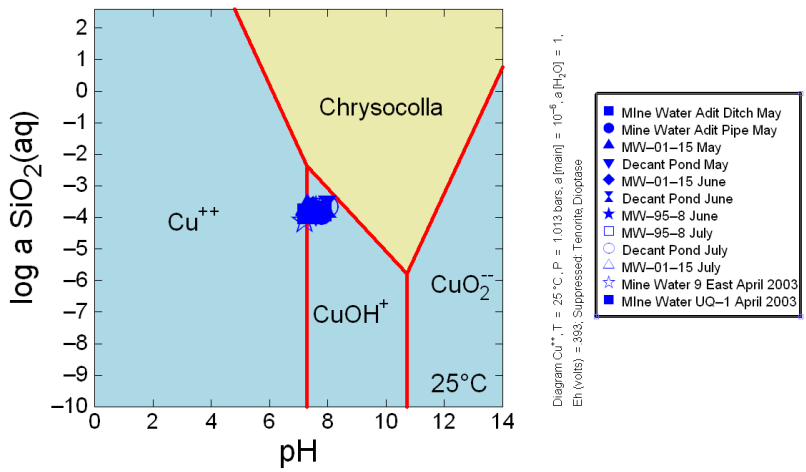
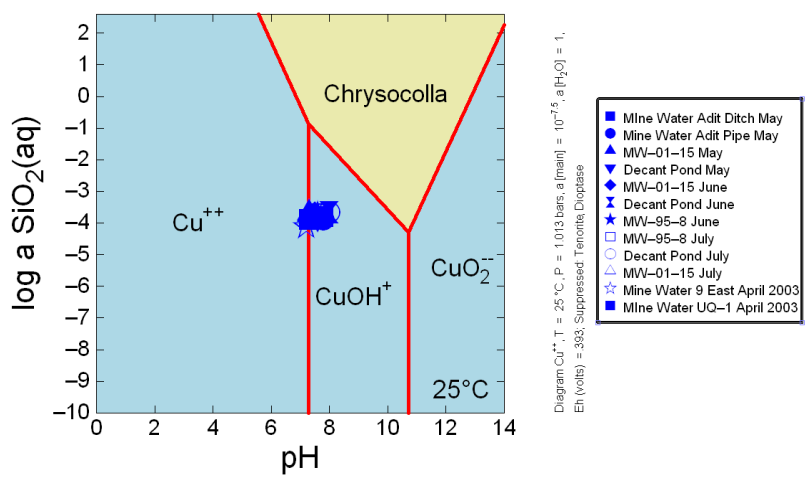


FIGURE 15. SILICA-PH DIAGRAM FOR COPPER (ACTIVITY = $10^{-7.5}$)



5.6.5 Iron

Iron minerals that are saturated or nearly saturated in mine water, decant water, and groundwater include iron oxides, copper iron oxides, iron hydroxides, and potassium iron hydroxysulfate minerals. These minerals are defined by systems containing iron, oxygen

(Eh), sulfate (sulfur), hydrogen (pH) and potassium. Copper iron oxides are discussed in Section 5.6.1 and are not further discussed in this section. Eh-pH diagrams for iron for the range of iron activities (10^{-6} to $10^{-6.2}$), sulfate ($10^{-3.5}$ to $10^{-4.25}$) and potassium ($10^{-3.2}$ to $10^{-4.3}$) activities present in water at the Troy Mine are shown in Figures 16 through 19. The Eh-pH of mine water, decant pond water, and groundwater are plotted on the diagrams for reference. The minerals hematite and magnetite were suppressed and omitted from the diagrams in order to show the more common secondary iron minerals ferric hydroxide ($Fe_3(OH)_3$), goethite ($FeO(OH)$), and jarosite ($KFe^{3+}{}_3(OH)_6(SO_4)_2$). Goethite was also suppressed in some diagrams to show ferric hydroxide stability.

FIGURE 16. EH-PH DIAGRAM FOR IRON (ACTIVITY = 10^{-6}) WITH SULFATE (ACTIVITY = $10^{-3.5}$) AND POTASSIUM (ACTIVITY=$10^{-3.2}$)

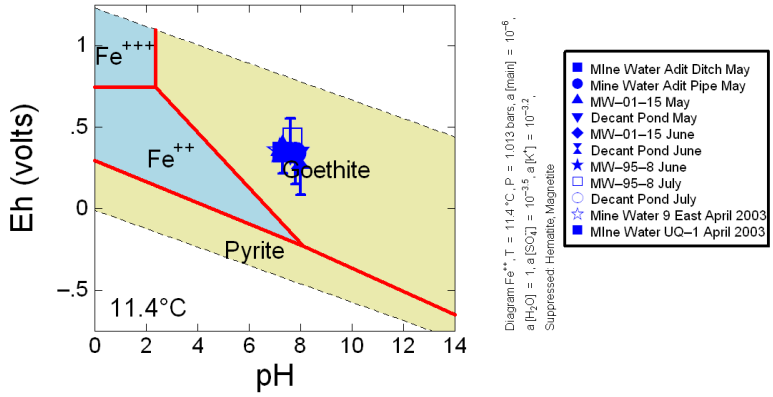


FIGURE 17. EH-PH DIAGRAM FOR IRON (ACTIVITY = 10^{-6}) WITH SULFATE (ACTIVITY = $10^{-3.5}$) AND POTASSIUM (ACTIVITY=$10^{-3.2}$), GOETHITE SUPPRESSED

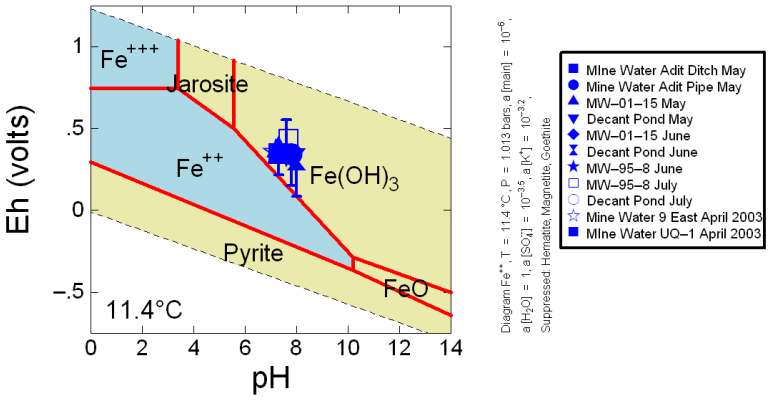


FIGURE 18. EH-PH DIAGRAM FOR IRON (ACTIVITY = $10^{-6.2}$ WITH SULFATE (ACTIVITY = $10^{-4.25}$) AND POTASSIUM (ACTIVITY=$10^{-4.3}$)

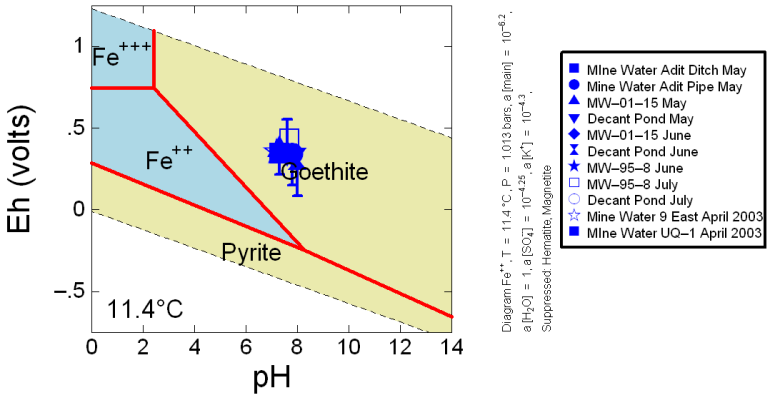
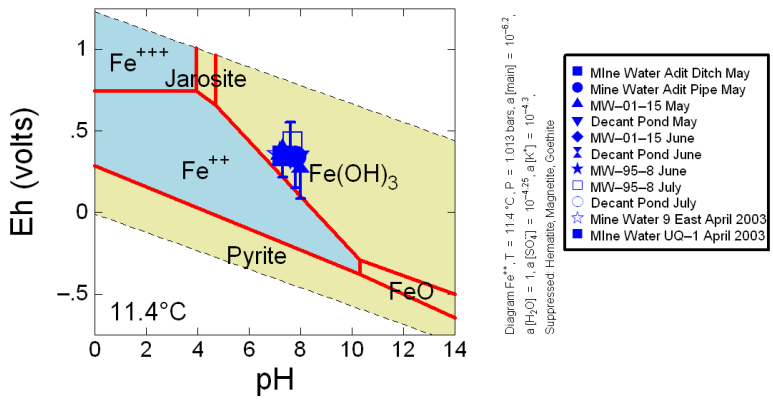


FIGURE 19. EH-PH DIAGRAM FOR IRON (ACTIVITY = $10^{-6.2}$ WITH SULFATE (ACTIVITY = $10^{-4.25}$) AND POTASSIUM (ACTIVITY=$10^{-4.3}$), GOETHITE SUPPRESSED



These diagrams illustrate that all of the Troy Mine waters are in the goethite or ferric hydroxide stability field. Formation and stability of goethite and ferric hydroxide is favored by:

1. Higher Eh (more oxidizing);
2. Higher pH; and
3. Higher iron concentrations.

Jarosite is only stable at relatively low pH and high sulfate conditions such as might occur in acid rock drainage. Given the lack of acid rock drainage and neutral pH of water at the Troy Mine, jarosite formation is not likely to form in the decant pond or the groundwater. Attenuation of metals by co-precipitation or adsorption is favored by conditions that lead to precipitation and stability of iron oxide and hydroxide minerals. Conditions that might lead to a reduction in metal attenuation effectiveness due to the lack of stability of iron oxide or hydroxide sorbent phases include lower Eh (more reducing) and acidic (lower pH) conditions.

5.6.6 Lead

Cerussite ($PbCO_3$) is the only lead mineral that is saturated or nearly saturated in mine water, decant water, and groundwater. Stability and solubility of cerussite is defined by a system containing copper, hydrogen (pH) and carbonate. Because the stability and solubility of cerussite is not directly dependent on Eh for the Eh range of interest, bicarbonate activity is shown on the y-axis instead of Eh. Solubility diagrams showing lead solubility as a function of pH in the presence of bicarbonate for the range of lead activities ($10^{-7.5}$ to $10^{-8.4}$) and bicarbonate activities ($10^{-2.6}$ to $10^{-3.2}$) present in water at the Troy Mine are shown in Figures 20 and 21. The pH and bicarbonate concentrations of decant pond water, and groundwater are plotted on the diagrams for reference. These diagrams illustrate that formation of cerussite is favored by:

1. Higher bicarbonate silica concentrations;
2. Higher pH; and
3. Higher lead concentrations.

Attenuation of lead by the mechanism of lead carbonate mineral formation would be impaired by acidic (low pH) conditions or low dissolved bicarbonate concentrations. If waters were to become acidic, the attenuation of lead by the formation of lead carbonate minerals would be reduced. If this condition were to occur, an effective mitigation would be to take actions (e.g. addition of a base such as lime or limestone) to raise the pH and bicarbonate of the water and restore the attenuation mechanism.

FIGURE 20. LEAD ACTIVITY-PH DIAGRAM WITH BICARBONATE ACTIVITY = $10^{-2.6}$

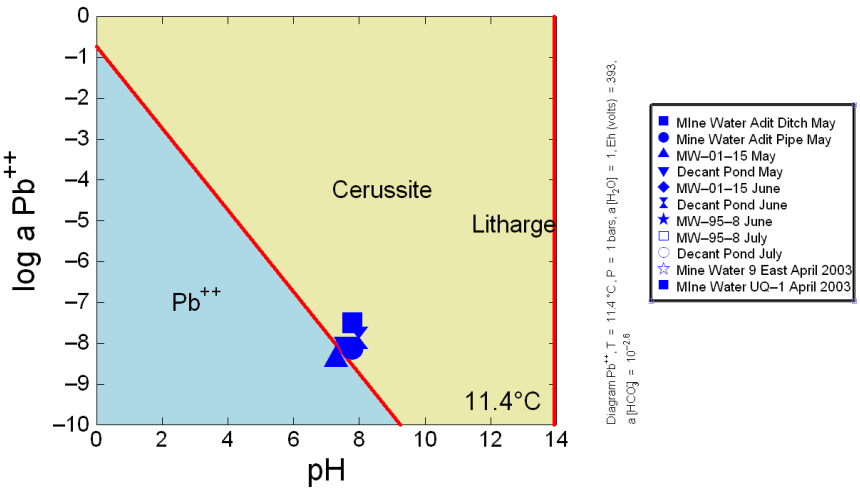
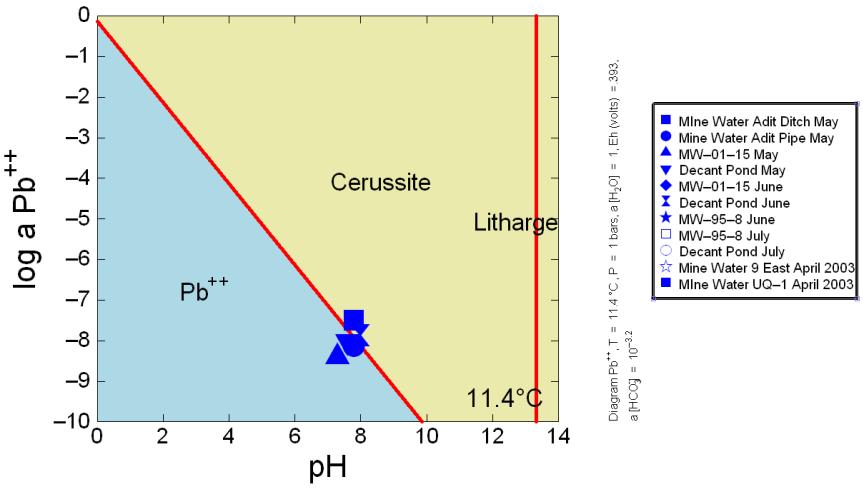


FIGURE 21. LEAD ACTIVITY-PH DIAGRAM WITH BICARBONATE ACTIVITY = $10^{-3.2}$



5.6.7 Manganese

Manganese minerals that are saturated or nearly saturated in mine water, decant water, and groundwater include manganese oxides (hausmannite (Mn_3O_4) and pyrolusite (MnO_2)) and the manganese carbonate mineral rhodochrosite ($MnCO_3$). These minerals are defined by a system containing manganese, oxygen (Eh), hydrogen (pH) and carbonate.

Solubility diagrams showing manganese solubility as a function of pH in the presence of bicarbonate for the range of bicarbonate activities ($10^{-2.6}$ to $10^{-3.2}$) present in water at the Troy Mine and the average field measured Eh (393 millivolts) are shown in Figures 22 and 23. Because the stability and solubility of the manganese minerals is not very sensitive to Eh for the Eh range of interest, bicarbonate activity is shown on the y-axis instead of Eh. The pH and bicarbonate concentrations of mine water, decant pond water, and groundwater are plotted on the diagrams for reference. These diagrams illustrate that formation and stability of manganese oxide minerals is favored by:

1. Higher pH; and
2. Higher manganese concentrations.

FIGURE 22. MANGANESE-pH DIAGRAM WITH BICARBONATE (ACTIVITY = $10^{-2.6}$)

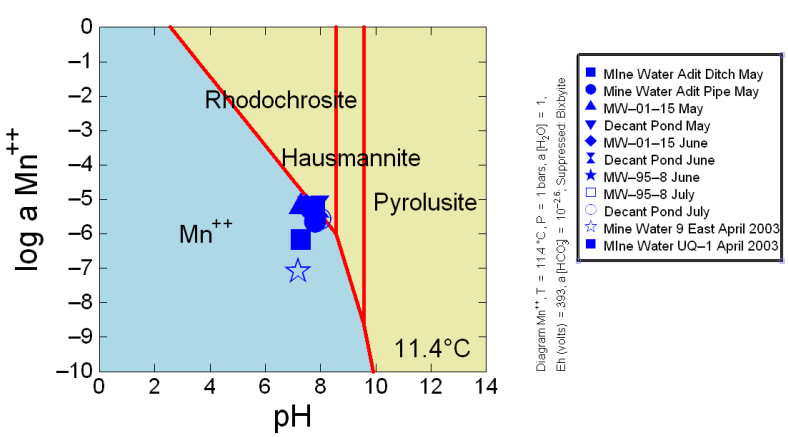
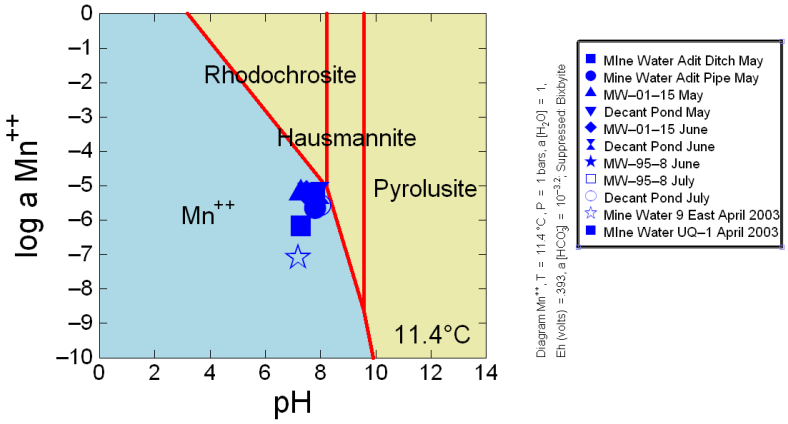


FIGURE 23. MANGANESE-pH DIAGRAM WITH BICARBONATE (ACTIVITY = $10^{-3.2}$)



Formation and stability of manganese carbonate minerals is favored by:

1. Higher bicarbonate silica concentrations;
2. Higher pH; and
3. Higher manganese concentrations.

Attenuation of metals by co-precipitation or adsorption is favored by conditions that lead to precipitation and stability of manganese oxide and hydroxide minerals. Conditions that might lead to a reduction in metal attenuation effectiveness by this attenuation mechanism include conditions of lower Eh (more reducing), lower pH (more acidic), and lower bicarbonate concentration. If this condition were to occur, an effective mitigation would be to take actions (e.g. addition of a base such as lime or limestone) to raise the pH and bicarbonate of the water and restore the attenuation mechanism.

6.0 SUMMARY SITE MODEL FOR NATURAL ATTENUATION

The summary site model for natural attenuation at the Troy Mine is that metals are attenuated (removed) from water by a combination of mineral precipitation, co-precipitation with other metals, and adsorption by various solid materials including iron and manganese oxides and hydroxides, clays, and organic matter. Field and laboratory testing, supported by geochemical equilibrium modeling, evidence the removal of copper and lead from water (i.e., attenuation) by precipitation of copper and lead minerals in sediments beneath the decant pond. Table 11 summarizes the minerals formed and the geochemical controls on the stability and solubility of copper and lead minerals.

Field and laboratory testing and geochemical modeling also evidence the removal of arsenic, antimony, copper, lead and uranium from water (i.e., attenuation) by co-precipitation or adsorption of these metals with iron and/or manganese minerals. Table 12 summarizes the geochemical controls on the stability of iron and manganese minerals. The extent of sorption of trace metals in groundwater is largely controlled by the following factors:

1. Groundwater pH;
2. Metal concentration in solution;
3. The quantity of sorbent material (principally hydrous ferric and manganese oxides, organic matter, and clays) within the aquifer; and
4. The concentration of competing ions and metal-complexing ions in solution.

TABLE 11. SUMMARY OF FACTORS AFFECTING METAL ATTENUATION BY MINERAL PRECIPITATION

Metal	Minerals	Geochemical Conditions Affecting Stability/Solubility	Factors Enhancing Attenuation	Factors Reducing Attenuation
Copper	Copper oxides (tenorite, ferrite-Cu, delafossite)	Redox: high Eh/oxygen preferred	Equilibration with atmospheric oxygen	Consumption of oxygen by organic material decomposition or sulfide minerals
		pH: high pH preferred	Buffering by carbonate rocks and minerals (e.g. calcite, limestone)	Sulfide mineral oxidation
	Copper carbonate (malachite)	pH: high pH preferred	Buffering by carbonate rocks and minerals (e.g. calcite, limestone)	Sulfide mineral oxidation
		Bicarbonate: high Bicarbonate preferred	Dissolution of carbonate rocks and minerals Equilibration with CO_2 in atmosphere	
	Copper silicates (chrysocolla)	pH: high pH preferred	Buffering by carbonate rocks and minerals (e.g. calcite, limestone)	Sulfide mineral oxidation
		Silica: high silica preferred	Equilibration with silicate minerals	
	Copper hydroxysulfates (brochantite)	pH: high pH preferred	Buffering by carbonate rocks and minerals (e.g. calcite, limestone)	Sulfide mineral oxidation
		High sulfate	Sulfide mineral oxidation Dissolution of sulfate minerals (e.g. gypsum)	
Lead	Lead carbonate (cerussite)	pH: high pH preferred	Buffering by carbonate rocks and minerals (e.g. calcite, limestone)	Sulfide mineral oxidation
		Bicarbonate: high Bicarbonate preferred	Dissolution of carbonate rocks and minerals Equilibration with CO_2 in atmosphere	

TABLE 12. SUMMARY OF FACTORS AFFECTING METAL ATTENUATION BY CO-PRECIPITATION OR ADSORPTION WITH IRON AND MANGANESE MINERALS

Metal	Minerals	Geochemical Conditions Affecting Stability/Solubility	Factors Enhancing Attenuation	Factors Reducing Attenuation
Iron	Iron oxides ($Fe(OH)_3$, goethite, ferrite-Cu, delafossite)	Redox: high Eh/oxygen preferred	Equilibration with atmospheric oxygen	Consumption of oxygen by organic material decomposition or sulfide minerals
		pH: high pH preferred	Buffering by carbonate rocks and minerals (e.g. calcite, limestone)	Sulfide mineral oxidation
Manganese	Manganese carbonate (rhodochrosite)	pH: high pH preferred	Buffering by carbonate rocks and minerals (e.g. calcite, limestone)	Sulfide mineral oxidation
		Bicarbonate: high Bicarbonate preferred	Dissolution of carbonate rocks and minerals Equilibration with CO_2 in atmosphere	
	Manganese oxides (hausmannite, pyrolusite)	Redox: high Eh/oxygen preferred	Equilibration with atmospheric oxygen	Consumption of oxygen by organic material decomposition or sulfide minerals
		pH: high pH preferred	Buffering by carbonate rocks and minerals (e.g. calcite, limestone)	Sulfide mineral oxidation

7.0 EVALUATION OF LONGEVITY OF NATURAL ATTENUATION MECHANISMS

As described in the preceding sections, the active attenuation mechanisms for metals at the Troy tailing impoundment site include the precipitation of metallic minerals from water and the adsorption of metals onto precipitated minerals (iron and possibly manganese oxides and hydroxides) present in sediments beneath the decant pond. The expected duration of the geochemical conditions and capacity of aquifer sediment for attenuation is described in this section.

The longevity of the natural attenuation mechanisms is dependent on the duration of the geochemical conditions conducive to attenuation and to the capacity of the tailing impoundment/aquifer sediments to continue to uptake metals. The mineral precipitation and co-precipitation mechanisms are expected to last indefinitely or in perpetuity as long as geochemical conditions remain similar to current conditions. The adsorption mechanisms are conservatively estimated to last a minimum of 600 years.

7.1 ATTENUATION BY MINERAL PRECIPITATION

Although there are numerous metals and minerals of interest, the conditions necessary for continuation of attenuation are similar for most of these and are:

1. Neutral or alkaline pH;
2. Oxidizing redox conditions (moderate to high Eh);
3. Presence of moderate amounts of silica; and
4. Presence of moderate amounts of bicarbonate

An additional condition that only applies to sulfate minerals is:

1. Presence of moderate amounts of sulfate.

However, sulfate minerals are likely a minor attenuation mechanism given the generally low sulfate concentrations present and will not be discussed further. The durations or longevities of the primary attenuation conditions are presented below.

7.2 NEUTRAL TO ALKALINE PH

There is nearly 30 years of water quality data demonstrating that mine water is consistently neutral in pH (Parametrix, 2008). Additionally, acid-base accounting tests and long-term laboratory testing with humidity cells indicates that waste rock, ore, and tailings from the Troy Mine are not acid-generating but rather are acid-neutralizing (i.e., contain an excess of alkaline materials (MDEQ and USFS, 2001; Maxim, 2003)). Therefore, mine water pH is expected to remain near neutral to alkaline in perpetuity, and pH conditions are not expected to limit the longevity of attenuation mechanisms.

The pH of mine water, decant pond water, and groundwater are controlled by reactions between atmospheric gas (carbon dioxide) and the various rocks and minerals that the water contacts. As described in the Process Model for Geochemical Equilibrium Modeling (Section 5.1), meteoric water dissolves carbon dioxide from the atmosphere (forming carbonic acid) and becomes mildly acidic. Meteoric waters become neutral to alkaline from reaction with soils and rocks, particularly carbonate minerals and rocks that buffer the water. Although the oxidation of sulfide minerals in the underground mine releases small amounts of sulfuric acid to the water, the amount of acid released is small relative to the buffering capacity of the mine water, and mine water remains near neutral in pH.

7.3 OXIDIZING REDOX CONDITIONS

The dissolved oxygen content and redox condition (Eh) of mine water, decant pond water, and groundwater are controlled by reactions between atmospheric gas (oxygen), the various rocks and minerals that the water contacts, and decomposition of organic matter. As described in the Process Model for Geochemical Equilibrium Modeling (Section 5.1), meteoric water dissolves oxygen from the atmosphere and becomes well oxygenated. During infiltration/percolation of rainfall and groundwater to the mine workings the amount of oxygen in mine water is reduced, first by soil biological activity and later by reaction with

sulfide minerals present in the ore and waste rock. In the mine workings and during disposal of mine water in the decant pond, water is once again exposed to abundant atmospheric oxygen which raises the Eh or redox condition of the water and results in the formation of oxide minerals.

As the supply of oxygen in the atmosphere is essentially limitless, oxygen does not pose a limit to the longevity of the attenuation mechanisms as long as 1) the waters continue to receive ample exposure to the atmosphere; and 2) materials/chemicals other than metals do not consume excess amounts of oxygen. Other potential oxygen consumers are sulfide minerals and organic carbon such as plant material.

As described above for pH, oxidation of sulfide minerals in the mine is relatively slow and produces minor amounts of sulfate and acid. No change in the future rate of sulfide mineral oxidation is anticipated. Therefore, oxidation of sulfide minerals is not expected to affect the duration and longevity of attenuation mechanisms.

Currently the amount of organic carbon in mine water and decant pond sediments is low to moderate. The decant pond was dewatered in 2004 and pond bottom sediments were found to be primarily sand and silt with some interbedded layers of organic materials that appeared to be primarily algae and other very fine organic particles, with the occasional leaf or stick (see photos in Land and Water (2004)). Under these current conditions there is sufficient oxygen in the water and sediments to oxidize metals in the presence of this organic material and there is no predicted limit to the duration or longevity of the attenuation mechanism. However, if pond conditions were to change such that large amounts of organic matter were present, then excessive oxygen consumption by the decay of organic matter could result in redox conditions such that the precipitation of oxide and hydroxide minerals is limited (i.e., low Eh). Therefore, monitoring and management actions should include monitoring of pond sediments for redox conditions and carbon content, and if needed, removal of excessive organic material from the pond bottom.

7.3.1 Dissolved Silica

Silica is abundant in nature as silicates are the primary rock-forming minerals in the earth's crust. Silicate minerals are particularly abundant in and around the Troy Mine in the form of quartz and quartzite rocks, which are nearly pure silica. Moreover, tailings are predominately fine-grained quartz and sediments in the decant pond contain significant tailings material. Silica is dissolved in mine water by interaction of groundwater and mine water with silicate minerals. Given the overwhelming abundance of silica in general and in the Troy Mine and tailings impoundment in particular, the supply of dissolved silica is essentially limitless and the supply of silica does not pose a limit to the longevity of the attenuation mechanisms.

7.3.2 Dissolved Bicarbonate

The dissolved bicarbonate content of mine water, decant pond water, and groundwater are controlled by reactions between atmospheric gas (carbon dioxide), the various rocks and minerals that the water contacts, and decomposition of organic matter.

As described in the Process Model for Geochemical Equilibrium Modeling (Section 5.1), meteoric water dissolves carbon dioxide from the atmosphere, forming carbonic acid (H_2CO_3) and bicarbonate (HCO_3^-). During infiltration/percolation of rainfall and groundwater to the mine workings the amount of bicarbonate in mine water is increased, by soil biological activity and by dissolution of carbonate minerals in the ore and waste rock. Given the abundance of carbon dioxide gas in nature and carbonate rocks in the Troy Mine and tailings impoundment, the supply of dissolved bicarbonate is essentially limitless and bicarbonate does not pose a limit to the longevity of the attenuation mechanisms.

Bicarbonate concentrations of decant pond water have increased since the mine re-start in 2005. This increase is believed to be related to the higher carbonate mineral content of the ore zone that is currently being mined and milled, relative to the entire mine workings. Therefore, it is likely that bicarbonate concentrations of decant water will decrease to concentrations similar to the interim closure period after final mine closure. Decreases in bicarbonate concentrations of this magnitude are not expected to limit attenuation as

evidence shows that metal attenuation was effective at these lower concentrations during the interim shutdown period.

7.4 ATTENUATION BY ADSORPTION TO MINERALS AND SEDIMENTS

Attenuation of metals to minerals and organic matter in sediments beneath the decant pond and in the underlying aquifer is dependent on the presence of solid sorbent phases (e.g. minerals such as $Fe(OH)_3$, clay minerals, and organic matter) and appropriate water chemistry (primarily pH). The extent, duration and longevity of sorption of trace metals in groundwater are largely controlled by the following factors:

1. Groundwater pH;
2. The quantity of sorbent material (principally hydrous ferric and manganese oxides, organic matter, and clays) within decant pond and aquifer sediments; and
3. The concentration of competing ions in solution.

Site-specific evidence of the longevity of the adsorption mechanisms is provided by the 30-year operating life of the decant pond disposal system. Groundwater quality data from monitoring wells within 100 to 150 of the decant pond demonstrate that metals are effectively attenuated over this short distance, and have been for over 30 years. In comparison the decant pond is located approximately 3,000 feet from Lake Creek, a distance 20 times greater than the current transport distance of the metals. At a minimum, it is estimated that greater than 600 years of adsorption attenuation capacity remain in the shortest potential flow path to Lake Creek. This estimate is based on the following assumptions and calculations:

1. Mine water concentrations are expected to remain similar to current and past levels.
2. The adsorption capacity of sediments in the flow path between the decant pond and the adjacent monitoring wells is similar to the capacity of sediments in the flow path between the monitoring wells and Lake Creek.
3. There are not significant processes providing a sustainable supply of fresh sorbent material. This assumption is known to be false but is made to simplify the calculation

and provide a conservative estimate of adsorption life. Organic matter will continue to be replenished by deposition of algae and detritus in the pond. Groundwater containing high concentrations of iron is known to exist between the tailing impoundment and Lake Creek. Geochemical modeling and laboratory testing demonstrate that this iron provides an effective source of iron oxide and hydroxides for co-precipitation and adsorption of metals (CDM, 2010).

4. The adsorption capacity of sediments in the flow path from the pond to the adjacent monitoring wells (150 feet flow path) is at least 30 years, and likely greater as it has not been depleted yet. To be conservative, the adsorption capacity of the sediments is calculated to be 30 years of attenuation per 150 feet of flow. Stated differently, the attenuation front would be calculated to move toward Lake Creek at the rate of 5 feet/year or less.
5. The time required to deplete the adsorption capacity in the shortest potential flow path between the monitoring wells and Lake Creek (a distance of 2,850 feet) is:

2,850 feet x (30 years attenuation/150 feet) = 570 years;
or approximately 600 years.

It is important to note that this estimate is only for the adsorption attenuation mechanism. As described in Section 7.3, the mineral precipitation mechanism is expected to last indefinitely.

7.4.1 Water pH

As described in Section 7.1.1, there is nearly 30 years of water quality data demonstrating that mine water is consistently neutral in pH (Parametrix, 2008). Additionally, acid-base accounting tests and long-term laboratory testing with humidity cells indicates that waste rock, ore, and tailings from the Troy Mine are not acid-generating but rather are acid-neutralizing (i.e., contain an excess of alkaline materials) (MDEQ and USFS, 2001; Maxim, 2003). Therefore, mine water pH is expected to remain near neutral to alkaline in perpetuity, and pH conditions are not expected to limit the longevity of the adsorption attenuation mechanism.

7.4.2 Quantity of Sorbent Material

The quantities of inorganic sorbent materials within the aquifer are very large and are not expected to be exhausted. Iron and manganese are the fourth and twelfth most abundant elements in the earth's crust and the average rock contains about 5 percent iron and about 0.1 percent manganese. Although a portion of the iron and manganese occurs in forms such as silicate minerals that are not strong sorbent materials, the amount of iron and manganese oxide and hydroxides in the aquifer is still very large. Moreover, the supply of fresh iron and manganese oxides and hydroxides is continually replenished by the precipitation of iron and manganese minerals from mine water and groundwater near the decant pond. As demonstrated by geochemical modeling and field and laboratory testing by CDM (2010), there is an additional supplemental source of iron and manganese oxides downgradient of the tailing impoundment toe ponds. Groundwater near the impoundment toe naturally contains high levels of dissolved iron and manganese. Should metal-bearing water from the decant pond migrate to this area, mixing of the two groundwaters would result in the formation of fresh iron and manganese oxide/hydroxide minerals and that would adsorb and attenuate metals. This process has been demonstrated to occur in laboratory jar tests (CDM, 2010).

The quantities of organic matter in the aquifer and infiltration area sediments is likely to be low, probably less than 1 percent based on visual estimates of decant pond sediments. The organic matter that is present in the decant ponds was naturally deposited by wind and water transport of detrital material such as leaves and small pieces of tree branches and by the growth and subsequent death and deposition of algae on the pond surface. These processes are expected to continue after mine closure. Deposition of organic matter in the pond may be increased after full reclamation of the tailing impoundment surface as there will be much greater vegetative cover of the impoundment and a larger source of leaves, twigs, etc. Thus, organic matter is a renewable source of sorbent material that will not be depleted.

7.4.3 Concentration of Competing Ions

Adsorption may be viewed as an electrostatic reaction between a charge surface (the sorbent) and the charged ions in water (Cu^{++}, etc.). In some cases, there may be specific sites on the surface that are more suited for one species than another, so that ions may be seen as

"competing" for adsorption sites. A simple classic case of competing ions is the ion exchange reaction occurring in a home water softener where calcium in water reacts with zeolite minerals so that adsorbed sodium ions are forced off the zeolites and into water, while calcium ions take the adsorption sites formerly occupied by sodium. At low concentrations of ions in water (dilute solutions) competition between ions is low as there are a large number of adsorption sites relative to the number of ions desiring sites. Conversely, competition is high at high ionic concentrations.

If the quality of the disposal water were to change such that the total ionic content (e.g. total dissolved solids or TDS) or dissolved metal concentrations were to increase greatly, adsorption could be limited for some species. However, given the dilute nature of the disposal waters and groundwater (total dissolved solids generally less than 400 mg/L) the concentrations of ions in water are relatively low at present and are expected to decrease further after the cessation of mining and milling due the absence of potassium and sodium-containing milling reagents (see Section 2.3 for discussion of common ion trends). Moreover, mine water metal concentrations have been fairly consistent for over 30 years and are not expected to increase in the future.

Competition between ions is not expected to limit the duration or longevity of the adsorption attenuation mechanism, with a few possible exceptions as described in Section 3.3 and summarized as follows:

- Dissolved phosphate competes with arsenic for adsorption sites, and thus high levels of dissolved phosphate may suppress arsenic adsorption and limit arsenic attenuation. Phosphate concentrations in mine water are expected to remain low. One possible source of phosphate to the decant pond would be from fertilizer used during reclamation. Excessive phosphate fertilizer use should be avoided.
- Calcium, magnesium and trace metals (primarily zinc) compete with cadmium for adsorption sites, and thus high levels of these constituents may suppress cadmium adsorption.

- Uranium adsorption is shown to be greatly reduced in water with high carbonate concentrations due to the formation of uranium carbonate complexes that are poorly sorbed. Bicarbonate concentrations are expected to be reduced from current levels after final mine closure. Bicarbonate concentrations of decant pond water have increased since the mine re-start in 2005 (see Section 2.3). This increase is believed to be related to the higher carbonate mineral content of the ore zone that is currently being mined and milled, relative to the entire mine workings. Therefore, it is likely that bicarbonate concentrations of decant water will decrease to concentrations similar to the interim closure period after final mine closure.

Increased concentrations of ions and dissolved organic species can in some cases increase metal adsorption effectiveness. This occurs when the ions or organics form complexes with metals and the complexed form of the metal has a higher adsorption affinity than the uncomplexed metal ion. A notable example of this is copper, which adsorbs better in high ionic strength solutions, especially in water containing dissolved organic chemicals such as humic acid.

8.0 MANAGEMENT PRACTICES AND MONITORING TO VERIFY CONTINUED EFFECTIVENESS OF METAL ATTENUATION

Potential monitoring and management practices that would help ensure the continued effectiveness of metal attenuation by maintaining the geochemical conditions that are conducive to attenuation are described in this Section. The goal of monitoring and management practices would be to maintain the following current conditions at the tailing impoundment:

1. Neutral or alkaline pH;
2. Oxidizing redox conditions (moderate to high Eh);
3. Presence of moderate amounts of dissolved silica;
4. Presence of moderate amounts of bicarbonate; and
5. Presence of low to moderate amounts of organic material.

8.1 MONITORING

Monitoring activities to assess ongoing conditions related to metals attenuation should include continued monitoring of the water quality of mine water, decant pond water, and groundwater near the decant pond and conditions in the decant pond. Water monitoring parameters critical to attenuation include pH, redox (Eh and dissolved oxygen), dissolved silica, bicarbonate, and dissolved metals. The infiltration site should be monitored for excessive build up of organic matter that may reduce oxygen levels and change redox conditions in the groundwater system.

8.2 MANAGEMENT PRACTICES

Management practices should be aimed at maintaining the existing geochemical conditions by:

1. Maintaining exposure of disposal water to atmospheric oxygen and carbon dioxide;
2. Avoiding excessive use of phosphate fertilizer for reclamation (high levels of dissolved phosphate may suppress arsenic adsorption and limit arsenic attenuation);

3. Maintaining pH by monitoring or mitigation; and
4. Maintaining the decant pond/infiltration site as an aerobic environment by monitoring and if necessary removing excessive organic material that may build up.

8.3 POTENTIAL CORRECTIVE ACTIONS

Corrective actions could be done if needed to adjust or maintain geochemical conditions to maintain or enhance metal attenuation. Corrective actions could include:

1. Actions to raise pH
    a. Add alkaline material to mine water and/or decant pond.
2. Actions to maintain oxidizing conditions
    a. Remove organic matter from pond bottom;
    b. Aeration of water; and
    c. Addition of a chemical oxidant.
3. Actions to raise dissolved silica
    a. Increase exposure to fine-grained silica material (e.g. place tailings in transport path or in pond bottom); and
    b. Raise pH to increase silica solubility.
4. Actions to raise bicarbonate
    a. Add carbonate material (crushed or powdered limestone) to mine water and/or decant pond.

9.0 SUMMARY AND CONCLUSIONS

Mine water and tailings impoundment water have been infiltrated to the groundwater system at the Troy Mine tailings impoundment for over 30 years without appreciable transport of metals in groundwater away from the infiltration pond (decant pond). The lack of transport of metals in groundwater is due to natural attenuation of metals in the sediments beneath the infiltration pond and in the groundwater aquifer. Field evidence for natural attenuation of metals is provided by the sampling and analysis of water and soil samples in the vicinity of the tailings impoundment infiltration pond and from laboratory testing.

Water quality data shows that the concentrations of chemical parameters that are not attenuated (e.g. chemically conservative parameters such as nitrate) are similar between the mine water/decant pond water and the underlying groundwater. This similarity in concentrations indicates that mine water is not appreciably diluted in the groundwater system in close proximity to the infiltration pond. In contrast, the concentrations of metal parameters are much lower in the groundwater than in the mine water/decant pond, indicating that metal parameters are attenuated (removed) in the groundwater system.

Analyses of sediments in the subsurface of the decant pond reveal that metals are enriched in the sediments, indicating that the metals attenuated/removed from groundwater are retained on the sediments. Microscopic and electron microprobe examination of sediments document the occurrence of secondary copper minerals (i.e., non-ore forming minerals) in the sediments. These secondary minerals form by precipitation of copper from mine water. Geochemical equilibrium modeling confirms that copper, iron, lead, and manganese minerals are oversaturated in mine water and are favored to form from mine water.

9.1 EFFECTIVENESS AND LONGEVITY OF MONITORED NATURAL ATTENUATION

The effectiveness of natural attenuation in reducing the concentrations of metals in mine water disposed at the Try tailing impoundment has been proven by extensive field, laboratory and modeling evidence. Disposal of mine water and/or decant water (a mixture of tailings

water, mine water and natural precipitation) at the tailing impoundment has been conducted for over 30 years with no detection of increased metal concentrations in Lake Creek or in groundwater near Lake Creek. Monitoring of groundwater in wells very close to the decant pond (within 150 feet) demonstrate the rapid removal of metals over relatively short distances.

The longevity of the natural attenuation mechanisms is dependent on the duration of the geochemical conditions conducive to attenuation and to the capacity of the decant pond/aquifer sediments to continue to uptake metals. The mineral precipitation and co-precipitation mechanisms are expected to last indefinitely or in perpetuity as long as geochemical conditions remain similar to current conditions. The adsorption mechanisms are conservatively estimated to last a minimum of 600 years.

9.2 ANTIMONY

Antimony concentrations are relatively low in mine water, ranging from <0.003 mg/L to 0.016 mg/L since 1999. Historically, decant water concentrations were similar to mine water but since the mine restart in 2005 antimony concentrations have ranged up to 0.062 mg/L in decant pond water. After the cessation of mining, mine disposal water is expected to be similar to current mine water (<0.003 to 0.016 mg/L).

The scientific literature documents that antimony attenuation occurs primarily by the adsorption of antimony by iron oxides and hydroxides. This effect was demonstrated for Troy Mine waters in a water mixing test by CDM (2010). Mixing of mine water and decant pond water with groundwater from the vicinity of the tailing impoundment resulted in the precipitation of iron and manganese oxides/hydroxides from the mixed waters and the concurrent removal of up to 59 percent of the antimony. Groundwater monitoring data from wells within 150 feet of the decant pond also demonstrates that antimony concentrations are reduced to about 50 percent of the decant pond water in the shallowest groundwater (0.032 mg/L in well MW-01-15). In deeper groundwater (well MW-95-8), antimony concentrations are further attenuated to 0.005 mg/L, a greater than 90 percent reduction.

9.3 ARSENIC

Arsenic concentrations in mine water and decant pond water are very low (0.001 to 0.008 mg/L) and are reduced further by attenuation mechanisms such that arsenic is not detectable in groundwater in the monitoring wells adjacent the decant pond (<0.001 to <0.003 mg/L). Literature reports and site-specific evidence suggests that the primary mechanism of arsenic attenuation is co-precipitation and adsorption to iron and manganese oxide/hydroxide minerals. Geochemical modeling of mine water and decant pond water suggests that pure arsenic mineral phases (i.e., phases containing only arsenic and no other metals) are not expected to precipitate from mine water, decant pond water, and groundwater. Laboratory tests by CDM (2010) in which mine water and decant pond water were mixed with ambient groundwater containing high concentrations of iron demonstrate that arsenic is attenuated simultaneously with the precipitation of iron and manganese oxide/hydroxide solid phases.

9.4 CADMIUM

Cadmium concentrations in decant pond water and mine water are low, typically <0.001 to 0.002 mg/L, and are probably similar to ambient cadmium concentrations in surface water and groundwater in the area. For comparison, Hem (1985, p. 142) estimates the median concentration of cadmium in surface water in the United States to be 0.001 mg/L. Because the cadmium concentrations in water are so low and are often unmeasurable, little is known about cadmium behavior in water at the Troy Mine. In the mine water, decant pond water, and groundwater laboratory mixing tests (CDM, 2010), cadmium concentrations in mine water and decant pond water were not detected at a detection limit of 0.00008 mg/L (i.e., <0.08 parts per billion). Cadmium attenuation could not be determined in these tests because of the extremely low and unmeasurable concentrations.

Cadmium concentrations in nearby groundwater are similar to decant pond water suggesting that little attenuation occurs over the short transport distance between the pond and the monitoring wells. If significantly higher concentrations of cadmium were to occur in mine disposal water after mine closure, it is likely that cadmium would be attenuated at these higher concentrations as cadmium attenuation by mineral precipitation/co-precipitation and adsorption as described in the literature (see Section 3.4).

9.5 COPPER

Copper concentrations ranged from 0.044 to 0.17 mg/L during the interim mine shutdown period of 2000 through 2004 and are expected to be similar after final mine closure. The fate of copper disposed in the decant pond and the attenuation of copper has been extensively studied (Cannon Microprobe (2003), Land Water Consulting (2004), CDM (2010)) by many methods including:

- Groundwater monitoring that demonstrates that copper concentrations are greatly reduced in close proximity to the decant pond;
- Microscopic and electron microprobe identification of secondary copper minerals that are formed within the sediments beneath the decant pond;
- Chemical analyses of sediments beneath the decant pond that demonstrate enrichment in copper by the attenuation mechanisms; and
- Sequential extraction analyses of sediments beneath the decant pond that demonstrate the fractionation of copper in solid phases formed by the attenuation mechanisms.

These studies demonstrate the effectiveness of the natural attenuation of copper in limiting the transport of copper in the groundwater system.

9.6 LEAD

Lead concentrations in mine water are very low (<0.002 to 0.003 during the interim shutdown period; 0.002 to 0.008 mg/L in 2009). Lead concentrations are significantly attenuated and reduced in groundwater adjacent the decant pond as the highest measured groundwater concentration is only 0.0011 mg/L. For comparison, the Montana Groundwater Quality Standard is an order of magnitude higher than groundwater concentration, 0.015 mg/L.

The attenuation of lead is most likely by adsorption and the precipitation of lead minerals from mine water. The scientific literature documents that adsorption and mineral precipitation are common methods of lead attenuation. Geochemical modeling of Troy mine

water, decant pond, and groundwater indicates that the waters are saturated or nearly saturated with cerussite ($PbCO_3$), meaning that precipitation of cerussite and removal of lead from solution is favored. The adsorption effect was demonstrated for Troy Mine waters in a water mixing test by CDM (2010). Mixing of mine water and decant pond water with groundwater from the vicinity of the tailing impoundment resulted in the precipitation of iron and manganese oxides/hydroxides from the mixed waters and the concurrent attenuation of lead concentrations to less than detectable amounts (<0.0005 mg/L).

9.7 MERCURY

Mercury has not been detected in mine water, decant pond water, or groundwater at the Troy Mine. The scientific literature documents that mercury is commonly attenuated by adsorption onto iron and manganese oxide minerals, clays, and organic matter. If significantly higher concentrations of mercury were to occur in mine disposal water after mine closure, it is likely that mercury would be attenuated by these mechanisms.

9.8 SILVER

Silver has not been detected in mine water, decant pond water, or groundwater at the Troy Mine. The scientific literature documents that silver is commonly attenuated by adsorption onto iron and manganese oxide minerals and clays. If significantly higher concentrations of silver were to occur in mine disposal water after mine closure, it is likely that silver would be attenuated by these mechanisms.

9.9 URANIUM

Uranium concentrations are low in mine water (ranging from <0.0003 to 0.0013 mg/L in 2009). For comparison the Montana Groundwater Quality Standard is significantly higher at 0.03 mg/L. Uranium is typically attenuated in groundwater by adsorption mechanisms, in particular by adsorption to iron and manganese oxides. This effect was demonstrated for Troy Mine waters in a test by CDM (2010) in which mixing of mine water and decant pond water with groundwater from the vicinity of the tailing impoundment resulted in the precipitation of iron and manganese oxides/hydroxides from the mixed waters and the concurrent removal of up to 85 percent of the uranium.

At the Troy Mine decant pond, attenuation of uranium is demonstrated by reductions in uranium concentrations as water flows from the decant pond to the adjacent groundwater monitoring wells. Uranium concentrations are reduced by approximately 30 percent during transport to the closest monitoring well (approximately 100 feet lateral distance) and further reduced by 85 percent during flow to the next closest well (approximately 150 feet lateral distance).

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APPENDIX A

WATER QUALITY SAMPLE SUMMARIES AND LAB REPORTS

Hydrometrics, Inc.
consulting scientists and engineers

262 Burlington
Missoula, MT 59801
(406) 543-3660
Fax: (406) 721-4916
www.hydrometrics.com

May 15, 2009

MEMO TO FILE: Troy Mine (Genesis Mine) Copper Attenuation Samples.

Six of the eight proposed sites for collecting Copper attenuation samples and data were sampled on May 12 – 14, 2009. Seven samples (six sites plus a duplicate) were shipped from the mine site to Energy Laboratories in Billings, MT on May 14, 2009.

Two of the monitor wells proposed for sampling, MW01-16 and MW95-8, were not sampled. MW01-16 was dry. MW95-8 was not accessible because a new surface riser had been added to it when the tailings cell divider dike was raised and access to the well had not been reestablished.

Sites that were sampled include MW95-4, MW95-5, MW01-15, the Service Adit Ditch, Service Adit Pipe, and the decant pond. The Service Adit Ditch, Service Adit Pipe, and Decant samples were all grab samples. Monitor well samples were collected using a rediflo pump. Wells were purged at flow rates less than 0.1 gpm and routed through a flow through cell where groundwater parameters (pH, conductivity, dissolved oxygen, temperature, and oxidation-reduction potential) were measured. Samples were taken when the groundwater parameters stabilized per Hydrometrics standard operating procedure HF-SOP-11. In one case (MW95-4) the oxidation-reduction potential appeared to still be climbing when the sample was taken, however the other parameters had stabilized when the sample was taken.

Sampling field data sheets are attached.

Water Sampling Form ~~ HF-430

Hydrometrics, Inc.
Consulting Scientists and Engineers

Project Name: Ray MINE
Project Code:
Sample Team Member(s): LJ | PK
Laboratory Used: ELI

Site Designation: MW 95-4
Sample Code Number:
Sample Date: 5/12/09
Sample Time: 10:30 (military)

If Duplicate Sample Collected, Please Record Below

Duplicate Sample Code #:
Duplicate Sample Time:

For Groundwater Samples

		Comments
well volume formula:	V = (TD-SWL)x(Dia.^{2}) / 25	
TD (ft):	17.7	
SWL (ft):	10.2	no access/pumping
Casing Diameter (I.D.")	2"	
Water Volume (V) (gal):	1.2	
x 3=(gal.)	3.6	
Actual Vol. Removed (gal.)	2+/-	
Water Level Recovery:	slow moderate (rapid)	

Site Conditions

New Site: Yes (No) Photo taken: Yes No
Site Type: DRY surface water process water (monitoring well) domestic well adit seep spring– other:
Weather Conditions: calm (breeze) windy no precip. (rain) snow clear p. cloudy overcast
Air Temperature: °C 55 °F

For Surface Water Samples

~~Flow Method: Marsh McBirney Volumetric Flume Weir Estimate~~
~~Other Flow or Description:~~
Flow: gpm cfs Staff Gage:

Field Parameter Stabilization

Time (military)	Oxidation Reduction Potential (mV)	Dissolved Oxygen (mg/l)	pH	S.C. (µmhos/cm)	Turbidity (n.t.u.)	Temperature (°C)	Additional Parameters or Notes
1059	-21.3	0.12	6.36	254	—	5.87	
1046	-26.2	0.15	7.39	286	—	7.02	
1100	13.6	0.18	7.38	347	—	7.43	
1105	38.7	0.19	7.70	358	—	7.70	
1110	45.4	0.20	7.79	367	—	7.80	
1115	32.7	0.18	7.31	374		~~7.29~~	7.93

Turbidity: (circle) clear moderate (slight) very

Sample Method: (describe) grab composite (pump) bailer other
200 FLO 0.1 gpm

Field Parameters

	Sample	Duplicate
ORP (mV)	32.7	
DO (mg/l)	0.18	
pH	7.31	
SC (µmhos/cm)	374	
Turbidity (ntu)	—	
H_2O Tmp. (°C)	7.93	
Color		
Other:		

Bottles Collected

Quantity	Size	Filter or Unfilt.	Preservative	Parameter	Additional Notes
1	500 ml	F or (UF)	—	Cond Alk Cl, Fe, SAR, Al	
1	500 ml	F or (UF)	—	TDS	
1	250 ml	(F) or UF	HNO_3	Diss MET	
1	250 ml	(F) or UF	HCl	Hg	
1	250 ml	F or (UF)	HNO_3	Total Rec MET	
1	250 ml	F or (UF)	H_2SO_4	Nitr-NO3 -Sc	
1	250 ml	F or (UF)	NaOH-ZnOAc	Sulfide	
1	500 ml	F or (UF)	H_3PO_4	C	
	ml	F or UF			

Comments: 2 in tubing, 1 filter

Sample Team Member Signature: Larry M Johnson

Page 1 of 1

Water Sampling Form ~~ HF-430

Hydrometrics, Inc.
Consulting Scientists and Engineers

Project Name: Way MIUE
Project Code:
Sample Team Member(s): LJ | RK
Laboratory Used: EL

Site Designation: M495 X3
Sample Code Number:
Sample Date: 5/12/09
Sample Time: 13:45 (military)

If Duplicate Sample Collected, Please Record Below

Duplicate Sample Code #:
Duplicate Time:

Site Conditions

New Site: Yes (No) Photo taken: Yes No
Site Type: DRY surface water process water (monitoring well) domestic well adit seep spring-- other:
Weather Conditions: calm (breeze) windy no precip. (rain) snow clear (p. cloudy) overcast
Air Temperature: °C 55 °F

For Groundwater Samples

well volume formula: V = (TD-SWL)x(Dia.^{2}) / 25 — Comments

TD (ft): 13.40 (sounded)
SWL (ft): 7.25 no access/pumping
Casing Diameter (I.D.") 2
Water Volume (V) (gal): 1
x 3=(gal.) 3
Actual Vol. Removed (gal.) 2.5
Water Level Recovery: slow moderate rapid

For Surface Water Samples

Flow Method: Marsh McBirney Volumetric Flume Weir Estimate
Other Flow or Description:
Flow: gpm cfs Staff Gage:

Field Parameter Stabilization Start Pump @ 13:10

Time (military)	Oxidation Reduction Potential (mV)	Dissolved Oxygen (mg/l)	pH	S.C. (µmhos/cm)	Turbidity (n.t.u.)	Temperature (°C)	Additional Parameters or Notes
1319	167.7	1.86	6.10	78	—	6.98	
1330	175.2	1.00	5.99	75	—	8.10	
1335	177.9	1.76	5.[illegible]	74		8.21	
1343	179.51	1.77	6.04	72	—	8.8	

Turbidity: (circle) clear (slight) (moderate) very

Sample Method: (describe) grab composite (pump) bailer other
Low Flow Pump ~0.1 gpm

Field Parameters

	Sample	Duplicate
ORP (mV)	179.51	
DO (mg/l)	1.77	
pH	6.04	
SC (µmhos/cm)	72	
Turbidity (ntu)	—	
H_2O Tmp. (°C)	8.8	
Color		
Other:		

Bottles Collected

Quantity	Size	Filter or Unfilt.	Preservative	Parameter	Additional Notes
1	500 ml	F or (UF)	—	Cond. M+, Fl, Fe, SO4, Alk	
1	500 ml	F or (UF)	—	TDS	P, pH
1	250 ml	(F) or UF	HNO_3	Diss MET	
1	250 ml	(F) or UF	HCl	Hg	
1	250 ml	F or (UF)	HNO_3	Tot Rec MET	
1	250 ml	F or (UF)	H_2SO_4	N	
1	250 ml	F or (UF)	NaOH+ZnOAc	Sulfide	
1	500 ml	F or (UF)	H_3PO_4	C	
	ml	F or UF			

Comments: 20' tubing, 1 filter

Sample Team Member Signature: Larry M Johnson

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Water Sampling Form ~~ HF-430

Hydrometrics, Inc.
Consulting Scientists and Engineers

Project Name: Ivy Mine
Project Code:
Sample Team Member(s): LJ/PK
Laboratory Used: GCI

Site Designation: Adit Pipe
Sample Code Number:
Sample Date: 5/12/09
Sample Time: 3:15 (military)

If Duplicate Sample Collected, Please Record Below

Duplicate Sample Code #:
Duplicate Sample Time:

For Groundwater Samples

well volume formula: $V = \frac{(TD-SWL)x(Dia.^2)}{25}$ — Comments

TD (ft):
SWL (ft): — no access/pumping
Casing Diameter (I.D.")
Water Volume (V) (gal):
x 3=(gal.)
Actual Vol. Removed (gal.)
Water Level Recovery: slow moderate rapid

Site Conditions

New Site: Yes (No) Photo taken: Yes No
Site Type: DRY surface water process water
monitoring well domestic well (adit) seep
spring– other:
Weather Conditions: calm (breeze) windy
no precip. (rain) snow
clear p. cloudy (overcast)
Air Temperature: °C 57 °F

For Surface Water Samples

Flow Method: Marsh McBirney Volumetric Flume Weir Estimate
Other Flow or Description:
Flow: gpm cfs Staff Gage:

Field Parameter Stabilization

Time (military)	Oxidation Reduction Potential (mV)	Dissolved Oxygen (mg/l)	pH	S.C. (µmhos/cm)	Turbidity (n.t.u.)	Temperature (°C)	Additional Parameters or Notes

Turbidity: (circle) clear slight (moderate) very

Sample Method: (grab) composite pump bailer other
(describe)

Field Parameters

	Sample	Duplicate
ORP (mV)	174.2	
DO (mg/l)	4.11	
pH	7.52	
SC (µmhos/cm)	245	
Turbidity (ntu)		
H_2O Tmp. (°C)	6.37	
Color		
Other:		

Bottles Collected

Quantity	Size	Filter or Unfilt.	Preservative	Parameter	Additional Notes
1	500 ml	F or (UF)	—	Cond. Alk, Cl, Fe	
1	500 ml	F or (UF)	—	TDS	
1	250 ml	(F) or UF	HNO_3	Diss Met	
1	250 ml	(F) or UF	HCl	HCl	Hg
1	250 ml	F or (UF)	HNO_3	Total Met	
1	250 ml	F or (UF)	H_2SO_4	N	
1	250 ml	F or (UF)	NaOH	NaOH	Sulfide
1	500 ml	F or (UF)	H_3PO_4	H_3PO_4	C
	ml	F or UF			

Comments:

Sample Team Member Signature: Lam H Sohn

Page 1 of 1

Water Sampling Form ~~ HF-430

Hydrometrics, Inc.
Consulting Scientists and Engineers

Project Name: TROY MINE
Project Code:
Sample Team Member(s): LJ/PK
Laboratory Used: ZL

Site Designation: ADIT DITCH
Sample Code Number:
Sample Date: 5/12/09
Sample Time: 3:30 (military)

If Duplicate Sample Collected, Please Record Below

Duplicate Sample Code #:
Duplicate Time:

For Groundwater Samples

well volume formula: V = (TD-SWL)x(Dia.^{2}) / 25 — Comments

TD (ft):
SWL (ft): — no access/pumping
Casing Diameter (I.D.")
Water Volume (V) (gal):
x 3=(gal.)
Actual Vol. Removed (gal.)
Water Level Recovery: slow moderate rapid

Site Conditions

New Site: Yes (No) Photo taken: Yes No
Site Type: DRY surface water process water
monitoring well domestic well (adit) seep
spring– other:
Weather Conditions: calm (breeze) windy
no precip. (rain) snow
clear p. cloudy overcast
Air Temperature: °C 55 °F

For Surface Water Samples

Flow Method: Marsh McBirney Volumetric Flume Weir Estimate
Other Flow or Description:
Flow: gpm cfs Staff Gage:

Field Parameter Stabilization

Time (military)	Oxidation Reduction Potential (mV)	Dissolved Oxygen (mg/l)	pH	S.C. (µmhos/cm)	Turbidity (n.t.u.)	Temperature (°C)	Additional Parameters or Notes
3:30	182.7	10.75	7.53	146		5.25	

Turbidity: (circle) clear slight (moderate) (very)

Sample Method: (describe) (grab) composite pump bailer other

Field Parameters

	Sample	Duplicate
ORP (mV)	182.7	
DO (mg/l)	10.75	
pH	7.53	
SC (µmhos/cm)	146	
Turbidity (ntu)		
H_2O Tmp. (°C)	5.25	
Color		
Other:		

Bottles Collected

Quantity	Size	Filter or Unfilt.	Preservative	Parameter	Additional Notes
1	500 ml	F or (UF)	—	Cond	M^+, Alk, Fl, Fe
1	500 ml	F or (UF)	—	TDS	
1	250 ml	(F) or UF	HNO_3	Diss.	Met
1	250 ml	(F) or UF	HCl	HCl	Hg
1	250 ml	F or (UF)	HNO_3	HNO_3	Ca, Mg, M^+
1	250 ml	F or (UF)	H_2SO_4	H_2SO_4	N
1	250 ml	F or (UF)	NaOH	Sulfide	
1	500 ml	F or (UF)	H_3PO_4	Cr+	
	ml	F or UF			

Comments:

Sample Team Member Signature: [signature]

Page 1 of 1

Water Sampling Form ~~ HF-430

Hydrometrics, Inc.
Consulting Scientists and Engineers

Project Name: Ray Mine
Project Code:
Sample Team Member(s): LS / GH PK
Laboratory Used: BL

Site Designation: MW-0115
Sample Code Number:
Sample Date: 5/13/09
Sample Time: 15:10 (military)

If Duplicate Sample Collected, Please Record Below

Duplicate Sample Code #:
Duplicate Sample Time:

For Groundwater Samples

well volume formula:	V = (TD-SWL)x(Dia.^{2}) / 25	Comments
TD (ft):	~~43.9~~ 53.25	
SWL (ft):	~~53~~ 43.9	no access/pumping
Casing Diameter (I.D.")	2"	
Water Volume (V) (gal):	1.5	
x 3=(gal.)	4.5	
Actual Vol. Removed (gal.)		
Water Level Recovery:	slow moderate rapid	

Site Conditions

New Site: Yes (No) Photo taken: Yes No
Site Type: (DRY) surface water process water
monitoring well domestic well adit seep
spring-- other:
Weather Conditions: calm (breeze) windy
no precip. rain (snow)
clear p. cloudy (overcast)
Air Temperature: °C 40°F

For Surface Water Samples

Flow Method: Marsh McBirney Volumetric Flume Weir Estimate
Other Flow or Description:
Flow: gpm cfs Staff Gage:

Field Parameter Stabilization

Time (military)	Oxidation Reduction Potential (mV)	Dissolved Oxygen (mg/l)	pH	S.C. (µmhos/cm)	Turbidity (n.t.u.)	Temperature (°C)	Additional Parameters or Notes
1426	185.7	3.80	7.18	390	—	8.69	
1449	181.8	3.49	7.26	390	—	9.97	
1501	180.9	4.98	7.30	390	—	10.9	
1510	183	5.17	7.24	390	—	10.85	

Turbidity: (circle) clear moderate (slight) very

Sample Method: (describe) grab composite (pump) bailer other
<0.1 gpm

Field Parameters

	Sample	Duplicate
ORP (mV)	183	
DO (mg/l)	5.17	
pH	7.24	
SC (µmhos/cm)	390	
Turbidity (ntu)		
H_2O Tmp. (°C)	10.85	
Color		
Other:		

Bottles Collected

Quantity	Size	Filter or Unfilt.	Preservative	Parameter	Additional Notes
1	500 ml	F or (UF)	—	Cond.	Alt
1	500 ml	F or (UF)	—	TDS	
1	250 ml	(F) or UF	HNO3	DISS.	Alt
1	250 ml	(F) or UF	HCl	Hg	
1	250 ml	F or (UF)	HNO3	Fe -	TOTAL
1	250 ml	F or (UF)	H2SO4	N	
1	250 ml	F or (UF)	NaOH	S	
1	500 ml	F or (UF)	H3PO4	Cr	
	ml	F or UF			

Comments: Set Pump @ 50': 60' hose, 1 filter
Start Purge @ 14:15

Sample Team Member Signature: [signature]

Page 1 of 1

Water Sampling Form ~~ HF-430

Hydrometrics, Inc.
Consulting Scientists and Engineers

Project Name: Troy Mine
Project Code:
Sample Team Member(s): LJ/AK
Laboratory Used: EL

Site Designation: RECAUT 1
Sample Code Number:
Sample Date: 5/14/2009
Sample Time: 8:30 (military)

If Duplicate Sample Collected, Please Record Below

Duplicate Sample Code #: RECAUT 2
Duplicate Sample Time: 8:45

For Groundwater Samples

well volume formula:	V = (TD-SWL)x(Dia.^{2}) / 25	Comments
TD (ft):		
SWL (ft):		no access/pumping
Casing Diameter (I.D.")		
Water Volume (V) (gal):		
x 3=(gal.)		
Actual Vol. Removed (gal.)		
Water Level Recovery:	slow moderate rapid	

Site Conditions

New Site: Yes (No) Photo taken: Yes (No)

Site Type: DRY surface water process water monitoring well domestic well adit seep spring other: Recaut Road

Weather Conditions: calm (breeze) windy; no precip. (rain) snow; clear p. cloudy overcast

Air Temperature: °C 40 °F

For Surface Water Samples

Flow Method: Marsh McBirney Volumetric Flume Weir Estimate

Other Flow or Description:

Flow: gpm cfs Staff Gage:

Field Parameter Stabilization

Time (military)	Oxidation Reduction Potential (mV)	Dissolved Oxygen (mg/l)	pH	S.C. (µmhos/cm)	Turbidity (n.t.u.)	Temperature (°C)	Additional Parameters or Notes

Turbidity: (circle) clear slight (moderate) very

Sample Method: (describe) (grab) composite pump bailer other

Field Parameters

	Sample	Duplicate
ORP (mV)	179.5	179.5
DO (mg/l)	8.19	8.19
pH	7.43	7.43
SC (µmhos/cm)	394	394
Turbidity (ntu)		
H_2O Tmp. (°C)	9.5	9.5
Color		
Other:		

Bottles Collected

Quantity	Size	Filter or Unfilt.	Preservative	Parameter	Additional Notes
1+1	500 ml	F or (UF)	—	Conduct	MF
1+1	500 ml	F or (UF)	—	TDS	
1+1	250 ml	(F) or UF	HNO_3	DISS	MF
1+1	250 ml	(F) or UF	HCl	Hg	
1+1	250 ml	F or (UF)	HNO_3	~~Fe~~	TOTAL Fe
1+1	250 ml	F or (UF)	H_2SO_4	N	
1+1	250 ml	F or (UF)	NaOH	S	
1+1	500 ml	F or (UF)	H_3PO_4	Cr	
	ml	F or UF			

Comments: Filter from Recaut pond #1 from pump/dif Resandat.

Sample Team Member Signature: [signature]

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Copper Attenuation - Scott Mason, Hydrometrics
Lab ID: B09051541-001
Client Sample ID: MW 95-4

Report Date: 05/29/09
Collection Date: 05/12/09 10:30
DateReceived: 05/18/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL PROPERTIES							
pH	6.5	s.u.		0.1		A4500-H B	05/18/09 14:52 / nlh
Conductivity	445	umhos/cm		1		A2510 B	05/18/09 15:51 / nlh
Solids, Total Dissolved TDS @ 180 C	292	mg/L		10		A2540 C	05/18/09 16:15 / afb
INORGANICS							
Alkalinity, Total as CaCO3	77	mg/L		4		A2320 B	05/18/09 22:56 / ehb
Bicarbonate as HCO3	94	mg/L		4		A2320 B	05/18/09 22:56 / ehb
Carbonate as CO3	ND	mg/L		4		A2320 B	05/18/09 22:56 / ehb
Chloride	1	mg/L		1		E300.0	05/20/09 20:08 / kh
Sulfate	111	mg/L		1		E300.0	05/20/09 20:08 / kh
Fluoride	ND	mg/L		0.1		A4500-F C	05/18/09 22:56 / ehb
Sulfide	0.22	mg/L		0.04		A4500 S-D	05/19/09 09:30 / afb
Hardness as CaCO3	108	mg/L		1		A2340 B	05/19/09 16:20 / rls
Sodium Adsorption Ratio (SAR)	0.53			0.01		Calculation	05/19/09 16:20 / rls
AGGREGATE ORGANICS (CONTRACT LAB WY00002)							
Organic Carbon, Total (TOC)	4.8	mg/L	D	0.8		A5310 C	05/20/09 11:12 / eli-ca
NUTRIENTS							
Nitrogen, Ammonia as N	3.72	mg/L		0.05		E350.1	05/19/09 10:48 / sam
Nitrogen, Nitrate+Nitrite as N	0.02	mg/L		0.01		E353.2	05/18/09 14:27 / bls
Phosphorus, Orthophosphate as P	0.014	mg/L	LH	0.005		E365.1	05/19/09 15:49 / mlm
- The sample was received after the holding time had expired for Orthophosphat.							
METALS - DISSOLVED							
Mercury	ND	ng/L		5		E245.7	05/27/09 17:30 / eli-c
METALS, DISSOLVED							
Aluminum	ND	mg/L		0.03		E200.8	05/19/09 17:32 / aje
Antimony	ND	mg/L		0.003		E200.8	05/19/09 17:32 / aje
Arsenic	0.002	mg/L		0.001		E200.8	05/19/09 17:32 / aje
Barium	0.114	mg/L		0.005		E200.8	05/19/09 17:32 / aje
Beryllium	ND	mg/L		0.001		E200.8	05/19/09 17:32 / aje
Cadmium	0.00093	mg/L		0.00008		E200.8	05/19/09 17:32 / aje
Calcium	29	mg/L		1		E200.7	05/19/09 16:20 / tao
Chromium	0.002	mg/L		0.001		E200.8	05/19/09 17:32 / aje
Copper	ND	mg/L		0.001		E200.8	05/19/09 17:32 / aje
Iron	7.84	mg/L		0.05		E200.7	05/19/09 16:20 / tao
Iron, Ferrous	7.84	mg/L		0.05		E200.7	05/19/09 16:20 / tao
Lead	ND	mg/L		0.0005		E200.8	05/19/09 17:32 / aje
Magnesium	8	mg/L		1		E200.7	05/19/09 16:20 / tao
Manganese	2.43	mg/L		0.005		E200.7	05/19/09 16:20 / tao

Report Definitions:

RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
L - Lowest available reporting limit for the analytical method used.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
H - Analysis performed past recommended holding time.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Copper Attenuation - Scott Mason, Hydrometrics
Lab ID: B09051541-001
Client Sample ID: MW 95-4

Report Date: 05/29/09
Collection Date: 05/12/09 10:30
DateReceived: 05/18/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, DISSOLVED							
Nickel	ND	mg/L		0.01		E200.7	05/19/09 16:20 / tao
Potassium	17	mg/L		1		E200.7	05/19/09 16:20 / tao
Selenium	0.003	mg/L		0.001		E200.8	05/19/09 17:32 / aje
Silicon	21.7	mg/L		0.1		E200.7	05/20/09 13:06 / tao
Silica	46.4	mg/L		0.2		E200.7	05/20/09 13:06 / tao
Silver	ND	mg/L		0.0005		E200.8	05/19/09 17:32 / aje
Sodium	13	mg/L		1		E200.7	05/19/09 16:20 / tao
Thallium	ND	mg/L		0.0002		E200.8	05/19/09 17:32 / aje
Uranium	ND	mg/L		0.0003		E200.8	05/19/09 17:32 / aje
Zinc	ND	mg/L		0.01		E200.8	05/19/09 17:32 / aje
METALS, TOTAL							
Iron, Ferric	3.46	mg/L		0.03		Calculation	05/27/09 09:16 / rls
METALS, TOTAL RECOVERABLE							
Iron	11.3	mg/L		0.05		E200.7	05/21/09 11:56 / tao
FIELD PARAMETERS							
Field pH, su	7.3	s.u.				FIELD	05/12/09 10:30 / ---
Field Temperature, C	8.0	C				FIELD	05/12/09 10:30 / ---

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Copper Attenuation - Scott Mason, Hydrometrics
Lab ID: B09051541-002
Client Sample ID: MW 95-5

Report Date: 05/29/09
Collection Date: 05/12/09 13:45
DateReceived: 05/18/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL PROPERTIES							
pH	5.9	s.u.		0.1		A4500-H B	05/18/09 14:52 / nlh
Conductivity	82	umhos/cm		1		A2510 B	05/19/09 11:13 / nlh
Solids, Total Dissolved TDS @ 180 C	97	mg/L		10		A2540 C	05/19/09 15:29 / afb
INORGANICS							
Alkalinity, Total as CaCO3	31	mg/L		4		A2320 B	05/18/09 23:04 / ehb
Bicarbonate as HCO3	38	mg/L		4		A2320 B	05/18/09 23:04 / ehb
Carbonate as CO3	ND	mg/L		4		A2320 B	05/18/09 23:04 / ehb
Chloride	ND	mg/L		1		E300.0	05/20/09 20:43 / kh
Sulfate	3	mg/L		1		E300.0	05/20/09 20:43 / kh
Fluoride	ND	mg/L		0.1		A4500-F C	05/18/09 23:04 / ehb
Sulfide	ND	mg/L		0.04		A4500 S-D	05/19/09 09:30 / afb
Hardness as CaCO3	20	mg/L		1		A2340 B	05/19/09 16:24 / rls
Sodium Adsorption Ratio (SAR)	0.51			0.01		Calculation	05/19/09 16:24 / rls
AGGREGATE ORGANICS (CONTRACT LAB WY00002)							
Organic Carbon, Total (TOC)	2.4	mg/L		0.5		A5310 C	05/20/09 11:23 / eli-ca
NUTRIENTS							
Nitrogen, Ammonia as N	ND	mg/L		0.05		E350.1	05/19/09 10:51 / sam
Nitrogen, Nitrate+Nitrite as N	0.09	mg/L		0.01		E353.2	05/18/09 14:28 / bls
Phosphorus, Orthophosphate as P	0.016	mg/L	LH	0.005		E365.1	05/19/09 15:52 / mlm
- The sample was received after the holding time had expired for Orthophosphat.							
METALS - DISSOLVED							
Mercury	ND	ng/L		5		E245.7	05/27/09 17:32 / eli-c
METALS, DISSOLVED							
Aluminum	ND	mg/L		0.03		E200.7	05/19/09 16:24 / tao
Antimony	ND	mg/L		0.003		E200.8	05/19/09 18:30 / aje
Arsenic	ND	mg/L		0.001		E200.8	05/19/09 18:30 / aje
Barium	0.016	mg/L		0.005		E200.8	05/19/09 18:30 / aje
Beryllium	ND	mg/L		0.001		E200.8	05/19/09 18:30 / aje
Cadmium	0.00089	mg/L		0.00008		E200.8	05/19/09 18:30 / aje
Calcium	6	mg/L		1		E200.7	05/19/09 16:24 / tao
Chromium	0.003	mg/L		0.001		E200.8	05/19/09 18:30 / aje
Copper	0.002	mg/L		0.001		E200.8	05/19/09 18:30 / aje
Iron	0.18	mg/L		0.05		E200.7	05/19/09 16:24 / tao
Iron, Ferrous	0.18	mg/L		0.05		E200.7	05/19/09 16:24 / tao
Lead	ND	mg/L		0.0005		E200.8	05/19/09 18:30 / aje
Magnesium	1	mg/L		1		E200.7	05/19/09 16:24 / tao
Manganese	0.457	mg/L		0.005		E200.7	05/19/09 16:24 / tao

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
H - Analysis performed past recommended holding time.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
L - Lowest available reporting limit for the analytical methoc used.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Copper Attenuation - Scott Mason, Hydrometrics
Lab ID: B09051541-002
Client Sample ID: MW 95-5

Report Date: 05/29/09
Collection Date: 05/12/09 13:45
DateReceived: 05/18/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, DISSOLVED							
Nickel	ND	mg/L		0.01		E200.7	05/19/09 16:24 / tao
Potassium	5	mg/L		1		E200.7	05/19/09 16:24 / tao
Selenium	0.001	mg/L		0.001		E200.8	05/20/09 14:06 / aje
Silicon	28.4	mg/L		0.1		E200.7	05/20/09 13:18 / tao
Silica	60.8	mg/L		0.2		E200.7	05/20/09 13:18 / tao
Silver	ND	mg/L		0.0005		E200.8	05/19/09 18:30 / aje
Sodium	5	mg/L		1		E200.7	05/19/09 16:24 / tao
Thallium	ND	mg/L		0.0002		E200.8	05/19/09 18:30 / aje
Uranium	ND	mg/L		0.0003		E200.8	05/19/09 18:30 / aje
Zinc	ND	mg/L		0.01		E200.8	05/19/09 18:30 / aje
METALS, TOTAL							
Iron, Ferric	0.20	mg/L		0.03		Calculation	05/27/09 09:16 / rls
METALS, TOTAL RECOVERABLE							
Iron	0.38	mg/L		0.05		E200.7	05/21/09 12:00 / tao
FIELD PARAMETERS							
Field pH, su	6.04	s.u.				FIELD	05/12/09 13:45 / ---
Field Temperature, C	8.8	C				FIELD	05/12/09 13:45 / ---

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Copper Attenuation - Scott Mason, Hydrometrics
Lab ID: B09051541-003
Client Sample ID: Adit Pipe

Report Date: 05/29/09
Collection Date: 05/12/09 15:15
DateReceived: 05/18/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL PROPERTIES							
pH	7.8	s.u.		0.1		A4500-H B	05/18/09 14:52 / nlh
Conductivity	269	umhos/cm		1		A2510 B	05/18/09 15:56 / nlh
Solids, Total Dissolved TDS @ 180 C	156	mg/L		10		A2540 C	05/18/09 16:21 / afb
INORGANICS							
Alkalinity, Total as CaCO3	79	mg/L		4		A2320 B	05/18/09 23:12 / ehb
Bicarbonate as HCO3	96	mg/L		4		A2320 B	05/18/09 23:12 / ehb
Carbonate as CO3	ND	mg/L		4		A2320 B	05/18/09 23:12 / ehb
Chloride	ND	mg/L		1		E300.0	05/20/09 20:55 / kh
Sulfate	17	mg/L		1		E300.0	05/20/09 20:55 / kh
Fluoride	ND	mg/L		0.1		A4500-F C	05/18/09 23:12 / ehb
Sulfide	ND	mg/L		0.04		A4500 S-D	05/19/09 09:30 / afb
Hardness as CaCO3	107	mg/L		1		A2340 B	05/19/09 16:28 / rls
Sodium Adsorption Ratio (SAR)	0.18			0.01		Calculation	05/19/09 16:28 / rls
AGGREGATE ORGANICS (CONTRACT LAB WY00002)							
Organic Carbon, Total (TOC)	ND	mg/L		0.5		A5310 C	05/20/09 11:33 / eli-ca
NUTRIENTS							
Nitrogen, Ammonia as N	2.33	mg/L		0.05		E350.1	05/19/09 10:52 / sam
Nitrogen, Nitrate+Nitrite as N	7.99	mg/L	D	0.02		E353.2	05/18/09 14:29 / bls
Phosphorus, Orthophosphate as P	0.096	mg/L	LH	0.005		E365.1	05/19/09 15:53 / mlm
- The sample was received after the holding time had expired for Orthophosphat.							
METALS - DISSOLVED							
Mercury	ND	ng/L		5		E245.7	05/27/09 17:34 / eli-c
METALS, DISSOLVED							
Aluminum	0.09	mg/L		0.03		E200.7	05/19/09 16:28 / tao
Antimony	0.015	mg/L		0.003		E200.8	05/19/09 18:37 / aje
Arsenic	0.002	mg/L		0.001		E200.8	05/19/09 18:37 / aje
Barium	0.070	mg/L		0.005		E200.8	05/19/09 18:37 / aje
Beryllium	ND	mg/L		0.001		E200.7	05/19/09 16:28 / tao
Cadmium	0.00220	mg/L		0.00008		E200.8	05/19/09 18:37 / aje
Calcium	32	mg/L		1		E200.7	05/19/09 16:28 / tao
Chromium	ND	mg/L		0.001		E200.8	05/19/09 18:37 / aje
Copper	0.041	mg/L		0.001		E200.8	05/19/09 18:37 / aje
Iron	0.05	mg/L		0.05		E200.7	05/19/09 16:28 / tao
Iron, Ferrous	0.05	mg/L		0.05		E200.7	05/19/09 16:28 / tao
Lead	0.0021	mg/L		0.0005		E200.8	05/19/09 18:37 / aje
Magnesium	7	mg/L		1		E200.7	05/19/09 16:28 / tao
Manganese	0.163	mg/L		0.005		E200.7	05/19/09 16:28 / tao

Report Definitions:

RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
L - Lowest available reporting limit for the analytical method used.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
H - Analysis performed past recommended holding time.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Copper Attenuation - Scott Mason, Hydrometrics
Lab ID: B09051541-003
Client Sample ID: Adit Pipe

Report Date: 05/29/09
Collection Date: 05/12/09 15:15
DateReceived: 05/18/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, DISSOLVED							
Nickel	ND	mg/L		0.01		E200.7	05/19/09 16:28 / tao
Potassium	2	mg/L		1		E200.7	05/19/09 16:28 / tao
Selenium	0.003	mg/L		0.001		E200.8	05/20/09 14:33 / aje
Silicon	3.6	mg/L		0.1		E200.8	05/20/09 14:33 / aje
Silica	7.7	mg/L		0.2		E200.8	05/20/09 14:33 / aje
Silver	ND	mg/L		0.0005		E200.8	05/19/09 18:37 / aje
Sodium	4	mg/L		1		E200.7	05/19/09 16:28 / tao
Thallium	ND	mg/L		0.0002		E200.8	05/19/09 18:37 / aje
Uranium	0.0013	mg/L		0.0003		E200.8	05/19/09 18:37 / aje
Zinc	ND	mg/L		0.01		E200.8	05/19/09 18:37 / aje
METALS, TOTAL							
Iron, Ferric	4.24	mg/L		0.03		Calculation	05/27/09 09:16 / rls
METALS, TOTAL RECOVERABLE							
Iron	4.29	mg/L		0.05		E200.7	05/21/09 12:04 / tao
FIELD PARAMETERS							
Field pH, su	7.52	s.u.				FIELD	05/12/09 15:15 / ---
Field Temperature, C	6.04	C				FIELD	05/12/09 15:15 / ---

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Copper Attenuation - Scott Mason, Hydrometrics
Lab ID: B09051541-004
Client Sample ID: Adit Ditch

Report Date: 05/29/09
Collection Date: 05/12/09 15:30
DateReceived: 05/18/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL PROPERTIES							
pH	7.8	s.u.		0.1		A4500-H B	05/18/09 14:52 / nlh
Conductivity	169	umhos/cm		1		A2510 B	05/18/09 15:55 / nlh
Solids, Total Dissolved TDS @ 180 C	96	mg/L		10		A2540 C	05/18/09 16:20 / afb
INORGANICS							
Alkalinity, Total as CaCO3	42	mg/L		4		A2320 B	05/18/09 23:20 / ehb
Bicarbonate as HCO3	52	mg/L		4		A2320 B	05/18/09 23:20 / ehb
Carbonate as CO3	ND	mg/L		4		A2320 B	05/18/09 23:20 / ehb
Chloride	ND	mg/L		1		E300.0	05/20/09 21:06 / kh
Sulfate	17	mg/L		1		E300.0	05/20/09 21:06 / kh
Fluoride	ND	mg/L		0.1		A4500-F C	05/18/09 23:20 / ehb
Sulfide	ND	mg/L		0.04		A4500 S-D	05/19/09 09:30 / afb
Hardness as CaCO3	57	mg/L		1		A2340 B	05/19/09 16:39 / rls
Sodium Adsorption Ratio (SAR)	0.20			0.01		Calculation	05/19/09 16:39 / rls
AGGREGATE ORGANICS (CONTRACT LAB WY00002)							
Organic Carbon, Total (TOC)	ND	mg/L		0.5		A5310 C	05/20/09 11:42 / eli-ca
NUTRIENTS							
Nitrogen, Ammonia as N	1.59	mg/L		0.05		E350.1	05/19/09 10:54 / sam
Nitrogen, Nitrate+Nitrite as N	3.22	mg/L		0.01		E353.2	05/18/09 14:31 / bls
Phosphorus, Orthophosphate as P	0.051	mg/L	LH	0.005		E365.1	05/19/09 15:54 / mlm
- The sample was received after the holding time had expired for Orthophosphat.							
METALS - DISSOLVED							
Mercury	5	ng/L		5		E245.7	05/27/09 17:36 / eli-c
METALS, DISSOLVED							
Aluminum	0.06	mg/L		0.03		E200.7	05/19/09 16:39 / tao
Antimony	0.008	mg/L		0.003		E200.8	05/19/09 18:44 / aje
Arsenic	0.001	mg/L		0.001		E200.8	05/19/09 18:44 / aje
Barium	0.065	mg/L		0.005		E200.8	05/19/09 18:44 / aje
Beryllium	ND	mg/L		0.001		E200.8	05/19/09 18:44 / aje
Cadmium	0.00087	mg/L		0.00008		E200.8	05/19/09 18:44 / aje
Calcium	17	mg/L		1		E200.7	05/19/09 16:39 / tao
Chromium	ND	mg/L		0.001		E200.8	05/19/09 18:44 / aje
Copper	0.084	mg/L		0.001		E200.8	05/19/09 18:44 / aje
Iron	ND	mg/L		0.05		E200.7	05/19/09 16:39 / tao
Iron, Ferrous	ND	mg/L		0.05		E200.7	05/19/09 16:39 / tao
Lead	0.0080	mg/L		0.0005		E200.8	05/19/09 18:44 / aje
Magnesium	3	mg/L		1		E200.7	05/19/09 16:39 / tao
Manganese	0.312	mg/L		0.005		E200.7	05/19/09 16:39 / tao

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
H - Analysis performed past recommended holding time.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
L - Lowest available reporting limit for the analytical methoc used.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Copper Attenuation - Scott Mason, Hydrometrics
Lab ID: B09051541-004
Client Sample ID: Adit Ditch

Report Date: 05/29/09
Collection Date: 05/12/09 15:30
DateReceived: 05/18/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, DISSOLVED							
Nickel	ND	mg/L		0.01		E200.7	05/19/09 16:39 / tao
Potassium	2	mg/L		1		E200.7	05/19/09 16:39 / tao
Selenium	0.001	mg/L		0.001		E200.8	05/20/09 14:40 / aje
Silicon	4.4	mg/L		0.1		E200.8	05/20/09 14:40 / aje
Silica	9.5	mg/L		0.2		E200.8	05/20/09 14:40 / aje
Silver	ND	mg/L		0.0005		E200.8	05/19/09 18:44 / aje
Sodium	3	mg/L		1		E200.7	05/19/09 16:39 / tao
Thallium	ND	mg/L		0.0002		E200.8	05/19/09 18:44 / aje
Uranium	ND	mg/L		0.0003		E200.8	05/19/09 18:44 / aje
Zinc	ND	mg/L		0.01		E200.8	05/19/09 18:44 / aje
METALS, TOTAL							
Iron, Ferric	8.51	mg/L		0.03		Calculation	05/27/09 09:16 / rls
METALS, TOTAL RECOVERABLE							
Iron	8.51	mg/L		0.05		E200.7	05/21/09 12:08 / tao
FIELD PARAMETERS							
Field pH, su	7.53	s.u.				FIELD	05/12/09 15:30 / ---
Field Temperature, C	5.25	C				FIELD	05/12/09 15:30 / ---

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Copper Attenuation - Scott Mason, Hydrometrics
Lab ID: B09051541-005
Client Sample ID: MW-01-15

Report Date: 05/29/09
Collection Date: 05/13/09 15:20
DateReceived: 05/18/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL PROPERTIES							
pH	7.3	s.u.		0.1		A4500-H B	05/18/09 14:52 / nlh
Conductivity	424	umhos/cm		1		A2510 B	05/18/09 15:57 / nlh
Solids, Total Dissolved TDS @ 180 C	256	mg/L		10		A2540 C	05/18/09 16:23 / afb
INORGANICS							
Alkalinity, Total as CaCO3	83	mg/L		4		A2320 B	05/18/09 23:28 / ehb
Bicarbonate as HCO3	102	mg/L		4		A2320 B	05/18/09 23:28 / ehb
Carbonate as CO3	ND	mg/L		4		A2320 B	05/18/09 23:28 / ehb
Chloride	4	mg/L		1		E300.0	05/20/09 21:18 / kh
Sulfate	31	mg/L		1		E300.0	05/20/09 21:18 / kh
Fluoride	0.2	mg/L		0.1		A4500-F C	05/18/09 23:28 / ehb
Sulfide	0.05	mg/L		0.04		A4500 S-D	05/19/09 09:30 / afb
Hardness as CaCO3	71	mg/L		1		A2340 B	05/19/09 16:43 / rls
Sodium Adsorption Ratio (SAR)	1.66			0.01		Calculation	05/19/09 16:43 / rls
AGGREGATE ORGANICS (CONTRACT LAB WY00002)							
Organic Carbon, Total (TOC)	1.6	mg/L		0.5		A5310 C	05/20/09 11:53 / eli-ca
NUTRIENTS							
Nitrogen, Ammonia as N	3.83	mg/L		0.05		E350.1	05/19/09 10:55 / sam
Nitrogen, Nitrate+Nitrite as N	16.8	mg/L	D	0.02		E353.2	05/18/09 14:32 / bls
Phosphorus, Orthophosphate as P	0.073	mg/L	LH	0.005		E365.1	05/19/09 15:55 / mlm
- The sample was received after the holding time had expired for Orthophosphat.							
METALS - DISSOLVED							
Mercury	ND	ng/L		5		E245.7	05/27/09 17:38 / eli-c
METALS, DISSOLVED							
Aluminum	0.04	mg/L		0.03		E200.8	05/19/09 18:51 / aje
Antimony	0.032	mg/L		0.003		E200.8	05/19/09 18:51 / aje
Arsenic	ND	mg/L		0.001		E200.8	05/19/09 18:51 / aje
Barium	0.101	mg/L		0.005		E200.8	05/19/09 18:51 / aje
Beryllium	ND	mg/L		0.001		E200.7	05/19/09 16:43 / tao
Cadmium	0.00090	mg/L		0.00008		E200.8	05/19/09 18:51 / aje
Calcium	22	mg/L		1		E200.7	05/19/09 16:43 / tao
Chromium	0.002	mg/L		0.001		E200.8	05/19/09 18:51 / aje
Copper	0.068	mg/L		0.001		E200.8	05/19/09 18:51 / aje
Iron	0.06	mg/L		0.05		E200.7	05/19/09 16:43 / tao
Iron, Ferrous	0.06	mg/L		0.05		E200.7	05/19/09 16:43 / tao
Lead	0.0011	mg/L		0.0005		E200.8	05/19/09 18:51 / aje
Magnesium	4	mg/L		1		E200.7	05/19/09 16:43 / tao
Manganese	0.455	mg/L		0.005		E200.7	05/19/09 16:43 / tao

Report Definitions:

RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
L - Lowest available reporting limit for the analytical method used.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
H - Analysis performed past recommended holding time.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Copper Attenuation - Scott Mason, Hydrometrics
Lab ID: B09051541-005
Client Sample ID: MW-01-15

Report Date: 05/29/09
Collection Date: 05/13/09 15:20
DateReceived: 05/18/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, DISSOLVED							
Nickel	ND	mg/L		0.01		E200.7	05/19/09 16:43 / tao
Potassium	22	mg/L		1		E200.7	05/19/09 16:43 / tao
Selenium	ND	mg/L		0.001		E200.8	05/19/09 18:51 / aje
Silicon	5.1	mg/L		0.1		E200.7	05/20/09 13:34 / tao
Silica	11.0	mg/L		0.2		E200.7	05/20/09 13:34 / tao
Silver	ND	mg/L		0.0005		E200.8	05/19/09 18:51 / aje
Sodium	32	mg/L		1		E200.7	05/19/09 16:43 / tao
Thallium	ND	mg/L		0.0002		E200.8	05/19/09 18:51 / aje
Uranium	0.0020	mg/L		0.0003		E200.8	05/19/09 18:51 / aje
Zinc	0.01	mg/L		0.01		E200.7	05/19/09 16:43 / tao
METALS, TOTAL							
Iron, Ferric	3.31	mg/L		0.03		Calculation	05/27/09 09:16 / rls
METALS, TOTAL RECOVERABLE							
Iron	3.37	mg/L		0.05		E200.7	05/21/09 12:12 / tao
FIELD PARAMETERS							
Field pH, su	7.24	s.u.				FIELD	05/13/09 15:20 / ---
Field Temperature, C	10.85	C				FIELD	05/13/09 15:20 / ---

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Copper Attenuation - Scott Mason, Hydrometrics
Lab ID: B09051541-006
Client Sample ID: Decant 1

Report Date: 05/29/09
Collection Date: 05/14/09 08:30
DateReceived: 05/18/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL PROPERTIES							
pH	7.6	s.u.		0.1		A4500-H B	05/18/09 14:52 / nlh
Conductivity	427	umhos/cm		1		A2510 B	05/18/09 16:00 / nlh
Solids, Total Dissolved TDS @ 180 C	305	mg/L		10		A2540 C	05/18/09 16:26 / afb
INORGANICS							
Alkalinity, Total as CaCO3	82	mg/L		4		A2320 B	05/18/09 23:36 / ehb
Bicarbonate as HCO3	99	mg/L		4		A2320 B	05/18/09 23:36 / ehb
Carbonate as CO3	ND	mg/L		4		A2320 B	05/18/09 23:36 / ehb
Chloride	4	mg/L		1		E300.0	05/20/09 21:30 / kh
Sulfate	33	mg/L		1		E300.0	05/20/09 21:30 / kh
Fluoride	0.2	mg/L		0.1		A4500-F C	05/18/09 23:36 / ehb
Sulfide	0.04	mg/L		0.04		A4500 S-D	05/19/09 09:30 / afb
Hardness as CaCO3	59	mg/L		1		A2340 B	05/19/09 16:47 / rls
Sodium Adsorption Ratio (SAR)	1.73			0.01		Calculation	05/19/09 16:47 / rls
AGGREGATE ORGANICS (CONTRACT LAB WY00002)							
Organic Carbon, Total (TOC)	1.6	mg/L		0.5		A5310 C	05/20/09 12:04 / eli-ca
NUTRIENTS							
Nitrogen, Ammonia as N	6.0	mg/L	D	0.1		E350.1	05/21/09 10:47 / sam
Nitrogen, Nitrate+Nitrite as N	17.6	mg/L	D	0.02		E353.2	05/18/09 14:33 / bls
Phosphorus, Orthophosphate as P	0.134	mg/L	LH	0.005		E365.1	05/19/09 15:56 / mlm
- The sample was received after the holding time had expired for Orthophosphat.							
METALS - DISSOLVED							
Mercury	ND	ng/L		5		E245.7	05/27/09 17:40 / eli-c
METALS, DISSOLVED							
Aluminum	0.11	mg/L		0.03		E200.8	05/19/09 18:58 / aje
Antimony	0.046	mg/L		0.003		E200.8	05/19/09 18:58 / aje
Arsenic	0.002	mg/L		0.001		E200.8	05/19/09 18:58 / aje
Barium	0.097	mg/L		0.005		E200.8	05/19/09 18:58 / aje
Beryllium	ND	mg/L		0.001		E200.8	05/19/09 18:58 / aje
Cadmium	0.00089	mg/L		0.00008		E200.8	05/19/09 18:58 / aje
Calcium	17	mg/L		1		E200.7	05/19/09 16:47 / tao
Chromium	ND	mg/L		0.001		E200.8	05/19/09 18:58 / aje
Copper	0.028	mg/L		0.001		E200.8	05/19/09 18:58 / aje
Iron	0.06	mg/L		0.05		E200.7	05/19/09 16:47 / tao
Iron, Ferrous	0.06	mg/L		0.05		E200.7	05/19/09 16:47 / tao
Lead	0.0026	mg/L		0.0005		E200.8	05/19/09 18:58 / aje
Magnesium	4	mg/L		1		E200.7	05/19/09 16:47 / tao
Manganese	0.554	mg/L		0.005		E200.7	05/19/09 16:47 / tao

Report Definitions:

RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
L - Lowest available reporting limit for the analytical method used.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
H - Analysis performed past recommended holding time.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Copper Attenuation - Scott Mason, Hydrometrics
Lab ID: B09051541-006
Client Sample ID: Decant 1

Report Date: 05/29/09
Collection Date: 05/14/09 08:30
DateReceived: 05/18/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, DISSOLVED							
Nickel	ND	mg/L		0.01		E200.7	05/19/09 16:47 / tao
Potassium	27	mg/L		1		E200.7	05/19/09 16:47 / tao
Selenium	0.001	mg/L		0.001		E200.8	05/20/09 15:15 / aje
Silicon	4.0	mg/L		0.1		E200.8	05/20/09 15:15 / aje
Silica	8.5	mg/L		0.2		E200.8	05/20/09 15:15 / aje
Silver	ND	mg/L		0.0005		E200.8	05/19/09 18:58 / aje
Sodium	31	mg/L		1		E200.7	05/19/09 16:47 / tao
Thallium	ND	mg/L		0.0002		E200.8	05/19/09 18:58 / aje
Uranium	0.0029	mg/L		0.0003		E200.8	05/19/09 18:58 / aje
Zinc	ND	mg/L		0.01		E200.8	05/19/09 18:58 / aje
METALS, TOTAL							
Iron, Ferric	2.96	mg/L		0.03		Calculation	05/27/09 09:16 / rls
METALS, TOTAL RECOVERABLE							
Iron	3.02	mg/L		0.05		E200.7	05/21/09 12:24 / tao
FIELD PARAMETERS							
Field pH, su	7.45	s.u.				FIELD	05/14/09 08:30 / ---
Field Temperature, C	9.5	C				FIELD	05/14/09 08:30 / ---

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Copper Attenuation - Scott Mason, Hydrometrics
Lab ID: B09051541-007
Client Sample ID: Decant

Report Date: 05/29/09
Collection Date: 05/14/09 08:45
DateReceived: 05/18/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL PROPERTIES							
pH	7.7	s.u.		0.1		A4500-H B	05/18/09 14:52 / nlh
Conductivity	429	umhos/cm		1		A2510 B	05/18/09 16:01 / nlh
Solids, Total Dissolved TDS @ 180 C	314	mg/L		10		A2540 C	05/18/09 16:27 / afb
INORGANICS							
Alkalinity, Total as CaCO3	82	mg/L		4		A2320 B	05/18/09 23:59 / ehb
Bicarbonate as HCO3	100	mg/L		4		A2320 B	05/18/09 23:59 / ehb
Carbonate as CO3	ND	mg/L		4		A2320 B	05/18/09 23:59 / ehb
Chloride	4	mg/L		1		E300.0	05/21/09 00:01 / kh
Sulfate	33	mg/L		1		E300.0	05/21/09 00:01 / kh
Fluoride	0.2	mg/L		0.1		A4500-F C	05/18/09 23:59 / ehb
Sulfide	0.10	mg/L		0.04		A4500 S-D	05/19/09 09:30 / afb
Hardness as CaCO3	59	mg/L		1		A2340 B	05/19/09 16:51 / rls
Sodium Adsorption Ratio (SAR)	1.76			0.01		Calculation	05/19/09 16:51 / rls
AGGREGATE ORGANICS (CONTRACT LAB WY00002)							
Organic Carbon, Total (TOC)	1.6	mg/L		0.5		A5310 C	05/20/09 12:16 / eli-ca
NUTRIENTS							
Nitrogen, Ammonia as N	6.0	mg/L	D	0.1		E350.1	05/21/09 10:48 / sam
Nitrogen, Nitrate+Nitrite as N	19.4	mg/L	D	0.02		E353.2	05/18/09 14:34 / bls
Phosphorus, Orthophosphate as P	0.169	mg/L	LH	0.005		E365.1	05/19/09 15:57 / mlm
- The sample was received after the holding time had expired for Orthophosphat.							
METALS - DISSOLVED							
Mercury	ND	ng/L		5		E245.7	05/27/09 17:44 / eli-c
METALS, DISSOLVED							
Aluminum	0.12	mg/L		0.03		E200.7	05/19/09 16:51 / tao
Antimony	0.047	mg/L		0.003		E200.8	05/19/09 19:05 / aje
Arsenic	0.002	mg/L		0.001		E200.8	05/19/09 19:05 / aje
Barium	0.099	mg/L		0.005		E200.8	05/19/09 19:05 / aje
Beryllium	ND	mg/L		0.001		E200.7	05/19/09 16:51 / tao
Cadmium	0.00091	mg/L		0.00008		E200.8	05/19/09 19:05 / aje
Calcium	17	mg/L		1		E200.7	05/19/09 16:51 / tao
Chromium	ND	mg/L		0.001		E200.8	05/19/09 19:05 / aje
Copper	0.024	mg/L		0.001		E200.8	05/19/09 19:05 / aje
Iron	ND	mg/L		0.05		E200.7	05/19/09 16:51 / tao
Iron, Ferrous	ND	mg/L		0.05		E200.7	05/19/09 16:51 / tao
Lead	0.0016	mg/L		0.0005		E200.8	05/19/09 19:05 / aje
Magnesium	4	mg/L		1		E200.7	05/19/09 16:51 / tao
Manganese	0.543	mg/L		0.005		E200.7	05/19/09 16:51 / tao

Report Definitions:

RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
L - Lowest available reporting limit for the analytical method used.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
H - Analysis performed past recommended holding time.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Copper Attenuation - Scott Mason, Hydrometrics
Lab ID: B09051541-007
Client Sample ID: Decant

Report Date: 05/29/09
Collection Date: 05/14/09 08:45
DateReceived: 05/18/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, DISSOLVED							
Nickel	ND	mg/L		0.01		E200.7	05/19/09 16:51 / tao
Potassium	27	mg/L		1		E200.7	05/19/09 16:51 / tao
Selenium	ND	mg/L		0.001		E200.8	05/20/09 15:22 / aje
Silicon	3.9	mg/L		0.1		E200.8	05/20/09 15:22 / aje
Silica	8.3	mg/L		0.2		E200.8	05/20/09 15:22 / aje
Silver	ND	mg/L		0.0005		E200.8	05/19/09 19:05 / aje
Sodium	31	mg/L		1		E200.7	05/19/09 16:51 / tao
Thallium	ND	mg/L		0.0002		E200.8	05/19/09 19:05 / aje
Uranium	0.0030	mg/L		0.0003		E200.8	05/19/09 19:05 / aje
Zinc	ND	mg/L		0.01		E200.7	05/19/09 16:51 / tao
METALS, TOTAL							
Iron, Ferric	2.95	mg/L		0.03		Calculation	05/27/09 09:16 / rls
METALS, TOTAL RECOVERABLE							
Iron	2.95	mg/L		0.05		E200.7	05/21/09 12:28 / tao
FIELD PARAMETERS							
Field pH, su	7.45	s.u.				FIELD	05/14/09 08:45 / ---
Field Temperature, C	9.5	C				FIELD	05/14/09 08:45 / ---

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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June 10, 2009

MEMO TO FILE
RE: COPPER ATTENUATION SAMPLING – TROY MINE

Three samples were taken to provide additional data for the copper attenuation modeling of the tailing facility at the Genesis Mine (Troy Mine). One set of samples was collected from each of the monitor wells MW01-15 and MW95-8. Monitor well MW01-16 was also checked and found to be dry. The third sample was taken from the Decant Pond. Sample field sheets are attached.

Recovery rates in both of sampled wells (MW01-15 and MW95-8) were moderate to slow within the screened interval, but full recovery is extremely slow. Well MW01-15 didn't produce enough water to maintain SWL while pumping at a rate of <0.1 gpm. Details of the purging and sampling of the wells are included below.

Samples were shipped to Energy Labs in Billings with a request for a rush turnaround.

Monitor Well MW01-15

The original completion notes for this well indicate a total well depth of 45 feet with screen from 30 to 40 feet below the ground surface. A lift has been put on the tailing divider dike on which the well is located since the well was installed. The sounded depth for the well is 53.25 feet with a 1.5 foot stick up, implying the screen is now at about 37 to 47 feet. Static water level (SWL) in the well was 44.54. The Rediflo pump was set at 50 feet. Initial pumping of the well at approximately 0.25 gpm drew the SWL to 50.5 feet. The SWL recovered to 44.7 feet in 42 minutes. The well was pumped down and allowed to recover five times yielding approximately 3.5 gallons. Initial recovery rates after purging the well were up to one foot of SWL recovery in four minutes. Recovery rates significantly declined after 2 to 2.5 feet of SWL recovery.

The sample was taken under low flow (<0.1 gpm) conditions. The SWL in the well was drawn down approximately 2 feet while sampling. Field parameters were taken after the sample was taken because it was not known if the well could be pumped long enough to allow stabilization of field parameters before the sample was taken without drawing the SWL down to the pump.

Monitor Well MW95-8

Completion notes for this well indicate a total depth of 54.5 feet with the screen at 48 to 53 feet (presumably below ground surface). The sounded depth of the well was 64.18

feet, reflecting additional casing added to the well because of a lift being put on the divider dike where the well is located. The initial SWL was 50.06 feet. Approximately 3.5 gallons of water were purged with a bailer, drawing the SWL down to 59 feet. The well was left to recover overnight and recovered to 51.0 feet. Another 2 gallons were bailed, drawing the SWL down to a SWL of 59.0 feet. The pump was put in the well at a depth of 60 feet, in preparation for sampling. SWL was measured at 58.25 after installing the pump. SWL showed no recovery after 2.5 hours. Pump was pulled from the well due to a lack of water in the well and poor recovery and a sample was taken using a bailer. SWL at initiation of bailing for the sample was 58.27 feet, and taking the sample drew the well down to 59.24 feet. Well recovered to 59.01 feet in ten minutes after taking the sample.

Monitoring Well MW01-16

Completion notes for this well indicate a total depth of 42 feet with screen from 32 to 42 feet. The well was sounded to a depth of 42.88 feet and was dry.

Decant Pond

A sample from the decant pond was taken from a point adjacent to the access ramp to the pump dock. The pumps were not running at the time of sampling.

Sampling MW01-15: Decant pond in background. Irrigation well visible on far left side of decant pond.

Monitor Well MW01-16

MW01-16 next to dike road, looking toward M95-8 on dike road on far side of decant pond

Monitor Well MW01-16. Looking back toward MW00-15

Water Sampling Form ~~ HF-430

Hydrometrics, Inc.
Consulting Scientists and Engineers

Project Name: TR01
Project Code:
Sample Team Member(s): LS/PK
Laboratory Used: ECI

Site Designation: MW 58
Sample Code Number:
Sample Date: 6/8/09
Sample Time: 12:15 (military)

If Duplicate Sample Collected, Please Record Below

Duplicate Sample Code #:
Duplicate Sample Time:

For Groundwater Samples

		Comments
well volume formula:	V = (TD-SWL)x(Dia.^{2}) / 25	
TD (ft):	~~60.18~~ 64.18	
SWL (ft):	~~50.60~~ 50.06	no access/pumping
Casing Diameter (I.D.")	2"	
Water Volume (V) (gal):	2.3	
x 3=(gal.)	6.8	
Actual Vol. Removed (gal.)	5.5	
Water Level Recovery:	slow moderate rapid	

Site Conditions

New Site: Yes No Photo taken: Yes No
Site Type: DRY surface water process water
monitoring well domestic well adit seep
spring– other:
Weather Conditions: calm breeze windy
no precip. rain snow
clear p. cloudy overcast
Air Temperature: °C °F

For Surface Water Samples

Flow Method: Marsh McBirney Volumetric Flume Weir Estimate
Other Flow or Description:
Flow: gpm cfs Staff Gage:

Field Parameter Stabilization

Time (military)	Oxidation Reduction Potential (mV)	Dissolved Oxygen (mg/l)	pH	S.C. (µmhos/cm)	Turbidity (n.t.u.)	Temperature (°C)	Additional Parameters or Notes

Turbidity: (circle) clear moderate slight very

Sample Method: (describe) grab composite pump (bailer) other

Field Parameters

	Sample	Duplicate
ORP (mV)	128.8	
DO (mg/l)	4.52	
pH	7.57	
SC (µmhos/cm)	532	
Turbidity (ntu)		
H_2O Tmp. (°C)	10.2	
Color	LLR	
Other:		

Bottles Collected

Quantity	Size	Filter or Unfilt.	Preservative	Parameter	Additional Notes
1	500 ml	F or (UF)	—	COND	Mt, Alk, Fe
1	500 ml	F or (UF)	—	TDS	
1	250 ml	(F) or UF	HNO_3	DISS. Mt	
1	250 ml	(F) or UF	HCl	Hg	
1	250 ml	F or (UF)	HNO_3	TOT Mt	
1	250 ml	F or (UF)	H_2SO_4	SO4	
1	250 ml	F or (UF)	H_2O_4	Sulfate	
1	500 ml	F or (UF)	H_2SO_4	CN	
	ml	~~F or UF~~			

Comments: Bailed ~3.5 gal : SWL → 59.00 : LET WELL SET OVERNITE → SWL 59.00 after 1 bailer : BAILED TO ~51' - let set for 2.5 hours → ND
Recovery: Run pump → SWL @ 58.27 : TOOK SAMPLE → SWL 59.24
WAIT 10 MIN SWL → 59.01

Sample Team Member Signature: [signature]

Page 1 of 1

Water Sampling Form ~~ HF-430

Hydrometrics, Inc.
Consulting Scientists and Engineers

Project Name: Ray Mine
Project Code:
Sample Team Member(s): LJ/PK
Laboratory Used: ALI

Site Designation: MW-01-15
Sample Code Number:
Sample Date: 6/2/09
Sample Time: 17:00 (military)

If Duplicate Sample Collected, Please Record Below

Duplicate Sample Code #:
Duplicate Sample Time:

For Groundwater Samples

		Comments
well volume formula:	V = (TD-SWL)x(Dia.^{2}) / 25	
TD (ft):	53.25*	
SWL (ft):	44.54	no access/pumping
Casing Diameter (I.D.")	2	
Water Volume (V) (gal):	1.4	
x 3=(gal.)	4.2	
Actual Vol. Removed (gal.)	3.5	
Water Level Recovery:	slow moderate rapid	

Site Conditions

New Site: Yes (No) Photo taken: Yes (No)
Site Type: DRY surface water process water (monitoring well) domestic well adit seep spring– other:
Weather Conditions: calm (breeze) windy (no precip.) rain snow clear p. cloudy (overcast)
Air Temperature: °C 50 °F

For Surface Water Samples

Flow Method: Marsh McBirney Volumetric Flume Weir Estimate
Other Flow or Description:
Flow: gpm cfs Staff Gage:

Field Parameter Stabilization

Time (military)	Oxidation Reduction Potential (mV)	Dissolved Oxygen (mg/l)	pH	S.C. (µmhos/cm)	Turbidity (n.t.u.)	Temperature (°C)	Additional Parameters or Notes
16:31	154.4	3.86	7.85	431	—	8.70	
16:34	153.0	3.79	7.56	423	—	8.79	
17:08	127.9	5.10	7.66	424	—	14.10	*AFTER
17:11	142.6	4.35	7.31	421	—	15.69	SMPLING

Turbidity: (circle) (clear) slight moderate very

Sample Method: (describe) grab composite (pump) bailer other
RECIRC

Field Parameters

	Sample	Duplicate
ORP (mV)	127.9	
DO (mg/l)	4.35	
pH	7.31	
SC (µmhos/cm)	421	
Turbidity (ntu)	—	
H_2O Tmp. (°C)	14.10	
Color		
Other:		

Bottles Collected

Quantity	Size	Filter or Unfilt.	Preservative	Parameter	Additional Notes
1	500 ml	F or (UF)	—	Cat. Mt, Alk, Fe, Fl	
1	500 ml	F or (UF)	—	TDS	
1	250 ml	(F) or UF	HNO_3	DISS Mt	
1	250 ml	(F) or UF	HCl	Hg	
1	250 ml	F or (UF)	HNO_3	TOTAL Mt	
1	250 ml	F or (UF)	H_2SO_4	SO4	Mt's
1	250 ml	F or (UF)	NaOH	S	
1	500 ml	F or (UF)	H_3PO_4	Cl	
	ml	F or UF			

Comments: *Some additional csg has been added since construction; Pumped @ 0.25 gpm; drawdown SWL to 50'; pump set @ 50'; 12:28 12:28 13:10 well recov to 44.7; drawdown to 44.9' 13:13; pumped to 50.0; SWL 3 times = 3.5 gal; pumping @ <<0.10 gpm; SWL comes up or is steady

Sample Team Member Signature: [signature]

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15:06 47.6 → 46.6 = 15:10 ⇒ lft vacuum | 4 min.

Water Sampling Form ~~ HF-430

Hydrometrics, Inc.
Consulting Scientists and Engineers

Project Name: TRO4
Project Code:
Sample Team Member(s): LS/DK
Laboratory Used: ECL

Site Designation: MW 58
Sample Code Number:
Sample Date: 6/8/09
Sample Time: 12:15 (military)

If Duplicate Sample Collected, Please Record Below

Duplicate Sample Code #:
Duplicate Sample Time:

For Groundwater Samples

well volume formula: V = (TD-SWL)x(Dia.^{2}) / 25

		Comments
TD (ft):	~~60.18~~ 64.18	
SWL (ft):	~~50.40~~ 50.06	no access/pumping
Casing Diameter (I.D.")	2"	
Water Volume (V) (gal):	2.3	
x 3=(gal.)	6.8	
Actual Vol. Removed (gal.)		
Water Level Recovery:	slow moderate rapid	

Site Conditions

New Site: Yes No Photo taken: Yes No
Site Type: DRY surface water process water
monitoring well domestic well adit seep
spring– other:
Weather Conditions: calm breeze windy
no precip. rain snow
clear p. cloudy overcast
Air Temperature: °C °F

For Surface Water Samples

Flow Method: Marsh McBirney Volumetric Flume Weir Estimate
Other Flow or Description:
Flow: gpm cfs Staff Gage:

Field Parameter Stabilization

Time (military)	Oxidation Reduction Potential (mV)	Dissolved Oxygen (mg/l)	pH	S.C. (µmhos/cm)	Turbidity (n.t.u.)	Temperature (°C)	Additional Parameters or Notes

Turbidity: (circle) clear moderate slight very

Sample Method: (describe) grab composite pump (bailer) other

Field Parameters

	Sample	Duplicate
ORP (mV)	128.8	
DO (mg/l)	4.52	
pH	7.57	
SC (µmhos/cm)	532	
Turbidity (ntu)		
H_2O Tmp. (°C)	10.2	
Color	CLR	
Other:		

Bottles Collected

Quantity	Size	Filter or Unfilt.	Preservative	Parameter	Additional Notes
1	500 ml	F or (UF)	—	COND	Mt, [illegible] Fe
1	500 ml	F or (UF)	—	TDS	
1	250 ml	(F) or UF	HNO_3	DISS. Mt.	
1	250 ml	(F) or UF	HCl	Hg	
	250 ml	F or (UF)	HNO_3	TOT [illegible]	
1	250 ml	F or (UF)	H_2SO_4	SO_4	
1	250 ml	F or (UF)	H_2O_4	Sulfate	
1	500 ml	F or (UF)	H_2SO_4	Cr	
	ml	~~F or (UF)~~			

Comments: Bailed ~3.5 gal : SW → 54.00 : LET HRS SET OVERNIGHT → SWL [illegible] 0.05 after 1 bailer : BAILED TO ~51' - let set for 2.5 HOURS → NO RECOVERY : RUN PUMP → SWL @ 58.27 : TURN SAMPLE → SWL 59.27 WAIT 10 MIN SWL → 59.01

Sample Team Member Signature: [signature]

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Hydrometrics, Inc.

STANDARD OPERATING PROCEDURE
WATER SAMPLING FORM
HF-FORM-430

Consulting Scientists and Engineers

Site Designation: MW01-16
Sample Code Number:
Sample Date: 6/8/09
Sample Time: 12:50 (military)

Project Name: Roof
Project Code:
Sample Team Member(s): CS/RK
Laboratory Used:

If Duplicate Sample Collected, Please Record Below

Duplicate Sample Code #:
Duplicate Sample Time:

For Groundwater Samples

well volume formula: $V = \frac{(TD-SWL)x(Dia.^2)}{25}$

Comments

TD (ft): 42.88
SWL (ft): 742.88
no access/pumping
Casing Diameter (I.D.") 2"
Water Volume (V) (gal):
x 3=(gal.)
Actual Vol. Removed (gal.)
Water Level Recovery: slow moderate rapid

Site Conditions

New Site: Yes No
Photo taken: Yes No
Site Type: DRY surface water process water monitoring well domestic well adit seep spring other:

Weather Conditions: calm breeze windy no precip. rain snow clear p. cloudy overcast

Air Temperature: °C 53 °F

For Surface Water Samples

Flow Method: ~~Marsh-McBirney~~ Volumetric Flume Weir Estimate
Other Flow or Description:

Flow: gpm cfs Staff Gage:

Field Parameter Stabilization

Time (military)	Oxidation Reduction Potential (mV)	Dissolved Oxygen (mg/l)	pH	S.C. (µmhos/cm)	Turbidity (n.t.u.)	Temperature (°C)	Additional Parameters or Notes

Turbidity: (circle) clear moderate slight very

Sample Method: (describe) grab composite pump bailer other

Field Parameters

	Sample	Duplicate
ORP (mV)		
DO (mg/l)		
pH		
SC (µmhos/cm)		
Turbidity (ntu)		
H_2O Tmp. (°C)		
Color		
Other:		

Bottles Collected

Quantity	Size	Filter or Unfilt.	Preservative	Parameter	Additional Notes
	ml	F or UF			
	ml	F or UF			
	ml	F or UF			
	ml	F or UF			
	ml	F or UF			
	ml	F or UF			
	ml	F or UF			
	ml	F or UF			
	ml	F or UF			

NO SAMPLE

Comments: WELL DRY AT 42.88 - TD

Sample Team Member Signature: [signature]

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Water Sampling Form ~~ HF-430

Hydrometrics, Inc.
Consulting Scientists and Engineers

Project Name: Ral
Project Code:
Sample Team Member(s): L & PK
Laboratory Used: ECL

Site Designation: DECANT
Sample Code Number: —
Sample Date: 6/9/09
Sample Time: 0935 (military)

If Duplicate Sample Collected, Please Record Below

Duplicate Sample Code #:
Duplicate Sample Time:

For Groundwater Samples

well volume formula: $V = \frac{(TD-SWL)x(Dia.^2)}{25}$ — Comments

TD (ft):
SWL (ft): no access/pumping
Casing Diameter (I.D.")
Water Volume (V) (gal):
x 3=(gal.)
Actual Vol. Removed (gal.)
Water Level Recovery: slow moderate rapid

Site Conditions

New Site: Yes No Photo taken: Yes No
Site Type: DRY surface water process water
monitoring well domestic well adit seep
spring– other: DECANT POND
Weather Conditions: calm breeze windy
no precip. rain snow
clear p. cloudy overcast
Air Temperature: °C 60 °F

For Surface Water Samples

Flow Method: Marsh McBirney Volumetric Flume Weir Estimate
Other Flow or Description:
Flow: gpm cfs Staff Gage:

Field Parameter Stabilization

Time (military)	Oxidation Reduction Potential (mV)	Dissolved Oxygen (mg/l)	pH	S.C. (µmhos/cm)	Turbidity (n.t.u.)	Temperature (°C)	Additional Parameters or Notes

Turbidity: (circle) clear moderate slight very

Sample Method: (describe) grab composite pump bailer other

Field Parameters

	Sample	Duplicate
ORP (mV)	125.4	
DO (mg/l)	6.86	
pH	6.92	
SC (µmhos/cm)	442	
Turbidity (ntu)	—	
H_2O Tmp. (°C)	15.1	
Color	WHITE	
Other:		

Bottles Collected

Quantity	Size	Filter or Unfilt.	Preservative	Parameter	Additional Notes
1	500 ml	F or UF	—		COLLIFORM
1	500 ml	F or UF	—		TDS
1	250 ml	F or UF	HNO_3	DISS MET	
1	250 ml	F or UF	HCl	Hg	
1	250 ml	F or UF	HNO_3	TOTAL	MET
1	250 ml	F or UF	H_2SO_4	NUTS	
1	250 ml	F or UF	$NaOH$	S	
1	500 ml	F or UF	H_3PO_4	CN	
	ml	F or UF			

Comments: SAMPLE FROM PUMP DOCK - PUMPS NOT RUNNING

Sample Team Member Signature: [signature]

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5/5/2009/1:15 PM

Hydrometrics, Inc.
Consulting Scientists and Engineers

STANDARD OPERATING PROCEDURE
INSTRUMENT CALIBRATION FORM
HF-FORM-500

Project Name: TRCC/ MWE

Project Number:

Date: 6/3/09

Personnel: LJ / PK

Weather Conditions:

calm | breeze | windy
no precip | rain | snow
clear | p. cloudy | overcast

Air Temperature:
°F 50 °C

pH

Meter Type:
SN:

Time	Buffer	Temperature	Reading (Temp Corrected)
11:52	4	18.5	4.00
11:55	7	18.1	7.00
	10		
Calibration check:			

Dissolved Oxygen

Meter Type:
SN:
Time: 11:47
Calibration Results: 9.12 mg/L

Specific Conductance

Meter Type: SN:

Time	Standard	Temperature	Reading (Temp Corrected)	Cell Factor
11:54	14.13	18	14.13	
Calibration check:				

Redox Potential (Eh)

Meter Type:
SN:
Electrode: Ag/AgCl
Other:
Time: 12:02
ZoBell Solution Potential (mV): 220
Temperature: 16.7

Turbidity

Meter Type: SN:
Standard: Reading:

PID/FID

Meter Type: SN:
Span Gas Type:

Time	Span Gas		Calibration Memory	Response Factor	Reading
	Gauge Pressure	Concentration			
Calibration Check:					

Notes/Additional Information:

Hydrometrics, Inc.
Consulting Scientists and Engineers

STANDARD OPERATING PROCEDURE
INSTRUMENT CALIBRATION FORM
HF-FORM-500

Project Name: TRCI

Project Number:

Date: 6/9/09

Personnel: LS

Weather Conditions:

calm	breeze	windy
no precip	rain	snow
clear	p. cloudy	overcast

Air Temperature:
°F °C

Dissolved Oxygen

Meter Type:
SN:
Time: 0844
Calibration Results: 10:47

Redox Potential (Eh)

Meter Type:
SN:
Electrode: Ag/AgCl
Other:
Time: 0858
ZoBell Solution Potential (mV): 220
Temperature: 8.9

pH

Meter Type:
SN:

Time	Buffer	Temperature	Reading (Temp Corrected)
0848	4	8.9	4.00
0852	7	8.6	7.00
	10		
Calibration check:			

Specific Conductance

Meter Type: SN:

Time	Standard	Temperature	Reading (Temp Corrected)	Cell Factor
	1415			
0855	1413	8.7	1414	
Calibration check:				

Turbidity

Meter Type: SN:
Standard: Reading:

PID/FID

Meter Type: SN:
Span Gas Type:

Time	Span Gas		Calibration Memory	Response Factor	Reading
	Gauge Pressure	Concentration			
Calibration Check:					

Notes/Additional Information:

ENERGY LABORATORIES, INC. • P.O. Box 30916 • 1120 South 27th Street • Billings, MT 59107-0916
800-735-4489 • 406-252-6325 • 406-252-6069 fax • eli@energylab.com

ANALYTICAL SUMMARY REPORT

July 31, 2009

Paul Kukay
Genesis Inc Troy Mine
PO Box 1660
Troy, MT 59935-1660

Workorder No.: B09072237 Quote ID: B1850 - Troy Mine Geochemical Modeling

Project Name: Cu Attenuation Study-Scott Mason Hydrometrics

Energy Laboratories Inc received the following 4 samples for Genesis Inc Troy Mine on 7/24/2009 for analysis.

Sample ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
B09072237-001	MW-95-8	07/21/09 9:10	07/24/09	Aqueous	Metals by ICP/ICPMS, Dissolved Metals by ICP/ICPMS, Tot. Rec. Alkalinity Anions by ion chromatography Conductivity Carbon, Total Organic Mercury, Dissolved Field Parameters Fluoride Hardness as CaCO3 Iron, ferric Nitrogen, Ammonia Nitrogen, Nitrate + Nitrite pH Metals Preparation by EPA 200.2 Phosphorus, Orthophosphate as P Sodium Adsorption Ratio Solids, Total Dissolved Sulfide, Methylene Blue Colorimetric
B09072237-002	Decant Pond	07/21/09 10:15	07/24/09	Aqueous	Same As Above
B09072237-003	MW-01-15	07/21/09 12:50	07/24/09	Aqueous	Same As Above
B09072237-004	MW-00	07/21/09 13:10	07/24/09	Aqueous	Same As Above

Any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative.

If you have any questions regarding these tests results, please call.

Report Approved By:

ENERGY LABORATORIES, INC. • P.O. Box 30916 • 1120 South 27th Street • Billings, MT 59107-0916
800-735-4489 • 406-252-6325 • 406-252-6069 fax • eli@energylab.com

CLIENT: Genesis Inc Troy Mine
Project: Cu Attenuation Study-Scott Mason Hydrometrics
Sample Delivery Group: B09072237

Date: *31-Jul-09*

CASE NARRATIVE

Tests Associated with Analyst identified as ELI-CA were subcontracted to Energy Laboratories Casper Branch, EPA Number WY00002.

ENERGY LABORATORIES, INC. • P.O. Box 30916 • 1120 South 27th Street • Billings, MT 59107-0916
800-735-4489 • 406-252-6325 • 406-252-6069 fax • eli@energylab.com

LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study-Scott Mason Hydrometrics
Lab ID: B09072237-001
Client Sample ID: MW-95-8

Report Date: 07/31/09
Collection Date: 07/21/09 09:10
DateReceived: 07/24/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL PROPERTIES							
pH	7.7	s.u.		0.1		A4500-H B	07/24/09 13:17 / nlh
Conductivity	534	umhos/cm		1		A2510 B	07/24/09 13:17 / nlh
Solids, Total Dissolved TDS @ 180 C	346	mg/L		10		A2540 C	07/24/09 15:41 / afb
INORGANICS							
Alkalinity, Total as CaCO3	139	mg/L		4		A2320 B	07/24/09 16:11 / ehb
Bicarbonate as HCO3	169	mg/L		4		A2320 B	07/24/09 16:11 / ehb
Carbonate as CO3	ND	mg/L		4		A2320 B	07/24/09 16:11 / ehb
Chloride	4	mg/L		1		E300.0	07/27/09 18:07 / kh
Sulfate	41	mg/L		1		E300.0	07/27/09 18:07 / kh
Fluoride	0.1	mg/L		0.1		A4500-F C	07/24/09 16:11 / ehb
Sulfide	ND	mg/L		0.04		A4500 S-D	07/24/09 12:15 / afb
Hardness as CaCO3	204	mg/L		1		A2340 B	07/27/09 11:58 / rls
Sodium Adsorption Ratio (SAR)	0.78			0.01		Calculation	07/27/09 11:58 / rls
AGGREGATE ORGANICS (CONTRACT LAB WY00002)							
Organic Carbon, Total (TOC)	ND	mg/L		0.5		A5310 C	07/28/09 15:58 / eli-ca
NUTRIENTS							
Nitrogen, Ammonia as N	ND	mg/L		0.05		E350.1	07/24/09 15:18 / sam
Nitrogen, Nitrate+Nitrite as N	22.1	mg/L	D	0.03		E353.2	07/24/09 14:28 / bls
Phosphorus, Orthophosphate as P	ND	mg/L	LH	0.005		E365.1	07/24/09 12:22 / sam
- The sample was received after the holding time had expired for Ortho Phosphate.							
METALS - DISSOLVED							
Mercury	ND	ng/L		5.0		E245.7	07/30/09 15:08 / eli-ca
METALS, DISSOLVED							
Aluminum	ND	mg/L		0.03		E200.8	07/27/09 21:03 / jjw
Antimony	ND	mg/L		0.003		E200.8	07/27/09 21:03 / jjw
Arsenic	ND	mg/L		0.001		E200.8	07/27/09 21:03 / jjw
Barium	0.135	mg/L		0.005		E200.7	07/27/09 11:58 / tao
Beryllium	ND	mg/L		0.001		E200.7	07/27/09 11:58 / tao
Cadmium	0.00148	mg/L		0.00008		E200.8	07/27/09 21:03 / jjw
Calcium	68	mg/L		1		E200.7	07/27/09 11:58 / tao
Chromium	ND	mg/L		0.001		E200.8	07/27/09 21:03 / jjw
Copper	0.007	mg/L		0.001		E200.8	07/27/09 21:03 / jjw
Iron	ND	mg/L		0.05		E200.7	07/27/09 11:58 / tao
Iron, Ferrous	ND	mg/L		0.05		E200.7	07/27/09 11:58 / tao
Lead	ND	mg/L		0.0005		E200.8	07/27/09 21:03 / jjw
Magnesium	8	mg/L		1		E200.7	07/27/09 11:58 / tao
Manganese	ND	mg/L		0.005		E200.7	07/27/09 11:58 / tao

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
L - Lowest available reporting limit for the analytical method used.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
H - Analysis performed past recommended holding time.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study-Scott Mason Hydrometrics
Lab ID: B09072237-001
Client Sample ID: MW-95-8

Report Date: 07/31/09
Collection Date: 07/21/09 09:10
DateReceived: 07/24/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, DISSOLVED							
Nickel	ND	mg/L		0.01		E200.7	07/27/09 11:58 / tao
Potassium	8	mg/L		1		E200.7	07/27/09 11:58 / tao
Selenium	0.002	mg/L		0.001		E200.8	07/27/09 21:03 / jjw
Silicon	5.4	mg/L		0.1		E200.7	07/27/09 11:58 / tao
Silica	11.7	mg/L		0.2		E200.7	07/27/09 11:58 / tao
Silver	ND	mg/L		0.0005		E200.8	07/27/09 21:03 / jjw
Sodium	26	mg/L		1		E200.7	07/27/09 11:58 / tao
Thallium	ND	mg/L		0.0002		E200.8	07/27/09 21:03 / jjw
Uranium	0.0005	mg/L		0.0003		E200.8	07/27/09 21:03 / jjw
Zinc	ND	mg/L		0.01		E200.7	07/27/09 11:58 / tao
METALS, TOTAL							
Iron, Ferric	6.94	mg/L		0.05		Calculation	07/29/09 16:23 / mep
METALS, TOTAL RECOVERABLE							
Iron	6.94	mg/L		0.05		E200.8	07/27/09 21:10 / jjw
FIELD PARAMETERS							
Field pH, su	6.85	s.u.				FIELD	07/21/09 09:10 / ---
Field Temperature, C	10.32	C				FIELD	07/21/09 09:10 / ---

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study-Scott Mason Hydrometrics
Lab ID: B09072237-002
Client Sample ID: Decant Pond

Report Date: 07/31/09
Collection Date: 07/21/09 10:15
DateReceived: 07/24/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL PROPERTIES							
pH	8.0	s.u.		0.1		A4500-H B	07/24/09 13:22 / nlh
Conductivity	398	umhos/cm		1		A2510 B	07/24/09 13:22 / nlh
Solids, Total Dissolved TDS @ 180 C	255	mg/L		10		A2540 C	07/24/09 15:40 / afb
INORGANICS							
Alkalinity, Total as CaCO3	81	mg/L		4		A2320 B	07/24/09 16:36 / ehb
Bicarbonate as HCO3	99	mg/L		4		A2320 B	07/24/09 16:36 / ehb
Carbonate as CO3	ND	mg/L		4		A2320 B	07/24/09 16:36 / ehb
Chloride	4	mg/L		1		E300.0	07/27/09 18:19 / kh
Sulfate	42	mg/L		1		E300.0	07/27/09 18:19 / kh
Fluoride	0.2	mg/L		0.1		A4500-F C	07/24/09 16:36 / ehb
Sulfide	ND	mg/L		0.04		A4500 S-D	07/24/09 12:15 / afb
Hardness as CaCO3	76	mg/L		1		A2340 B	07/27/09 12:05 / rls
Sodium Adsorption Ratio (SAR)	1.34			0.01		Calculation	07/27/09 12:05 / rls
AGGREGATE ORGANICS (CONTRACT LAB WY00002)							
Organic Carbon, Total (TOC)	0.9	mg/L		0.5		A5310 C	07/28/09 16:09 / eli-ca
NUTRIENTS							
Nitrogen, Ammonia as N	3.14	mg/L		0.05		E350.1	07/24/09 15:19 / sam
Nitrogen, Nitrate+Nitrite as N	13.6	mg/L	D	0.03		E353.2	07/24/09 14:29 / bls
Phosphorus, Orthophosphate as P	0.006	mg/L	LH	0.005		E365.1	07/24/09 12:23 / sam
- The sample was received after the holding time had expired for Ortho Phosphate.							
METALS - DISSOLVED							
Mercury	ND	ng/L		5.0		E245.7	07/30/09 15:10 / eli-ca
METALS, DISSOLVED							
Aluminum	ND	mg/L		0.03		E200.7	07/27/09 12:05 / tao
Antimony	0.062	mg/L		0.003		E200.8	07/27/09 21:17 / jjw
Arsenic	0.005	mg/L		0.001		E200.8	07/27/09 21:17 / jjw
Barium	0.111	mg/L		0.005		E200.7	07/27/09 12:05 / tao
Beryllium	ND	mg/L		0.001		E200.7	07/27/09 12:05 / tao
Cadmium	0.00097	mg/L		0.00008		E200.8	07/27/09 21:17 / jjw
Calcium	22	mg/L		1		E200.7	07/27/09 12:05 / tao
Chromium	ND	mg/L		0.001		E200.8	07/27/09 21:17 / jjw
Copper	0.013	mg/L		0.001		E200.8	07/27/09 21:17 / jjw
Iron	ND	mg/L		0.05		E200.7	07/27/09 12:05 / tao
Iron, Ferrous	ND	mg/L		0.05		E200.7	07/27/09 12:05 / tao
Lead	ND	mg/L		0.0005		E200.8	07/27/09 21:17 / jjw
Magnesium	5	mg/L		1		E200.7	07/27/09 12:05 / tao
Manganese	0.209	mg/L		0.005		E200.7	07/27/09 12:05 / tao

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
L - Lowest available reporting limit for the analytical method used.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
H - Analysis performed past recommended holding time.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study-Scott Mason Hydrometrics
Lab ID: B09072237-002
Client Sample ID: Decant Pond

Report Date: 07/31/09
Collection Date: 07/21/09 10:15
DateReceived: 07/24/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, DISSOLVED							
Nickel	ND	mg/L		0.01		E200.7	07/27/09 12:05 / tao
Potassium	26	mg/L		1		E200.7	07/27/09 12:05 / tao
Selenium	0.002	mg/L		0.001		E200.8	07/27/09 21:17 / jjw
Silicon	6.3	mg/L		0.1		E200.7	07/27/09 12:05 / tao
Silica	13.5	mg/L		0.2		E200.7	07/27/09 12:05 / tao
Silver	ND	mg/L		0.0005		E200.8	07/27/09 21:17 / jjw
Sodium	27	mg/L		1		E200.7	07/27/09 12:05 / tao
Thallium	ND	mg/L		0.0002		E200.8	07/27/09 21:17 / jjw
Uranium	0.0029	mg/L		0.0003		E200.8	07/27/09 21:17 / jjw
Zinc	ND	mg/L		0.01		E200.7	07/27/09 12:05 / tao
METALS, TOTAL							
Iron, Ferric	0.55	mg/L		0.05		Calculation	07/29/09 16:23 / mep
METALS, TOTAL RECOVERABLE							
Iron	0.55	mg/L		0.05		E200.7	07/28/09 17:30 / tao
FIELD PARAMETERS							
Field pH, su	7.66	s.u.				FIELD	07/21/09 10:15 / ---
Field Temperature, C	20.9	C				FIELD	07/21/09 10:15 / ---

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study-Scott Mason Hydrometrics
Lab ID: B09072237-003
Client Sample ID: MW-01-15

Report Date: 07/31/09
Collection Date: 07/21/09 12:50
DateReceived: 07/24/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL PROPERTIES							
pH	7.3	s.u.		0.1		A4500-H B	07/24/09 13:24 / nlh
Conductivity	418	umhos/cm		1		A2510 B	07/24/09 13:24 / nlh
Solids, Total Dissolved TDS @ 180 C	239	mg/L		10		A2540 C	07/24/09 15:40 / afb
INORGANICS							
Alkalinity, Total as CaCO3	95	mg/L		4		A2320 B	07/24/09 16:44 / ehb
Bicarbonate as HCO3	115	mg/L		4		A2320 B	07/24/09 16:44 / ehb
Carbonate as CO3	ND	mg/L		4		A2320 B	07/24/09 16:44 / ehb
Chloride	4	mg/L		1		E300.0	07/27/09 18:54 / kh
Sulfate	41	mg/L		1		E300.0	07/27/09 18:54 / kh
Fluoride	0.2	mg/L		0.1		A4500-F C	07/24/09 16:44 / ehb
Sulfide	ND	mg/L		0.04		A4500 S-D	07/24/09 12:15 / afb
Hardness as CaCO3	82	mg/L		1		A2340 B	07/27/09 12:09 / rls
Sodium Adsorption Ratio (SAR)	1.49			0.01		Calculation	07/27/09 12:09 / rls
AGGREGATE ORGANICS (CONTRACT LAB WY00002)							
Organic Carbon, Total (TOC)	0.9	mg/L		0.5		A5310 C	07/28/09 16:19 / eli-ca
NUTRIENTS							
Nitrogen, Ammonia as N	3.19	mg/L		0.05		E350.1	07/24/09 15:20 / sam
Nitrogen, Nitrate+Nitrite as N	14.1	mg/L	D	0.03		E353.2	07/24/09 14:30 / bls
Phosphorus, Orthophosphate as P	0.010	mg/L	LH	0.005		E365.1	07/24/09 12:24 / sam
- The sample was received after the holding time had expired for Ortho Phosphate.							
METALS - DISSOLVED							
Mercury	ND	ng/L		5.0		E245.7	07/30/09 15:12 / eli-ca
METALS, DISSOLVED							
Aluminum	ND	mg/L		0.03		E200.7	07/27/09 12:09 / tao
Antimony	0.026	mg/L		0.003		E200.8	07/27/09 21:31 / jjw
Arsenic	ND	mg/L		0.001		E200.8	07/27/09 21:31 / jjw
Barium	0.106	mg/L		0.005		E200.7	07/27/09 12:09 / tao
Beryllium	ND	mg/L		0.001		E200.7	07/27/09 12:09 / tao
Cadmium	0.00193	mg/L		0.00008		E200.8	07/27/09 21:31 / jjw
Calcium	25	mg/L		1		E200.7	07/27/09 12:09 / tao
Chromium	0.002	mg/L		0.001		E200.8	07/27/09 21:31 / jjw
Copper	0.007	mg/L		0.001		E200.8	07/27/09 21:31 / jjw
Iron	0.06	mg/L		0.05		E200.7	07/27/09 12:09 / tao
Iron, Ferrous	0.06	mg/L		0.05		E200.7	07/27/09 12:09 / tao
Lead	ND	mg/L		0.0005		E200.8	07/27/09 21:31 / jjw
Magnesium	5	mg/L		1		E200.7	07/27/09 12:09 / tao
Manganese	0.491	mg/L		0.005		E200.7	07/27/09 12:09 / tao

Report Definitions:

RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
L - Lowest available reporting limit for the analytical method used.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
H - Analysis performed past recommended holding time.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study-Scott Mason Hydrometrics
Lab ID: B09072237-003
Client Sample ID: MW-01-15

Report Date: 07/31/09
Collection Date: 07/21/09 12:50
DateReceived: 07/24/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, DISSOLVED							
Nickel	0.01	mg/L		0.01		E200.7	07/27/09 12:09 / tao
Potassium	22	mg/L		1		E200.7	07/27/09 12:09 / tao
Selenium	0.002	mg/L		0.001		E200.8	07/27/09 21:31 / jjw
Silicon	5.8	mg/L		0.1		E200.7	07/27/09 12:09 / tao
Silica	12.3	mg/L		0.2		E200.7	07/27/09 12:09 / tao
Silver	ND	mg/L		0.0005		E200.8	07/27/09 21:31 / jjw
Sodium	31	mg/L		1		E200.7	07/27/09 12:09 / tao
Thallium	ND	mg/L		0.0002		E200.8	07/27/09 21:31 / jjw
Uranium	0.0020	mg/L		0.0003		E200.8	07/27/09 21:31 / jjw
Zinc	ND	mg/L		0.01		E200.7	07/27/09 12:09 / tao
METALS, TOTAL							
Iron, Ferric	6.40	mg/L		0.05		Calculation	07/29/09 16:23 / mep
METALS, TOTAL RECOVERABLE							
Iron	6.46	mg/L		0.05		E200.8	07/27/09 22:05 / jjw
FIELD PARAMETERS							
Field pH, su	7.21	s.u.				FIELD	07/21/09 12:50 / ---
Field Temperature, C	22.1	C				FIELD	07/21/09 12:50 / ---

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study-Scott Mason Hydrometrics
Lab ID: B09072237-004
Client Sample ID: MW-00 duplicate of MW-01-15

Report Date: 07/31/09
Collection Date: 07/21/09 13:10
DateReceived: 07/24/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL PROPERTIES							
pH	7.4	s.u.		0.1		A4500-H B	07/24/09 13:26 / nlh
Conductivity	414	umhos/cm		1		A2510 B	07/24/09 13:26 / nlh
Solids, Total Dissolved TDS @ 180 C	248	mg/L		10		A2540 C	07/24/09 15:44 / afb
INORGANICS							
Alkalinity, Total as CaCO3	94	mg/L		4		A2320 B	07/24/09 16:52 / ehb
Bicarbonate as HCO3	115	mg/L		4		A2320 B	07/24/09 16:52 / ehb
Carbonate as CO3	ND	mg/L		4		A2320 B	07/24/09 16:52 / ehb
Chloride	4	mg/L		1		E300.0	07/27/09 19:05 / kh
Sulfate	42	mg/L		1		E300.0	07/27/09 19:05 / kh
Fluoride	0.2	mg/L		0.1		A4500-F C	07/24/09 16:52 / ehb
Sulfide	ND	mg/L		0.04		A4500 S-D	07/24/09 12:15 / afb
Hardness as CaCO3	86	mg/L		1		A2340 B	07/27/09 12:37 / rls
Sodium Adsorption Ratio (SAR)	1.43			0.01		Calculation	07/27/09 12:37 / rls
AGGREGATE ORGANICS (CONTRACT LAB WY00002)							
Organic Carbon, Total (TOC)	0.7	mg/L		0.5		A5310 C	07/28/09 16:29 / eli-ca
NUTRIENTS							
Nitrogen, Ammonia as N	3.12	mg/L		0.05		E350.1	07/24/09 15:22 / sam
Nitrogen, Nitrate+Nitrite as N	12.8	mg/L	D	0.03		E353.2	07/24/09 14:31 / bls
Phosphorus, Orthophosphate as P	0.012	mg/L	LH	0.005		E365.1	07/24/09 12:25 / sam
- The sample was received after the holding time had expired for Ortho Phosphate.							
METALS - DISSOLVED							
Mercury	ND	ng/L		5.0		E245.7	07/30/09 15:14 / eli-ca
METALS, DISSOLVED							
Aluminum	ND	mg/L		0.03		E200.7	07/27/09 12:37 / tao
Antimony	0.026	mg/L		0.003		E200.8	07/28/09 12:50 / jjw
Arsenic	ND	mg/L		0.001		E200.8	07/28/09 12:50 / jjw
Barium	0.115	mg/L		0.005		E200.7	07/27/09 12:37 / tao
Beryllium	ND	mg/L		0.001		E200.7	07/27/09 12:37 / tao
Cadmium	0.00137	mg/L		0.00008		E200.8	07/28/09 12:50 / jjw
Calcium	26	mg/L		1		E200.7	07/27/09 12:37 / tao
Chromium	0.003	mg/L		0.001		E200.8	07/28/09 12:50 / jjw
Copper	0.012	mg/L		0.001		E200.8	07/28/09 12:50 / jjw
Iron	0.06	mg/L		0.05		E200.7	07/27/09 12:37 / tao
Iron, Ferrous	0.06	mg/L		0.05		E200.7	07/27/09 12:37 / tao
Lead	0.0014	mg/L		0.0005		E200.8	07/27/09 22:12 / jjw
Magnesium	5	mg/L		1		E200.7	07/27/09 12:37 / tao
Manganese	0.516	mg/L		0.005		E200.7	07/27/09 12:37 / tao

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
L - Lowest available reporting limit for the analytical method used.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
H - Analysis performed past recommended holding time.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study-Scott Mason Hydrometrics
Lab ID: B09072237-004
Client Sample ID: MW-00

Report Date: 07/31/09
Collection Date: 07/21/09 13:10
DateReceived: 07/24/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, DISSOLVED							
Nickel	0.01	mg/L		0.01		E200.7	07/27/09 12:37 / tao
Potassium	23	mg/L		1		E200.7	07/27/09 12:37 / tao
Selenium	0.002	mg/L		0.001		E200.8	07/27/09 22:12 / jjw
Silicon	6.1	mg/L		0.1		E200.7	07/27/09 12:37 / tao
Silica	13.1	mg/L		0.2		E200.7	07/27/09 12:37 / tao
Silver	ND	mg/L		0.0005		E200.8	07/28/09 12:50 / jjw
Sodium	31	mg/L		1		E200.7	07/27/09 12:37 / tao
Thallium	ND	mg/L		0.0002		E200.8	07/27/09 22:12 / jjw
Uranium	0.0021	mg/L		0.0003		E200.8	07/27/09 22:12 / jjw
Zinc	ND	mg/L		0.01		E200.7	07/27/09 12:37 / tao
METALS, TOTAL							
Iron, Ferric	1.87	mg/L		0.05		Calculation	07/29/09 16:23 / mep
METALS, TOTAL RECOVERABLE							
Iron	1.93	mg/L		0.05		E200.8	07/27/09 22:19 / jjw
FIELD PARAMETERS							
Field pH, su	7.28	s.u.				FIELD	07/21/09 13:10 / ---
Field Temperature, C	18.56	C				FIELD	07/21/09 13:10 / ---

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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QA/QC Summary Report

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study-Scott Mason Hydrometrics

Report Date: 07/31/09
Work Order: B09072237

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: A2320 B									Batch: R133312
Sample ID: MB	Method Blank				Run: MAN-TECH_090724B				07/24/09 15:11
Alkalinity, Total as CaCO3	ND	mg/L	4						
Bicarbonate as HCO3	ND	mg/L	4						
Carbonate as CO3	ND	mg/L	4						
Sample ID: LCS	Laboratory Control Sample				Run: MAN-TECH_090724B				07/24/09 15:17
Alkalinity, Total as CaCO3	97.4	mg/L	4.0	97	90	110			
Sample ID: B09072237-001AMS	Sample Matrix Spike				Run: MAN-TECH_090724B				07/24/09 16:19
Alkalinity, Total as CaCO3	262	mg/L	4.0	93	80	120			
Sample ID: B09072237-001AMSD	Sample Matrix Spike Duplicate				Run: MAN-TECH_090724B				07/24/09 16:28
Alkalinity, Total as CaCO3	256	mg/L	4.0	88	80	120	2.5	20	
Method: A2510 B									Batch: R133226
Sample ID: SC 150	Laboratory Control Sample				Run: PHSC _101-B_090724A				07/24/09 09:00
Conductivity	156	umhos/cm	1.0	104	90	110			
Sample ID: SC 5000	Laboratory Control Sample				Run: PHSC _101-B_090724A				07/24/09 09:02
Conductivity	4930	umhos/cm	1.0	99	90	110			
Sample ID: B09072235-002ADUP	Sample Duplicate				Run: PHSC _101-B_090724A				07/24/09 13:20
Conductivity	472	umhos/cm	1.0				1.1	10	
Method: A2540 C									Batch: TDS090724B
Sample ID: MBLK3	Method Blank				Run: CPA124S_090724B				07/24/09 15:38
Solids, Total Dissolved TDS @ 180 C	ND	mg/L	10						
Sample ID: LFB3	Laboratory Fortified Blank				Run: CPA124S_090724B				07/24/09 15:39
Solids, Total Dissolved TDS @ 180 C	1100	mg/L	10	99	90	110			
Sample ID: B09072237-001A MS	Sample Matrix Spike				Run: CPA124S_090724B				07/24/09 15:42
Solids, Total Dissolved TDS @ 180 C	2350	mg/L	10	101	80	120			
Sample ID: B09072237-001A MSD	Sample Matrix Spike Duplicate				Run: CPA124S_090724B				07/24/09 15:42
Solids, Total Dissolved TDS @ 180 C	2360	mg/L	10	101	80	120	0.5	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

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QA/QC Summary Report

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study-Scott Mason Hydrometrics

Report Date: 07/31/09
Work Order: B09072237

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: A4500 S-D								Analytical Run: SPEC_090724A	
Sample ID: ICV1_090724A	Initial Calibration Verification Standard							07/24/09 09:00	
Sulfide	0.190	mg/L	0.040	95	90	110			
Method: A4500 S-D								Batch: 090724A-SULFIDE-MB-W	
Sample ID: B09072120-001DMS	Sample Matrix Spike				Run: SPEC_090724A			07/24/09 09:00	
Sulfide	0.192	mg/L	0.040	82	70	130			
Sample ID: B09072120-001DMSD	Sample Matrix Spike Duplicate				Run: SPEC_090724A			07/24/09 09:00	
Sulfide	0.195	mg/L	0.040	84	70	130	1.8	30	
Sample ID: MBLK1_090724A	Method Blank				Run: SPEC_090724A			07/24/09 09:00	
Sulfide	ND	mg/L	0.02						
Sample ID: LFB1_090724A	Laboratory Fortified Blank				Run: SPEC_090724A			07/24/09 09:00	
Sulfide	0.190	mg/L	0.040	93	70	130			
Method: A4500-F C								Analytical Run: MAN-TECH_090724B	
Sample ID: ICV	Initial Calibration Verification Standard							07/24/09 15:30	
Fluoride	1.01	mg/L	0.10	101	90	110			
Method: A4500-F C								Batch: R133312	
Sample ID: MB	Method Blank				Run: MAN-TECH_090724B			07/24/09 15:24	
Fluoride	ND	mg/L	0.05						
Sample ID: LFB	Laboratory Fortified Blank				Run: MAN-TECH_090724B			07/24/09 15:27	
Fluoride	0.960	mg/L	0.10	96	90	110			
Sample ID: B09072237-001AMS	Sample Matrix Spike				Run: MAN-TECH_090724B			07/24/09 16:19	
Fluoride	1.08	mg/L	0.10	97	80	120			
Sample ID: B09072237-001AMSD	Sample Matrix Spike Duplicate				Run: MAN-TECH_090724B			07/24/09 16:28	
Fluoride	1.07	mg/L	0.10	96	80	120	0.9	10	
Method: A4500-H B								Batch: R133226	
Sample ID: pH 4	Laboratory Control Sample				Run: PHSC _101-B_090724A			07/24/09 08:56	
pH	4.06	s.u.	0.10	101	97	103			
Sample ID: pH 7	Laboratory Control Sample				Run: PHSC _101-B_090724A			07/24/09 08:57	
pH	7.08	s.u.	0.10	101	98	102			
Sample ID: B09072235-002ADUP	Sample Duplicate				Run: PHSC _101-B_090724A			07/24/09 13:20	
pH	7.91	s.u.	0.10				0.3	10	

Qualifiers:

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QA/QC Summary Report

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study-Scott Mason Hydrometrics

Report Date: 07/31/09
Work Order: B09072237

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: A5310 C								Analytical Run: SUB-C121564	
Sample ID: ICV-23206	Initial Calibration Verification Standard							07/28/09 09:44	
Organic Carbon, Dissolved (DOC)	10.4	mg/L	0.10	104	90	110			
Method: A5310 C								Batch: C_R121564	
Sample ID: MBLK	Method Blank				Run: SUB-C121564			07/28/09 15:00	
Organic Carbon, Total (TOC)	0.05	mg/L	0.04						
Sample ID: C09070914-002AMS	Sample Matrix Spike				Run: SUB-C121564			07/28/09 16:40	
Organic Carbon, Total (TOC)	9.10	mg/L	0.50	98	85	115			
Sample ID: C09070914-002AMSD	Sample Matrix Spike Duplicate				Run: SUB-C121564			07/28/09 16:51	
Organic Carbon, Total (TOC)	9.25	mg/L	0.50	101	85	115	1.7	10	
Sample ID: LCS-5085	Laboratory Control Sample				Run: SUB-C121564			07/28/09 17:02	
Organic Carbon, Total (TOC)	10.1	mg/L	0.50	100	90	110			
Method: E245.7								Batch: C_23241	
Sample ID: QCS-23241	Quality Control Sample				Run: SUB-C121686			07/30/09 14:16	
Mercury	22.8	ng/L	5.0	91	90	110			
Sample ID: MB-23241	Method Blank				Run: SUB-C121686			07/30/09 14:31	
Mercury	1	ng/L	1						
Sample ID: LCS-23241	Laboratory Control Sample				Run: SUB-C121686			07/30/09 14:34	
Mercury	22.9	ng/L	5.0	87	85	115			
Sample ID: C09070682-001CMS	Sample Matrix Spike				Run: SUB-C121686			07/30/09 14:44	
Mercury	13.6	ng/L	5.0	112	63	111			S
Sample ID: C09070682-001CMSD	Sample Matrix Spike Duplicate				Run: SUB-C121686			07/30/09 14:46	
Mercury	12.8	ng/L	5.0	104	63	111	6.1	18	

Qualifiers:

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ND - Not detected at the reporting limit.

S - Spike recovery outside of advisory limits.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study (Scott Mason, Hydrometrics)
Lab ID: B09061251-001
Client Sample ID: MW-01-15

Report Date: 06/22/09
Collection Date: 06/08/09 17:00
DateReceived: 06/12/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL PROPERTIES							
pH	7.5	s.u.		0.1		A4500-H B	06/12/09 12:17 / kh
Conductivity	405	umhos/cm		1		A2510 B	06/12/09 12:17 / kh
Solids, Total Dissolved TDS @ 180 C	247	mg/L		10		A2540 C	06/12/09 16:23 / afb
INORGANICS							
Alkalinity, Total as CaCO3	85	mg/L		4		A2320 B	06/12/09 17:22 / ehb
Bicarbonate as HCO3	104	mg/L		4		A2320 B	06/12/09 17:22 / ehb
Carbonate as CO3	ND	mg/L		4		A2320 B	06/12/09 17:22 / ehb
Chloride	4	mg/L		1		E300.0	06/15/09 16:31 / kh
Sulfate	41	mg/L		1		E300.0	06/15/09 16:31 / kh
Fluoride	0.3	mg/L		0.1		A4500-F C	06/15/09 15:32 / ehb
Sulfide	ND	mg/L		0.04		A4500 S-D	06/15/09 09:30 / afb
Hardness as CaCO3	78	mg/L		1		A2340 B	06/15/09 13:02 / rls
Sodium Adsorption Ratio (SAR)	1.57			0.01		Calculation	06/15/09 13:02 / rls
AGGREGATE ORGANICS (CONTRACT LAB WY00002)							
Organic Carbon, Total (TOC)	0.8	mg/L		0.5		A5310 C	06/17/09 11:37 / eli-ca
NUTRIENTS							
Nitrogen, Ammonia as N	3.64	mg/L		0.05		E350.1	06/13/09 12:43 / sam
Nitrogen, Nitrate+Nitrite as N	14.5	mg/L	D	0.02		E353.2	06/15/09 14:28 / bls
Phosphorus, Orthophosphate as P	0.025	mg/L	LH	0.005		E365.1	06/13/09 13:56 / mlm
METALS - DISSOLVED							
Mercury	ND	ng/L		10		E245.7	06/19/09 11:32 / eli-ca
METALS, DISSOLVED							
Aluminum	ND	mg/L		0.03		E200.7	06/15/09 13:02 / tao
Antimony	0.029	mg/L		0.003		E200.8	06/15/09 20:43 / jjw
Arsenic	ND	mg/L		0.001		E200.8	06/15/09 20:43 / jjw
Barium	0.107	mg/L		0.005		E200.7	06/15/09 13:02 / tao
Beryllium	ND	mg/L		0.001		E200.7	06/15/09 13:02 / tao
Cadmium	0.00136	mg/L		0.00008		E200.8	06/15/09 20:43 / jjw
Calcium	23	mg/L		1		E200.7	06/15/09 13:02 / tao
Chromium	ND	mg/L		0.001		E200.8	06/15/09 20:43 / jjw
Copper	0.009	mg/L		0.001		E200.8	06/15/09 20:43 / jjw
Iron	ND	mg/L		0.05		E200.7	06/15/09 13:02 / tao
Iron, Ferrous	ND	mg/L		0.05		E200.7	06/15/09 13:02 / tao
Lead	ND	mg/L		0.0005		E200.8	06/15/09 20:43 / jjw
Magnesium	5	mg/L		1		E200.7	06/15/09 13:02 / tao
Manganese	0.467	mg/L		0.005		E200.7	06/15/09 13:02 / tao
Nickel	ND	mg/L		0.01		E200.7	06/15/09 13:02 / tao

Report Definitions:

RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
L - Lowest available reporting limit for the analytical method used.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
H - Analysis performed past recommended holding time.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study (Scott Mason, Hydrometrics)
Lab ID: B09061251-001
Client Sample ID: MW-01-15

Report Date: 06/22/09
Collection Date: 06/08/09 17:00
DateReceived: 06/12/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, DISSOLVED							
Potassium	23	mg/L		1		E200.7	06/15/09 13:02 / tao
Selenium	0.002	mg/L		0.001		E200.8	06/15/09 20:43 / jjw
Silicon	5.3	mg/L		0.1		E200.7	06/15/09 13:02 / tao
Silica	11.4	mg/L		0.2		E200.7	06/15/09 13:02 / tao
Silver	ND	mg/L		0.0005		E200.8	06/15/09 20:43 / jjw
Sodium	32	mg/L		1		E200.7	06/15/09 13:02 / tao
Thallium	ND	mg/L		0.0002		E200.8	06/15/09 20:43 / jjw
Uranium	0.0018	mg/L		0.0003		E200.8	06/15/09 20:43 / jjw
Zinc	ND	mg/L		0.01		E200.7	06/15/09 13:02 / tao
METALS, TOTAL							
Iron, Ferric	0.17	mg/L		0.03		Calculation	06/18/09 10:52 / mep
METALS, TOTAL RECOVERABLE							
Iron	0.17	mg/L		0.05		E200.7	06/15/09 22:47 / tao
FIELD PARAMETERS							
Field pH, su	7.3	s.u.				FIELD	06/08/09 17:00 / ---
Field Temperature, C	14.1	C				FIELD	06/08/09 17:00 / ---

Report Definitions:
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MCL - Maximum contaminant level.
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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study (Scott Mason, Hydrometrics)
Lab ID: B09061251-002
Client Sample ID: Decant Pond

Report Date: 06/22/09
Collection Date: 06/09/09 09:35
DateReceived: 06/12/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL PROPERTIES							
pH	8.0	s.u.		0.1		A4500-H B	06/12/09 12:19 / kh
Conductivity	411	umhos/cm		1		A2510 B	06/12/09 12:19 / kh
Solids, Total Dissolved TDS @ 180 C	300	mg/L		10		A2540 C	06/12/09 16:25 / afb
INORGANICS							
Alkalinity, Total as CaCO3	83	mg/L		4		A2320 B	06/12/09 17:31 / ehb
Bicarbonate as HCO3	101	mg/L		4		A2320 B	06/12/09 17:31 / ehb
Carbonate as CO3	ND	mg/L		4		A2320 B	06/12/09 17:31 / ehb
Chloride	4	mg/L		1		E300.0	06/15/09 16:42 / kh
Sulfate	45	mg/L		1		E300.0	06/15/09 16:42 / kh
Fluoride	0.2	mg/L		0.1		A4500-F C	06/15/09 15:35 / ehb
Sulfide	ND	mg/L		0.04		A4500 S-D	06/15/09 09:30 / afb
Hardness as CaCO3	73	mg/L		1		A2340 B	06/15/09 13:10 / rls
Sodium Adsorption Ratio (SAR)	1.51			0.01		Calculation	06/15/09 13:10 / rls
AGGREGATE ORGANICS (CONTRACT LAB WY00002)							
Organic Carbon, Total (TOC)	1.2	mg/L		0.5		A5310 C	06/17/09 11:48 / eli-ca
NUTRIENTS							
Nitrogen, Ammonia as N	4.4	mg/L	D	0.1		E350.1	06/13/09 12:44 / sam
Nitrogen, Nitrate+Nitrite as N	14.5	mg/L	D	0.03		E353.2	06/15/09 12:40 / bls
Phosphorus, Orthophosphate as P	0.083	mg/L	LH	0.005		E365.1	06/13/09 13:59 / mlm
METALS - DISSOLVED							
Mercury	ND	ng/L		10		E245.7	06/19/09 11:38 / eli-ca
METALS, DISSOLVED							
Aluminum	0.18	mg/L		0.03		E200.7	06/15/09 13:10 / tao
Antimony	0.050	mg/L		0.003		E200.8	06/15/09 20:51 / jjw
Arsenic	0.002	mg/L		0.001		E200.8	06/15/09 20:51 / jjw
Barium	0.117	mg/L		0.005		E200.7	06/15/09 13:10 / tao
Beryllium	ND	mg/L		0.001		E200.7	06/15/09 13:10 / tao
Cadmium	0.00126	mg/L		0.00008		E200.8	06/15/09 20:51 / jjw
Calcium	21	mg/L		1		E200.7	06/15/09 13:10 / tao
Chromium	ND	mg/L		0.001		E200.8	06/15/09 20:51 / jjw
Copper	0.024	mg/L		0.001		E200.8	06/15/09 20:51 / jjw
Iron	0.05	mg/L		0.05		E200.7	06/15/09 13:10 / tao
Iron, Ferrous	0.05	mg/L		0.05		E200.7	06/15/09 13:10 / tao
Lead	0.0038	mg/L		0.0005		E200.8	06/15/09 20:51 / jjw
Magnesium	5	mg/L		1		E200.7	06/15/09 13:10 / tao
Manganese	0.458	mg/L		0.005		E200.7	06/15/09 13:10 / tao
Nickel	ND	mg/L		0.01		E200.7	06/15/09 13:10 / tao

Report Definitions:

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study (Scott Mason, Hydrometrics)
Lab ID: B09061251-002
Client Sample ID: Decant Pond

Report Date: 06/22/09
Collection Date: 06/09/09 09:35
DateReceived: 06/12/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, DISSOLVED							
Potassium	28	mg/L		1		E200.7	06/15/09 13:10 / tao
Selenium	0.001	mg/L		0.001		E200.8	06/15/09 20:51 / jjw
Silicon	6.2	mg/L		0.1		E200.7	06/15/09 13:10 / tao
Silica	13.2	mg/L		0.2		E200.7	06/15/09 13:10 / tao
Silver	ND	mg/L		0.0005		E200.8	06/15/09 20:51 / jjw
Sodium	30	mg/L		1		E200.7	06/15/09 13:10 / tao
Thallium	ND	mg/L		0.0002		E200.8	06/15/09 20:51 / jjw
Uranium	0.0033	mg/L		0.0003		E200.8	06/15/09 20:51 / jjw
Zinc	ND	mg/L		0.01		E200.7	06/15/09 13:10 / tao
METALS, TOTAL							
Iron, Ferric	0.77	mg/L		0.03		Calculation	06/18/09 10:52 / mep
METALS, TOTAL RECOVERABLE							
Iron	0.82	mg/L		0.05		E200.7	06/16/09 20:42 / tao
FIELD PARAMETERS							
Field pH, su	6.92	s.u.				FIELD	06/09/09 09:35 / ---
Field Temperature, C	15.1	C				FIELD	06/09/09 09:35 / ---

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study (Scott Mason, Hydrometrics)
Lab ID: B09061251-003
Client Sample ID: MW 95-8

Report Date: 06/22/09
Collection Date: 06/09/09 12:15
DateReceived: 06/12/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL PROPERTIES							
pH	7.6	s.u.		0.1		A4500-H B	06/12/09 12:22 / kh
Conductivity	540	umhos/cm		1		A2510 B	06/12/09 12:22 / kh
Solids, Total Dissolved TDS @ 180 C	353	mg/L		10		A2540 C	06/12/09 16:26 / afb
INORGANICS							
Alkalinity, Total as CaCO3	134	mg/L		4		A2320 B	06/12/09 17:39 / ehb
Bicarbonate as HCO3	163	mg/L		4		A2320 B	06/12/09 17:39 / ehb
Carbonate as CO3	ND	mg/L		4		A2320 B	06/12/09 17:39 / ehb
Chloride	4	mg/L		1		E300.0	06/15/09 17:17 / kh
Sulfate	36	mg/L		1		E300.0	06/15/09 17:17 / kh
Fluoride	0.1	mg/L		0.1		A4500-F C	06/15/09 15:38 / ehb
Sulfide	ND	mg/L		0.04		A4500 S-D	06/15/09 09:30 / afb
Hardness as CaCO3	203	mg/L		1		A2340 B	06/15/09 13:14 / rls
Sodium Adsorption Ratio (SAR)	0.77			0.01		Calculation	06/15/09 13:14 / rls
AGGREGATE ORGANICS (CONTRACT LAB WY00002)							
Organic Carbon, Total (TOC)	1.3	mg/L		0.5		A5310 C	06/17/09 12:00 / eli-ca
NUTRIENTS							
Nitrogen, Ammonia as N	0.77	mg/L		0.05		E350.1	06/13/09 12:46 / sam
Nitrogen, Nitrate+Nitrite as N	24.5	mg/L	D	0.03		E353.2	06/15/09 12:50 / bls
Phosphorus, Orthophosphate as P	ND	mg/L	LH	0.005		E365.1	06/13/09 14:00 / mlm
METALS - DISSOLVED							
Mercury	ND	ng/L		10		E245.7	06/19/09 11:40 / eli-ca
METALS, DISSOLVED							
Aluminum	ND	mg/L		0.03		E200.7	06/15/09 13:14 / tao
Antimony	0.005	mg/L		0.003		E200.8	06/15/09 20:58 / jjw
Arsenic	ND	mg/L		0.001		E200.8	06/15/09 20:58 / jjw
Barium	0.149	mg/L		0.005		E200.7	06/15/09 13:14 / tao
Beryllium	ND	mg/L		0.001		E200.7	06/15/09 13:14 / tao
Cadmium	0.00296	mg/L		0.00008		E200.8	06/15/09 20:58 / jjw
Calcium	68	mg/L		1		E200.7	06/15/09 13:14 / tao
Chromium	ND	mg/L		0.001		E200.8	06/15/09 20:58 / jjw
Copper	0.011	mg/L		0.001		E200.8	06/15/09 20:58 / jjw
Iron	ND	mg/L		0.05		E200.7	06/15/09 13:14 / tao
Iron, Ferrous	ND	mg/L		0.05		E200.7	06/15/09 13:14 / tao
Lead	ND	mg/L		0.0005		E200.8	06/15/09 20:58 / jjw
Magnesium	8	mg/L		1		E200.7	06/15/09 13:14 / tao
Manganese	ND	mg/L		0.005		E200.7	06/15/09 13:14 / tao
Nickel	ND	mg/L		0.01		E200.7	06/15/09 13:14 / tao

Report Definitions:

RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
L - Lowest available reporting limit for the analytical method used.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
H - Analysis performed past recommended holding time.

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Toll Free 800.735.4489 * 406.252.6325 * FAX 406.252.6069 * eli@energylab.com

LABORATORY ANALYTICAL REPORT

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study (Scott Mason, Hydrometrics)
Lab ID: B09061251-003
Client Sample ID: MW 95-8

Report Date: 06/22/09
Collection Date: 06/09/09 12:15
DateReceived: 06/12/09
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS, DISSOLVED							
Potassium	9	mg/L		1		E200.7	06/15/09 13:14 / tao
Selenium	0.004	mg/L		0.001		E200.8	06/15/09 20:58 / jjw
Silicon	5.2	mg/L		0.1		E200.7	06/15/09 13:14 / tao
Silica	11.1	mg/L		0.2		E200.7	06/15/09 13:14 / tao
Silver	ND	mg/L		0.0005		E200.8	06/15/09 20:58 / jjw
Sodium	25	mg/L		1		E200.7	06/15/09 13:14 / tao
Thallium	ND	mg/L		0.0002		E200.8	06/15/09 20:58 / jjw
Uranium	0.0005	mg/L		0.0003		E200.8	06/15/09 20:58 / jjw
Zinc	ND	mg/L		0.01		E200.8	06/15/09 20:58 / jjw
METALS, TOTAL							
Iron, Ferric	1.62	mg/L		0.03		Calculation	06/18/09 10:52 / mep
METALS, TOTAL RECOVERABLE							
Iron	1.62	mg/L		0.05		E200.7	06/16/09 20:50 / tao
FIELD PARAMETERS							
Field pH, su	7.57	s.u.				FIELD	06/09/09 12:15 / ---
Field Temperature, C	10.2	C				FIELD	06/09/09 12:15 / ---

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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QA/QC Summary Report

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study-Scott Mason Hydrometrics

Report Date: 07/31/09
Work Order: B09072237

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E300.0								Analytical Run: IC202-B_090727A	
Sample ID: ICV072709-11	Initial Calibration Verification Standard							07/27/09 12:19	
Chloride	24.1	mg/L	1.0	96	90	110			
Sulfate	103	mg/L	1.0	103	90	110			
Method: E300.0								Batch: R133371	
Sample ID: ICB072709-12	Method Blank				Run: IC202-B_090727A			07/27/09 12:30	
Chloride	ND	mg/L	0.03						
Sulfate	ND	mg/L	0.06						
Sample ID: LFB072709-13	Laboratory Fortified Blank				Run: IC202-B_090727A			07/27/09 12:42	
Chloride	22.8	mg/L	1.0	91	90	110			
Sulfate	101	mg/L	1.0	101	90	110			
Sample ID: B09072237-002AMS	Sample Matrix Spike				Run: IC202-B_090727A			07/27/09 18:30	
Chloride	28.0	mg/L	1.0	98	90	110			
Sulfate	152	mg/L	1.0	110	90	110			
Sample ID: B09072237-002AMSD	Sample Matrix Spike Duplicate				Run: IC202-B_090727A			07/27/09 18:42	
Chloride	28.4	mg/L	1.0	100	90	110	1.4	20	
Sulfate	154	mg/L	1.0	112	90	110	1.1	20	S
Method: E350.1								Analytical Run: FIA202-B_090724C	
Sample ID: ICV	Initial Calibration Verification Standard							07/24/09 13:23	
Nitrogen, Ammonia as N	5.52	mg/L	0.11	101	90	110			
Method: E350.1								Batch: R133268	
Sample ID: MBLK	Method Blank				Run: FIA202-B_090724C			07/24/09 13:24	
Nitrogen, Ammonia as N	ND	mg/L	0.02						
Sample ID: LFB	Laboratory Fortified Blank				Run: FIA202-B_090724C			07/24/09 13:26	
Nitrogen, Ammonia as N	1.03	mg/L	0.050	104	90	110			
Sample ID: B09072233-003BMS	Sample Matrix Spike				Run: FIA202-B_090724C			07/24/09 15:16	
Nitrogen, Ammonia as N	1.43	mg/L	0.050	104	90	110			
Sample ID: B09072233-003BMSD	Sample Matrix Spike Duplicate				Run: FIA202-B_090724C			07/24/09 15:17	
Nitrogen, Ammonia as N	1.43	mg/L	0.050	105	90	110	0.2	10	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

S - Spike recovery outside of advisory limits.

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QA/QC Summary Report

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study-Scott Mason Hydrometrics

Report Date: 07/31/09
Work Order: B09072237

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E353.2								Analytical Run: FIA203-B_090724A	
Sample ID: ICV	Initial Calibration Verification Standard								07/24/09 08:53
Nitrogen, Nitrate+Nitrite as N	37.4	mg/L	0.032	106	90	110			
Method: E353.2									Batch: R133234
Sample ID: MBLK	Method Blank				Run: FIA203-B_090724A				07/24/09 08:54
Nitrogen, Nitrate+Nitrite as N	ND	mg/L	0.002						
Sample ID: LFB	Laboratory Fortified Blank				Run: FIA203-B_090724A				07/24/09 08:55
Nitrogen, Nitrate+Nitrite as N	1.00	mg/L	0.010	102	90	110			
Sample ID: B09072233-003BMS	Sample Matrix Spike				Run: FIA203-B_090724A				07/24/09 14:22
Nitrogen, Nitrate+Nitrite as N	0.979	mg/L	0.010	98	90	110			
Sample ID: B09072233-003BMSD	Sample Matrix Spike Duplicate				Run: FIA203-B_090724A				07/24/09 14:23
Nitrogen, Nitrate+Nitrite as N	0.981	mg/L	0.010	98	90	110	0.2	10	
Sample ID: B09071811-003AMS	Sample Matrix Spike				Run: FIA203-B_090724A				07/24/09 14:38
Nitrogen, Nitrate+Nitrite as N	0.971	mg/L	0.010	99	90	110			
Sample ID: B09071811-003AMSD	Sample Matrix Spike Duplicate				Run: FIA203-B_090724A				07/24/09 14:40
Nitrogen, Nitrate+Nitrite as N	0.980	mg/L	0.010	100	90	110	0.9	10	

Qualifiers:

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ND - Not detected at the reporting limit.

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QA/QC Summary Report

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study-Scott Mason Hydrometrics

Report Date: 07/31/09
Work Order: B09072237

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E365.1								Analytical Run: FIA202-B_090724B	
Sample ID: ICV	Initial Calibration Verification Standard							07/24/09 11:11	
Phosphorus, Orthophosphate as P	0.245	mg/L	0.0050	98	90	110			
Method: E365.1								Batch: R133252	
Sample ID: MBLK	Method Blank				Run: FIA202-B_090724B			07/24/09 11:14	
Phosphorus, Orthophosphate as P	ND	mg/L	0.005						
Sample ID: LFB	Laboratory Fortified Blank				Run: FIA202-B_090724B			07/24/09 11:15	
Phosphorus, Orthophosphate as P	0.0940	mg/L	0.0050	94	90	110			
Sample ID: B09072221-002AMS	Sample Matrix Spike				Run: FIA202-B_090724B			07/24/09 11:31	
Phosphorus, Orthophosphate as P	0.134	mg/L	0.0050	95	90	110			
Sample ID: B09072221-002AMSD	Sample Matrix Spike Duplicate				Run: FIA202-B_090724B			07/24/09 11:32	
Phosphorus, Orthophosphate as P	0.135	mg/L	0.0050	96	90	110	0.7	10	
Sample ID: B09072233-002AMS	Sample Matrix Spike				Run: FIA202-B_090724B			07/24/09 12:19	
Phosphorus, Orthophosphate as P	0.165	mg/L	0.0050	99	90	110			
Sample ID: B09072233-002AMSD	Sample Matrix Spike Duplicate				Run: FIA202-B_090724B			07/24/09 12:20	
Phosphorus, Orthophosphate as P	0.164	mg/L	0.0050	98	90	110	0.6	10	
Sample ID: B09072231-003AMS	Sample Matrix Spike				Run: FIA202-B_090724B			07/24/09 12:31	
Phosphorus, Orthophosphate as P	0.101	mg/L	0.0050	101	90	110			
Sample ID: B09072231-003AMSD	Sample Matrix Spike Duplicate				Run: FIA202-B_090724B			07/24/09 12:32	
Phosphorus, Orthophosphate as P	0.101	mg/L	0.0050	101	90	110	0	10	

Qualifiers:

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QA/QC Summary Report

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study-Scott Mason Hydrometrics

Report Date: 07/31/09
Work Order: B09072237

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7									Batch: 40344
Sample ID: MB-40344	Method Blank				Run: ICP202-B_090728A				07/28/09 16:30
Iron	0.04	mg/L	0.008						
Sample ID: LCS5-40344	Laboratory Control Sample				Run: ICP202-B_090728A				07/28/09 16:34
Iron	2.61	mg/L	0.030	103	85	115			
Sample ID: B09072246-001BMS5	Sample Matrix Spike				Run: ICP202-B_090728A				07/28/09 17:45
Iron	15.1	mg/L	0.030		70	130			A
Sample ID: B09072246-001BMSD5	Sample Matrix Spike Duplicate				Run: ICP202-B_090728A				07/28/09 17:49
Iron	15.1	mg/L	0.030		70	130	0.3	20	A

Qualifiers:

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ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.

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QA/QC Summary Report

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study-Scott Mason Hydrometrics

Report Date: 07/31/09
Work Order: B09072237

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7								Analytical Run: ICP202-B_090727A	
Sample ID: ICV	Continuing Calibration Verification Standard								07/27/09 10:48
Aluminum	2.47	mg/L	0.10	99	95	105			
Barium	2.59	mg/L	0.10	104	95	105			
Beryllium	1.21	mg/L	0.010	96	95	105			
Calcium	24.2	mg/L	1.0	97	95	105			
Iron	2.60	mg/L	0.030	104	95	105			
Magnesium	25.2	mg/L	1.0	101	95	105			
Manganese	2.41	mg/L	0.010	96	95	105			
Nickel	2.60	mg/L	0.050	104	95	105			
Potassium	23.7	mg/L	1.0	95	95	105			
Silicon	5.08	mg/L	0.10	102	95	105			
Sodium	24.6	mg/L	1.0	98	95	105			
Zinc	2.55	mg/L	0.010	102	95	105			
Method: E200.7									Batch: R133358
Sample ID: MB-SPDIS090727A	Method Blank				Run: ICP202-B_090727A				07/27/09 10:13
Aluminum	ND	mg/L	0.008						
Barium	0.001	mg/L	0.0001						
Beryllium	0.0005	mg/L	9E-05						
Calcium	0.03	mg/L	0.009						
Iron	ND	mg/L	0.002						
Magnesium	0.01	mg/L	0.01						
Manganese	0.0005	mg/L	0.0003						
Nickel	ND	mg/L	0.002						
Potassium	ND	mg/L	0.01						
Silicon	ND	mg/L	0.01						
Sodium	ND	mg/L	0.03						
Zinc	0.002	mg/L	0.002						
Sample ID: LFB-SPDIS090727A	Laboratory Fortified Blank				Run: ICP202-B_090727A				07/27/09 10:16
Aluminum	5.05	mg/L	0.10	101	85	115			
Barium	0.972	mg/L	0.10	97	85	115			
Beryllium	0.484	mg/L	0.010	97	85	115			
Calcium	48.3	mg/L	1.0	97	85	115			
Iron	5.19	mg/L	0.030	104	85	115			
Magnesium	51.1	mg/L	1.0	102	85	115			
Manganese	4.83	mg/L	0.010	97	85	115			
Nickel	1.05	mg/L	0.050	105	85	115			
Potassium	50.4	mg/L	1.0	101	85	115			
Silicon	11.0	mg/L	0.10	110	85	115			
Sodium	49.4	mg/L	1.0	99	85	115			
Zinc	1.02	mg/L	0.010	102	85	115			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

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QA/QC Summary Report

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study-Scott Mason Hydrometrics

Report Date: 07/31/09
Work Order: B09072237

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7									Batch: R133358
Sample ID: B09072234-001BMS2	Sample Matrix Spike				Run: ICP202-B_090727A				07/27/09 11:51
Aluminum	4.79	mg/L	0.10	96	70	130			
Barium	1.04	mg/L	0.10	94	70	130			
Beryllium	0.461	mg/L	0.0010	92	70	130			
Calcium	82.9	mg/L	1.0	84	70	130			
Iron	4.95	mg/L	0.030	99	70	130			
Magnesium	107	mg/L	1.0	89	70	130			
Manganese	4.68	mg/L	0.010	94	70	130			
Nickel	1.01	mg/L	0.010	100	70	130			
Potassium	50.8	mg/L	1.0	99	70	130			
Silicon	14.7	mg/L	0.10	94	70	130			
Sodium	52.4	mg/L	1.0	98	70	130			
Zinc	0.981	mg/L	0.010	98	70	130			
Iron, Ferrous	4.95	mg/L	0.030	99	70	130			
Silica	31.4	mg/L	0.21	94	70	130			
Sample ID: B09072234-001BMSD2	Sample Matrix Spike Duplicate				Run: ICP202-B_090727A				07/27/09 11:55
Aluminum	4.84	mg/L	0.10	97	70	130	1	20	
Barium	1.03	mg/L	0.10	93	70	130	1.3	20	
Beryllium	0.465	mg/L	0.0010	93	70	130	0.9	20	
Calcium	83.6	mg/L	1.0	86	70	130	0.9	20	
Iron	5.03	mg/L	0.030	100	70	130	1.7	20	
Magnesium	109	mg/L	1.0	92	70	130	1.4	20	
Manganese	4.72	mg/L	0.010	94	70	130	0.8	20	
Nickel	1.01	mg/L	0.010	101	70	130	0.4	20	
Potassium	50.3	mg/L	1.0	98	70	130	1	20	
Silicon	14.9	mg/L	0.10	97	70	130	1.6	20	
Sodium	52.1	mg/L	1.0	98	70	130	0.6	20	
Zinc	0.988	mg/L	0.010	98	70	130	0.7	20	
Iron, Ferrous	5.03	mg/L	0.030	100	70	130	1.7	20	
Silica	31.9	mg/L	0.21	97	70	130	1.6	20	
Sample ID: B09072251-005BMS2	Sample Matrix Spike				Run: ICP202-B_090727A				07/27/09 13:02
Aluminum	4.86	mg/L	0.10	97	70	130			
Barium	1.45	mg/L	0.10	92	70	130			
Beryllium	0.471	mg/L	0.0010	94	70	130			
Calcium	123	mg/L	1.0	78	70	130			
Iron	109	mg/L	0.030		70	130			A
Magnesium	67.8	mg/L	1.0	94	70	130			
Manganese	6.98	mg/L	0.010	90	70	130			
Nickel	0.994	mg/L	0.010	98	70	130			
Potassium	51.9	mg/L	1.0	98	70	130			
Silicon	27.5	mg/L	0.10	92	70	130			
Sodium	70.7	mg/L	1.0	97	70	130			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.

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QA/QC Summary Report

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study-Scott Mason Hydrometrics

Report Date: 07/31/09
Work Order: B09072237

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7								Batch: R133358	
Sample ID: B09072251-005BMS2	Sample Matrix Spike				Run: ICP202-B_090727A			07/27/09 13:02	
Zinc	0.962	mg/L	0.010	96	70	130			
Iron, Ferrous	109	mg/L	0.030		70	130			A
Silica	58.8	mg/L	0.21	92	70	130			
Sample ID: B09072251-005BMSD2	Sample Matrix Spike Duplicate				Run: ICP202-B_090727A			07/27/09 13:05	
Aluminum	5.14	mg/L	0.10	103	70	130	5.6	20	
Barium	1.47	mg/L	0.10	95	70	130	1.6	20	
Beryllium	0.482	mg/L	0.0010	96	70	130	2.4	20	
Calcium	125	mg/L	1.0	83	70	130	1.7	20	
Iron	110	mg/L	0.030		70	130	1.3	20	A
Magnesium	69.3	mg/L	1.0	97	70	130	2.3	20	
Manganese	7.13	mg/L	0.010	93	70	130	2	20	
Nickel	1.05	mg/L	0.010	104	70	130	5.5	20	
Potassium	54.9	mg/L	1.0	104	70	130	5.6	20	
Silicon	28.0	mg/L	0.10	97	70	130	1.8	20	
Sodium	72.9	mg/L	1.0	102	70	130	3.2	20	
Zinc	1.01	mg/L	0.010	101	70	130	5.3	20	
Iron, Ferrous	110	mg/L	0.030		70	130	1.3	20	A
Silica	59.9	mg/L	0.21	97	70	130	1.8	20	
Method: E200.7								Analytical Run: ICP202-B_090728A	
Sample ID: ICV	Continuing Calibration Verification Standard							07/28/09 10:54	
Iron	2.57	mg/L	0.030	103	95	105			
Method: E200.8								Batch: 40344	
Sample ID: MB-40344	Method Blank				Run: ICPMS203-B_090727A			07/27/09 20:43	
Iron	0.08	mg/L	0.0008						
Sample ID: LCS5-40344	Laboratory Control Sample				Run: ICPMS203-B_090727A			07/27/09 20:50	
Iron	2.55	mg/L	0.030	99	85	115			
Sample ID: B09072246-001BMS5	Sample Matrix Spike				Run: ICPMS203-B_090727A			07/27/09 22:32	
Iron	15.7	mg/L	0.030		70	130			A
Sample ID: B09072246-001BMSD5	Sample Matrix Spike Duplicate				Run: ICPMS203-B_090727A			07/27/09 22:39	
Iron	15.8	mg/L	0.030		70	130	0.7	20	A

Qualifiers:

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QA/QC Summary Report

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study-Scott Mason Hydrometrics

Report Date: 07/31/09
Work Order: B09072237

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8							Analytical Run: ICPMS203-B_090727A		
Sample ID: QCS-090602A,090609B,0	Initial Calibration Verification Standard								07/27/09 19:40
Aluminum	0.245	mg/L	0.10	98	90	110			
Antimony	0.0480	mg/L	0.050	96	90	110			
Arsenic	0.0490	mg/L	0.0050	98	90	110			
Cadmium	0.0257	mg/L	0.0010	103	90	110			
Chromium	0.0500	mg/L	0.010	100	90	110			
Copper	0.0512	mg/L	0.010	102	90	110			
Iron	0.273	mg/L	0.030	107	90	110			
Lead	0.0493	mg/L	0.010	99	90	110			
Selenium	0.0497	mg/L	0.0050	99	90	110			
Silver	0.0261	mg/L	0.0050	104	90	110			
Thallium	0.0501	mg/L	0.10	100	90	110			
Uranium	0.0191	mg/L	0.0010	95	90	110			
Method: E200.8									Batch: R133351
Sample ID: LRB	Method Blank				Run: ICPMS203-B_090727A				07/27/09 11:55
Aluminum	0.005	mg/L	0.00010						
Antimony	ND	mg/L	1E-05						
Arsenic	ND	mg/L	2E-05						
Cadmium	ND	mg/L	4E-06						
Chromium	ND	mg/L	2E-05						
Copper	ND	mg/L	3E-05						
Lead	ND	mg/L	3E-06						
Selenium	ND	mg/L	4E-05						
Silver	3E-05	mg/L	9E-06						
Thallium	ND	mg/L	8E-06						
Uranium	ND	mg/L	2E-06						
Sample ID: LFB	Laboratory Fortified Blank				Run: ICPMS203-B_090727A				07/27/09 12:15
Aluminum	0.0530	mg/L	0.10	96	85	115			
Antimony	0.0496	mg/L	0.050	99	85	115			
Arsenic	0.0495	mg/L	0.0050	99	85	115			
Cadmium	0.0495	mg/L	0.0010	99	85	115			
Chromium	0.0499	mg/L	0.010	100	85	115			
Copper	0.0485	mg/L	0.010	97	85	115			
Lead	0.0497	mg/L	0.010	99	85	115			
Selenium	0.0487	mg/L	0.0050	97	85	115			
Silver	0.0191	mg/L	0.0050	95	85	115			
Thallium	0.0506	mg/L	0.10	101	85	115			
Uranium	0.0491	mg/L	0.0010	98	85	115			
Sample ID: B09072057-005CMS	Sample Matrix Spike				Run: ICPMS203-B_090727A				07/28/09 00:29
Aluminum	0.0942	mg/L	0.10	94	70	130			
Antimony	0.100	mg/L	0.0050	100	70	130			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. • P.O. Box 30916 • 1120 South 27th Street • Billings, MT 59107-0916
800-735-4489 • 406-252-6325 • 406-252-6069 fax • eli@energylab.com

QA/QC Summary Report

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study-Scott Mason Hydrometrics

Report Date: 07/31/09
Work Order: B09072237

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8									Batch: R133351
Sample ID: B09072057-005CMS	Sample Matrix Spike				Run: ICPMS203-B_090727A				07/28/09 00:29
Arsenic	0.101	mg/L	0.0050	101	70	130			
Cadmium	0.0988	mg/L	0.0010	99	70	130			
Chromium	0.102	mg/L	0.010	102	70	130			
Copper	0.156	mg/L	0.010	94	70	130			
Lead	0.101	mg/L	0.010	100	70	130			
Selenium	0.104	mg/L	0.0050	103	70	130			
Silver	0.0389	mg/L	0.0050	97	70	130			
Thallium	0.101	mg/L	0.0050	101	70	130			
Uranium	0.109	mg/L	0.0010	100	70	130			
Sample ID: B09072057-005CMSD	Sample Matrix Spike Duplicate				Run: ICPMS203-B_090727A				07/28/09 01:03
Aluminum	0.0933	mg/L	0.10	93	70	130		20	
Antimony	0.100	mg/L	0.0050	100	70	130	0.3	20	
Arsenic	0.102	mg/L	0.0050	102	70	130	1	20	
Cadmium	0.0982	mg/L	0.0010	98	70	130	0.6	20	
Chromium	0.0996	mg/L	0.010	100	70	130	2.2	20	
Copper	0.156	mg/L	0.010	94	70	130	0.3	20	
Lead	0.102	mg/L	0.010	100	70	130	0.4	20	
Selenium	0.102	mg/L	0.0050	101	70	130	2.2	20	
Silver	0.0385	mg/L	0.0050	96	70	130	1.1	20	
Thallium	0.101	mg/L	0.0050	101	70	130	0.6	20	
Uranium	0.109	mg/L	0.0010	101	70	130	0.3	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

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800-735-4489 • 406-252-6325 • 406-252-6069 fax • eli@energylab.com

QA/QC Summary Report

Client: Genesis Inc Troy Mine
Project: Cu Attenuation Study-Scott Mason Hydrometrics

Report Date: 07/31/09
Work Order: B09072237

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8								Analytical Run: ICPMS202-B_090728A	
Sample ID: QCS - 090602A,090609B,	Initial Calibration Verification Standard								07/28/09 09:41
Antimony	0.0465	mg/L	0.050	93	90	110			
Arsenic	0.0499	mg/L	0.0050	100	90	110			
Cadmium	0.0247	mg/L	0.0010	99	90	110			
Chromium	0.0493	mg/L	0.010	99	90	110			
Copper	0.0501	mg/L	0.010	100	90	110			
Silver	0.0258	mg/L	0.0050	103	90	110			
Method: E200.8									Batch: R133463
Sample ID: LRB	Method Blank				Run: ICPMS202-B_090728A				07/28/09 12:22
Antimony	ND	mg/L	5E-05						
Arsenic	ND	mg/L	3E-05						
Cadmium	ND	mg/L	1E-05						
Chromium	ND	mg/L	0.0002						
Copper	ND	mg/L	8E-05						
Silver	ND	mg/L	2E-05						
Sample ID: LFB	Laboratory Fortified Blank				Run: ICPMS202-B_090728A				07/28/09 12:26
Antimony	0.0507	mg/L	0.050	101	85	115			
Arsenic	0.0495	mg/L	0.0050	99	85	115			
Cadmium	0.0487	mg/L	0.0010	97	85	115			
Chromium	0.0477	mg/L	0.010	95	85	115			
Copper	0.0470	mg/L	0.010	94	85	115			
Silver	0.0175	mg/L	0.0050	88	85	115			
Sample ID: B09072234-001BMS	Sample Matrix Spike				Run: ICPMS202-B_090728A				07/28/09 12:38
Antimony	0.0512	mg/L	0.0050	100	70	130			
Arsenic	0.0519	mg/L	0.0050	100	70	130			
Cadmium	0.0488	mg/L	0.0010	97	70	130			
Chromium	0.0491	mg/L	0.010	97	70	130			
Copper	0.0493	mg/L	0.010	94	70	130			
Silver	0.0177	mg/L	0.0050	88	70	130			
Sample ID: B09072234-001BMSD	Sample Matrix Spike Duplicate				Run: ICPMS202-B_090728A				07/28/09 12:42
Antimony	0.0510	mg/L	0.0050	100	70	130	0.4	20	
Arsenic	0.0519	mg/L	0.0050	100	70	130	0.1	20	
Cadmium	0.0484	mg/L	0.0010	97	70	130	0.9	20	
Chromium	0.0491	mg/L	0.010	97	70	130	0.1	20	
Copper	0.0491	mg/L	0.010	94	70	130	0.3	20	
Silver	0.0180	mg/L	0.0050	90	70	130	1.7	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

Energy Laboratories Inc
Workorder Receipt Checklist

Genesis Inc Troy Mine

B09072237

Login completed by: Gina McCartney

Date and Time Received: 7/24/2009 9:00 AM

Reviewed by: Denise Ruby

Received by: lg

Reviewed Date: 7/24/2009 5:35:00 PM

Carrier name: Return-UPS Ground

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shipping container/cooler?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time?	Yes ☐	No ☑	
Container/Temp Blank temperature:	5°C On Ice		
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☑
Water - pH acceptable upon receipt?	Yes ☑	No ☐	Not Applicable ☐

Contact and Corrective Action Comments:

All samples for Ortho Phosphorus received past the 48 hour hold time. Analyze, per ELI's project manager.

ENERGY LABORATORIES

Chain of Custody and Analytical Request Record

Page ____ of ____

PLEASE PRINT- Provide as much information as possible.

Company Name: Genesis Inc - Troy Mine	Project Name, PWS, Permit, Etc. Cu Attenuation Study - Scott Mason Hydrometrics	Sample Origin State: Mont.	EPA/State Compliance: Yes ☐ No ☒
Report Mail Address: PO Box 1660 Troy, MT 59935	Contact Name: Paul Kukay Phone/Fax: 295-5882 x221	Email: PKukay@hotmail.com	Sampler: (Please Print) Kukay/Johnson
Invoice Address: Same	Invoice Contact & Phone: Same	Purchase Order:	Quote/Bottle Order: 1850

Special Report/Formats – ELI must be notified prior to sample submittal for the following:

☐ DW ☐ A2LA
☐ GSA ☐ EDD/EDT (Electronic Data)
☐ POTW/WWTP Format: ____
☐ State: ____ ☐ LEVEL IV
☐ Other: ____ ☐ NELAC

Contact ELI prior to **RUSH** sample submittal for charges and scheduling – See Instruction Page

Comments:

Shipped by: Hand Delivered
Cooler ID(s):
Receipt Temp 5 °C
On Ice: Yes No
Custody Seal Y N
Bottles/Coolers B C
Intact Y N
Signature Match Y N

ANALYSIS REQUESTED: wyoming per Scott Mason's note: Scott Mason - Hydrometrics - Trace

	SAMPLE IDENTIFICATION (Name, Location, Interval, etc.)	Collection Date	Collection Time	MATRIX (Number of Containers; Sample Type: A W S V B O; Air Water Soils/Solids Vegetation Bioassay Other)	SEE ATTACHED	Normal Turnaround (TAT)	RUSH	Comments	LABORATORY USE ONLY
1	MW-95-8	21 July 09	9:10am	W	X		X	pH 6.85 temp 10.32°C	B0907237-001
2	Decant Pond	"	10:15am	W	X		X	pH 7.66 temp 20.9°C	-002
3	MW-01-15	"	12:50pm	W	X		X	pH 7.21 temp 22.1°C	-003
4	MW-00	"	1:10pm	W	X		X	pH 7.28 temp 18.8°C	-004
5									
6									
7									
8									
9									
10									

Custody Record MUST be Signed

Relinquished by (print)	Date/Time	Signature	Received by (print)	Date/Time	Signature
Paul Kukay	22 July 09 8:00am	Paul D Kukay			

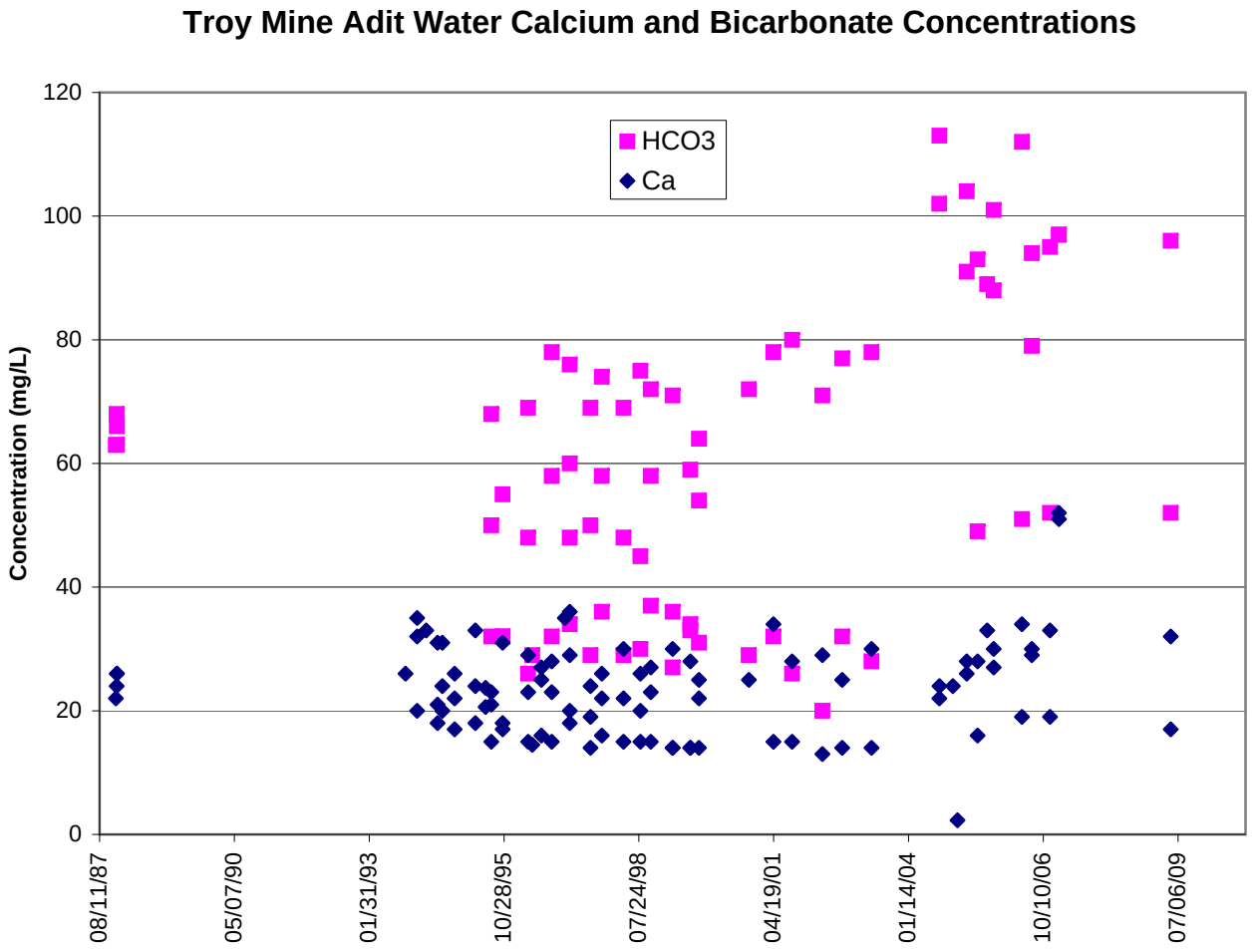
Received by Laboratory: 7-24-09 9:00

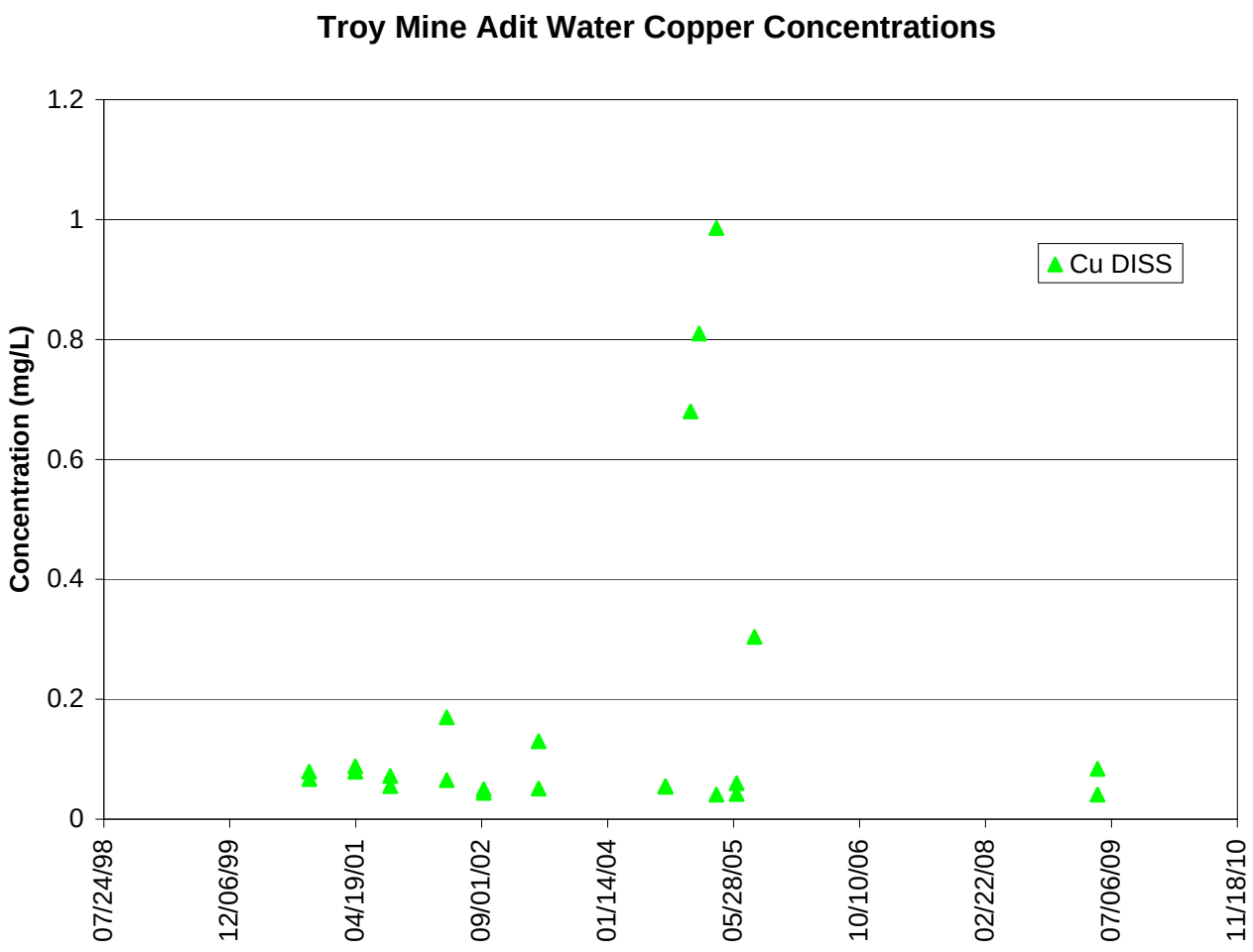
Sample Disposal: Return to Client: ____ Lab Disposal: ____

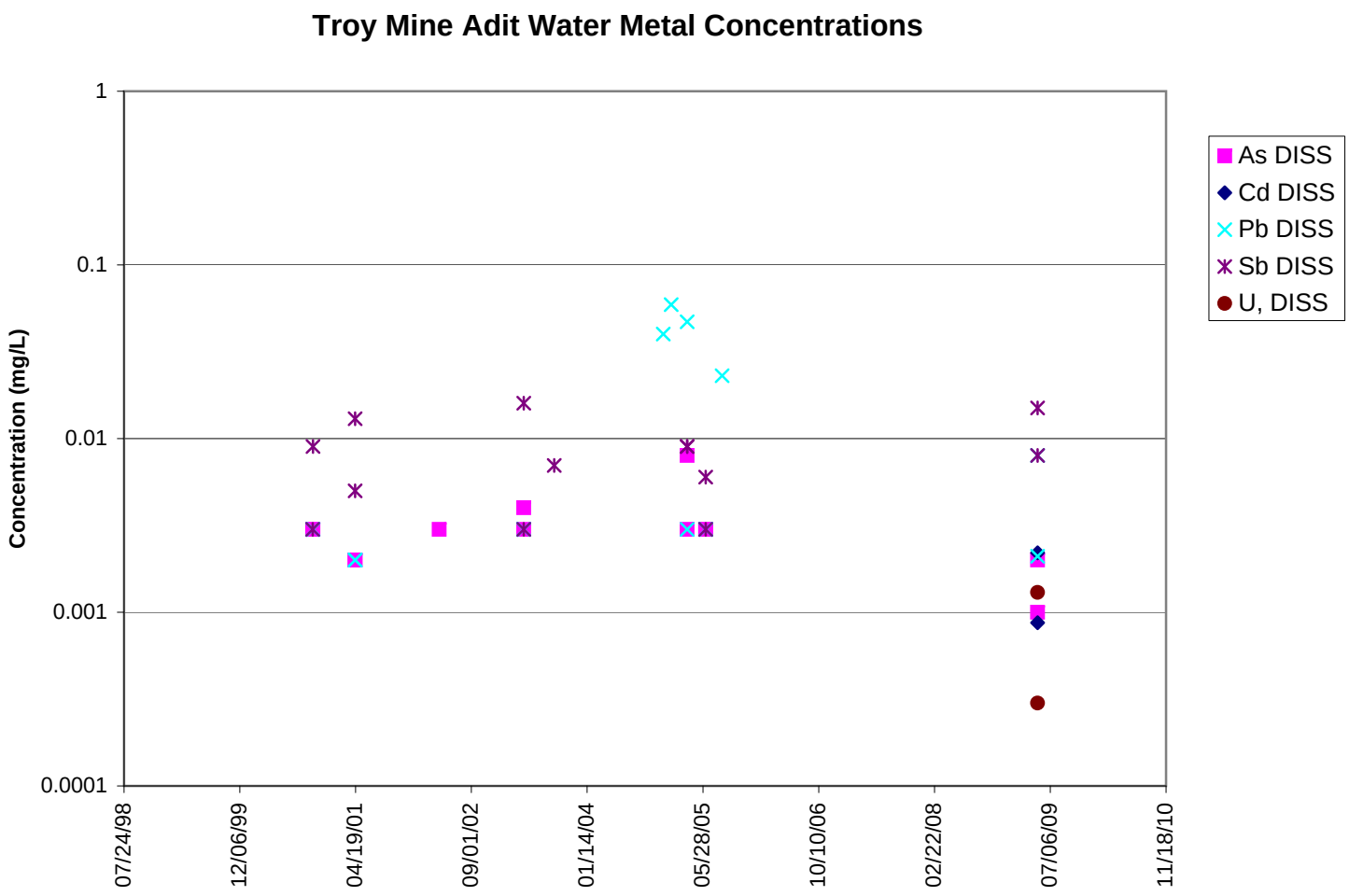
In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report.
Visit our web site at www.energylab.com for additional information, downloadable fee schedule, forms, and links.

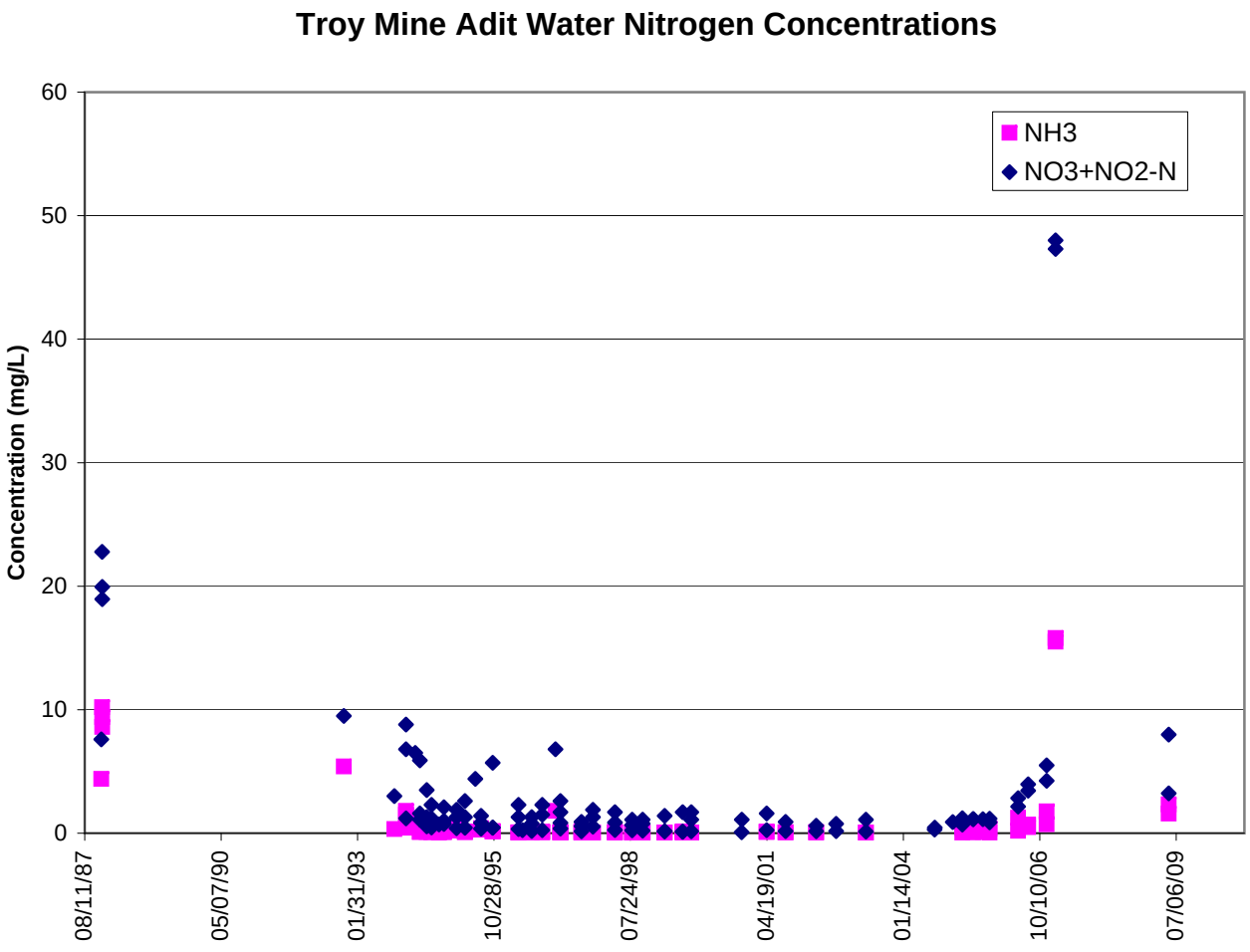
APPENDIX B

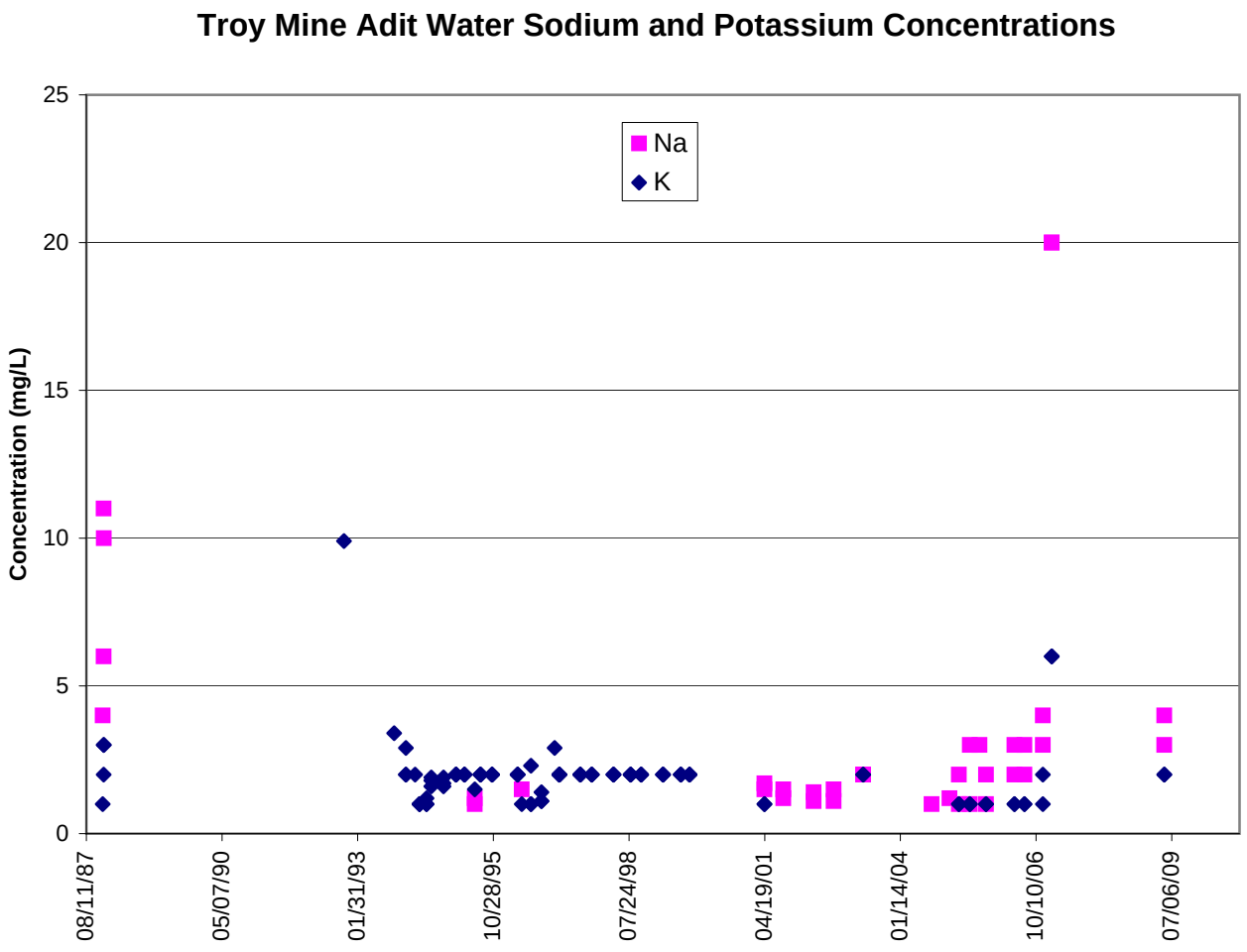
CONCENTRATION TIME SERIES GRAPHS

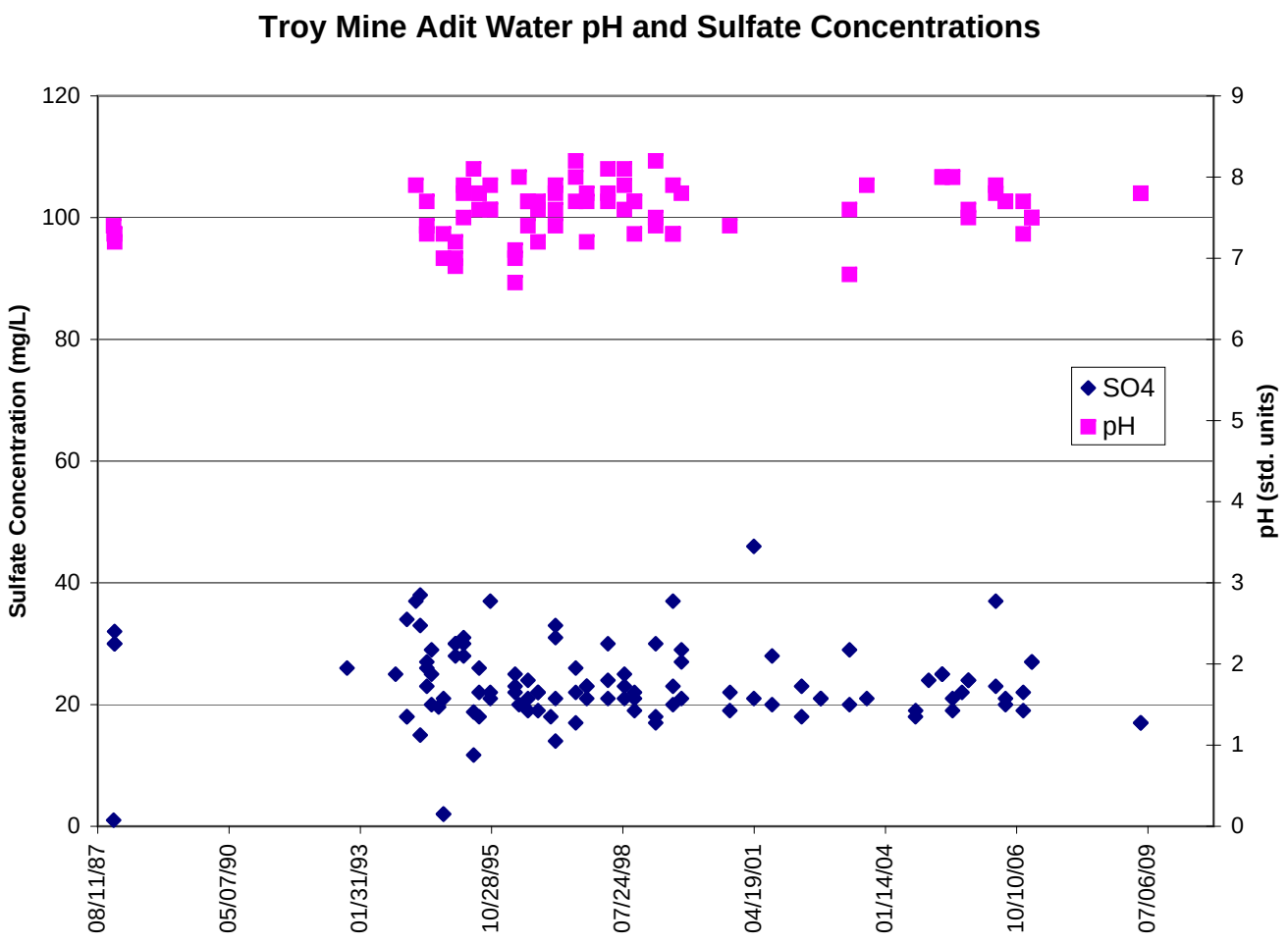

Troy Mine Adit Water Calcium and Bicarbonate Concentrations
HCO3
Ca
Concentration (mg/L)
120
100
80
60
40
20
0
08/11/87
05/07/90
01/31/93
10/28/95
07/24/98
04/19/01
01/14/04
10/10/06
07/06/09


Troy Mine Adit Water Copper Concentrations
Concentration (mg/L)
1.2
1
0.8
0.6
0.4
0.2
0
Cu DISS
07/24/98
12/06/99
04/19/01
09/01/02
01/14/04
05/28/05
10/10/06
02/22/08
07/06/09
11/18/10

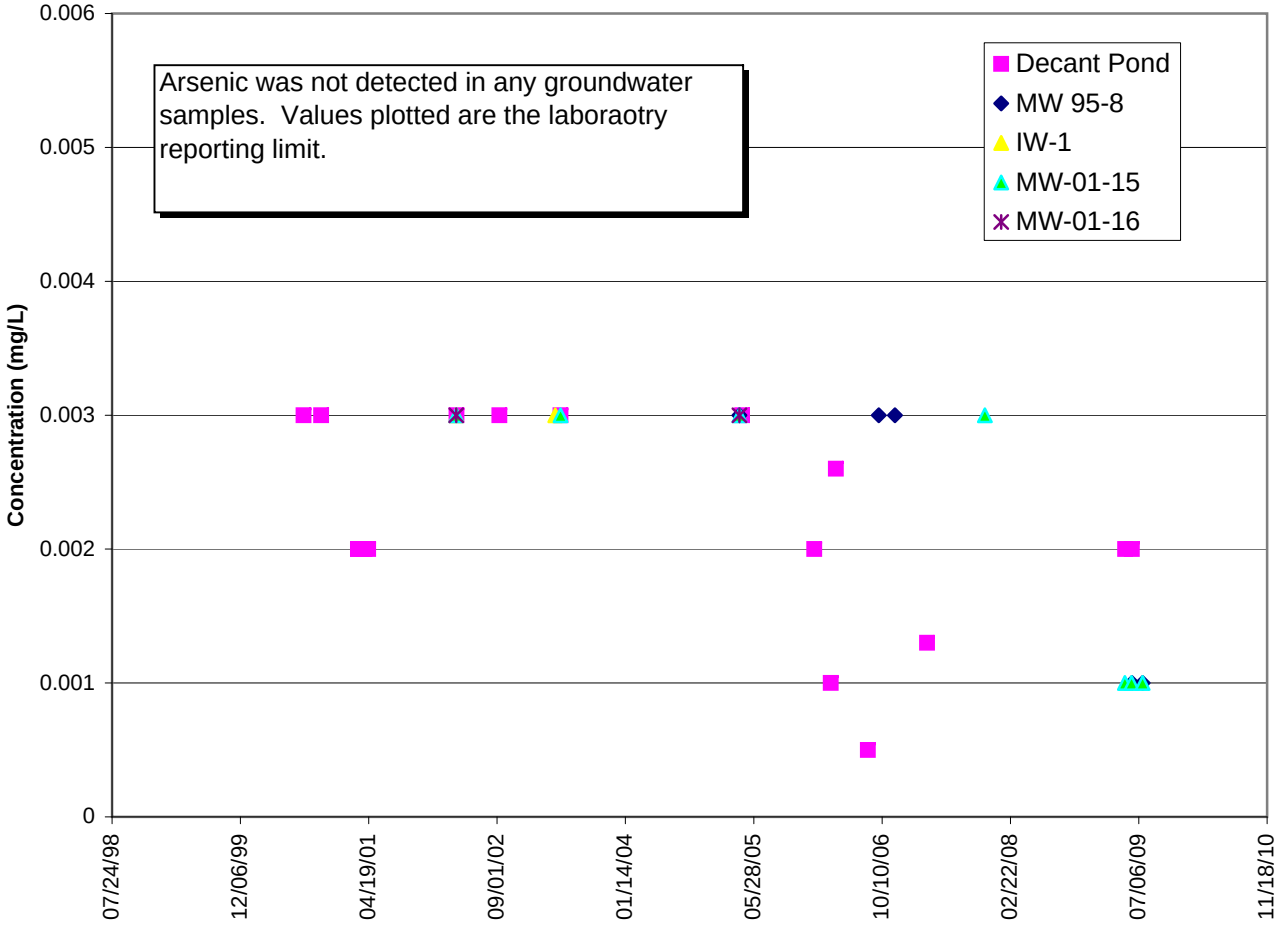

Troy Mine Adit Water Metal Concentrations
Concentration (mg/L)
1
0.1
0.01
0.001
0.0001
07/24/98
12/06/99
04/19/01
09/01/02
01/14/04
05/28/05
10/10/06
02/22/08
07/06/09
11/18/10
As DISS
Cd DISS
Pb DISS
Sb DISS
U, DISS

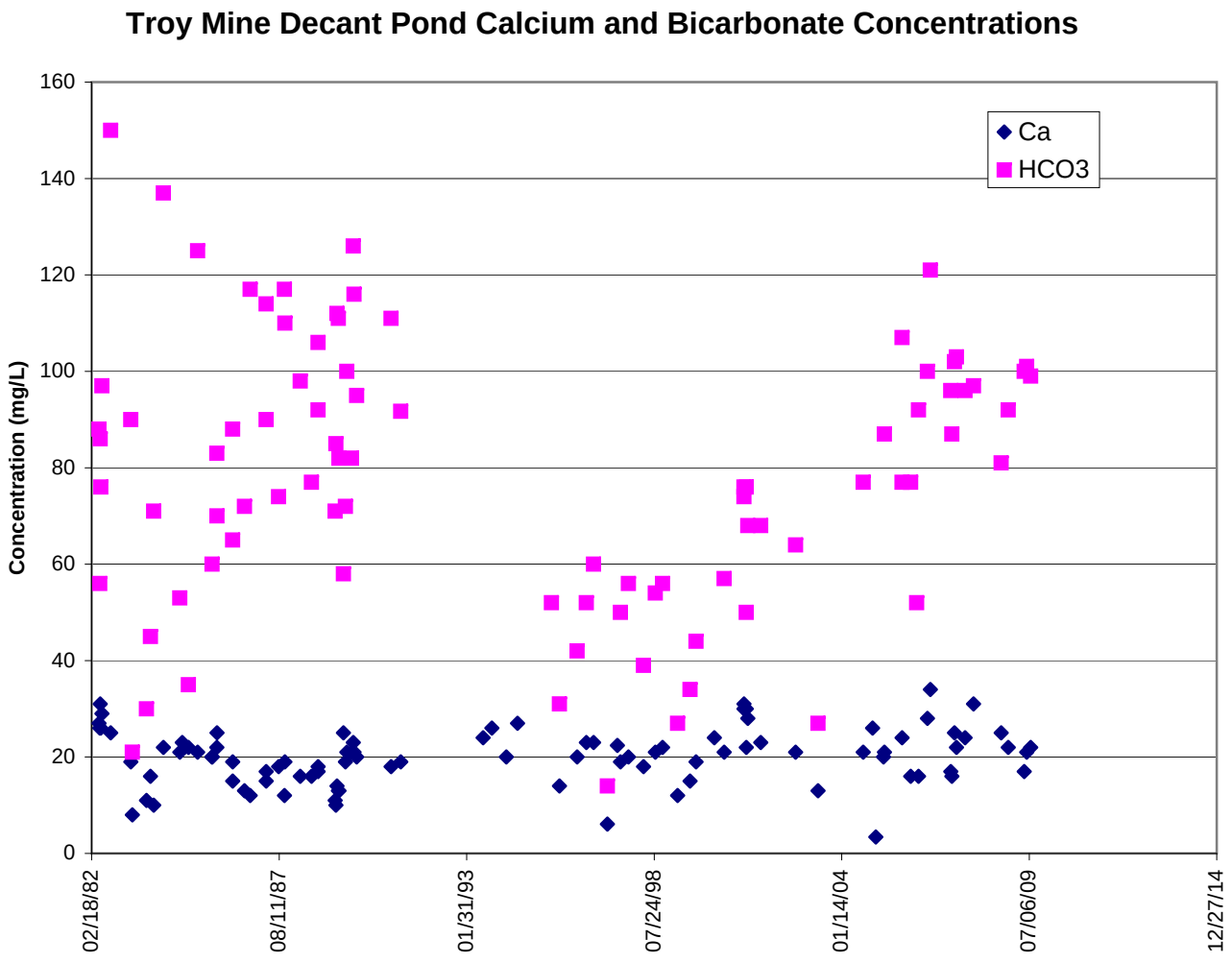

Troy Mine Adit Water Nitrogen Concentrations
Concentration (mg/L)
60
50
40
30
20
10
0
NH3
NO3+NO2-N
08/11/87
05/07/90
01/31/93
10/28/95
07/24/98
04/19/01
01/14/04
10/10/06
07/06/09


Troy Mine Adit Water Sodium and Potassium Concentrations
Na
K
Concentration (mg/L)
25
20
15
10
5
0
08/11/87
05/07/90
01/31/93
10/28/95
07/24/98
04/19/01
01/14/04
10/10/06
07/06/09

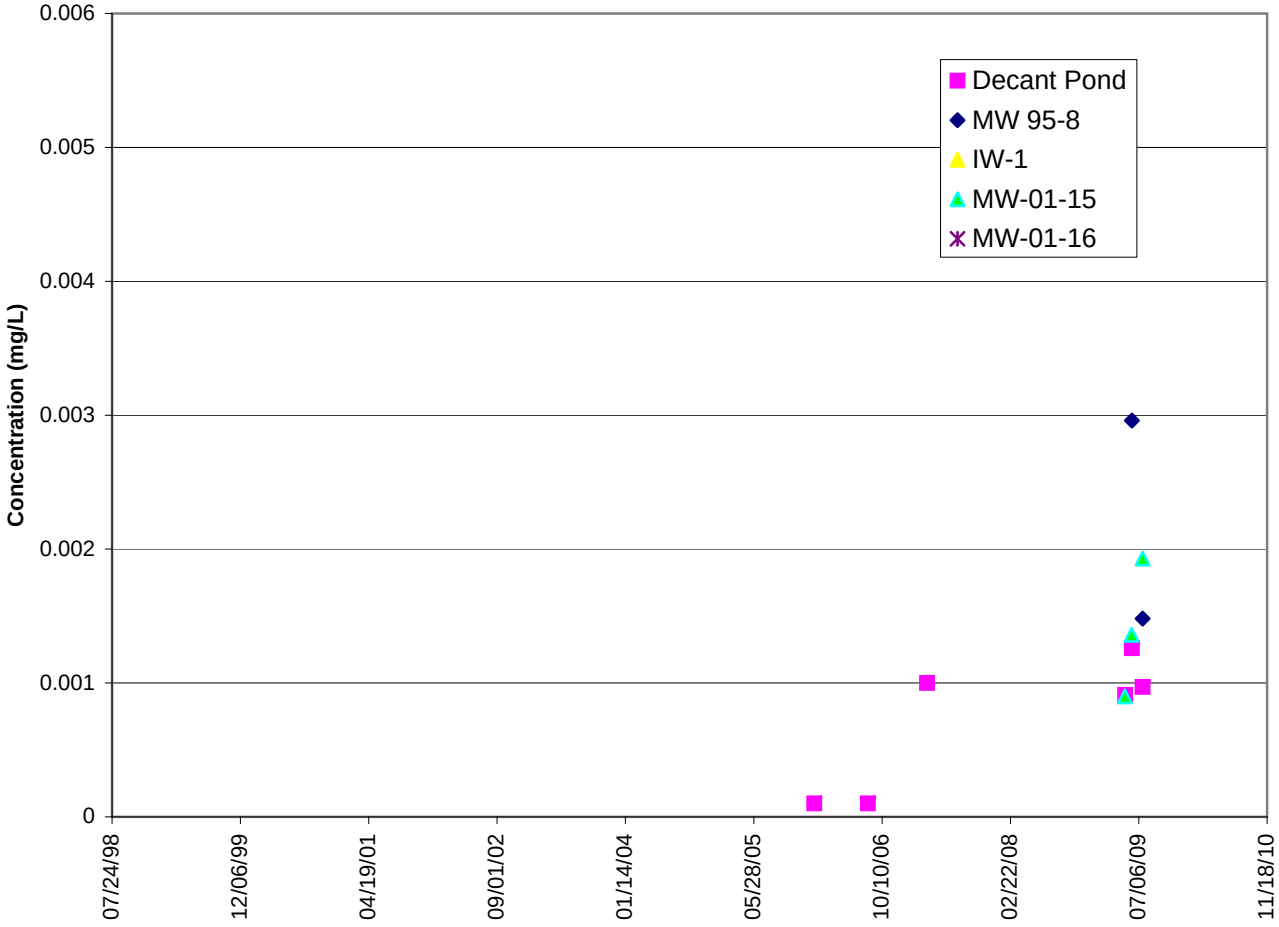

Troy Mine Adit Water pH and Sulfate Concentrations
Sulfate Concentration (mg/L)
pH (std. units)
120
100
80
60
40
20
0
9
8
7
6
5
4
3
2
1
0
SO4
pH
08/11/87
05/07/90
01/31/93
10/28/95
07/24/98
04/19/01
01/14/04
10/10/06
07/06/09

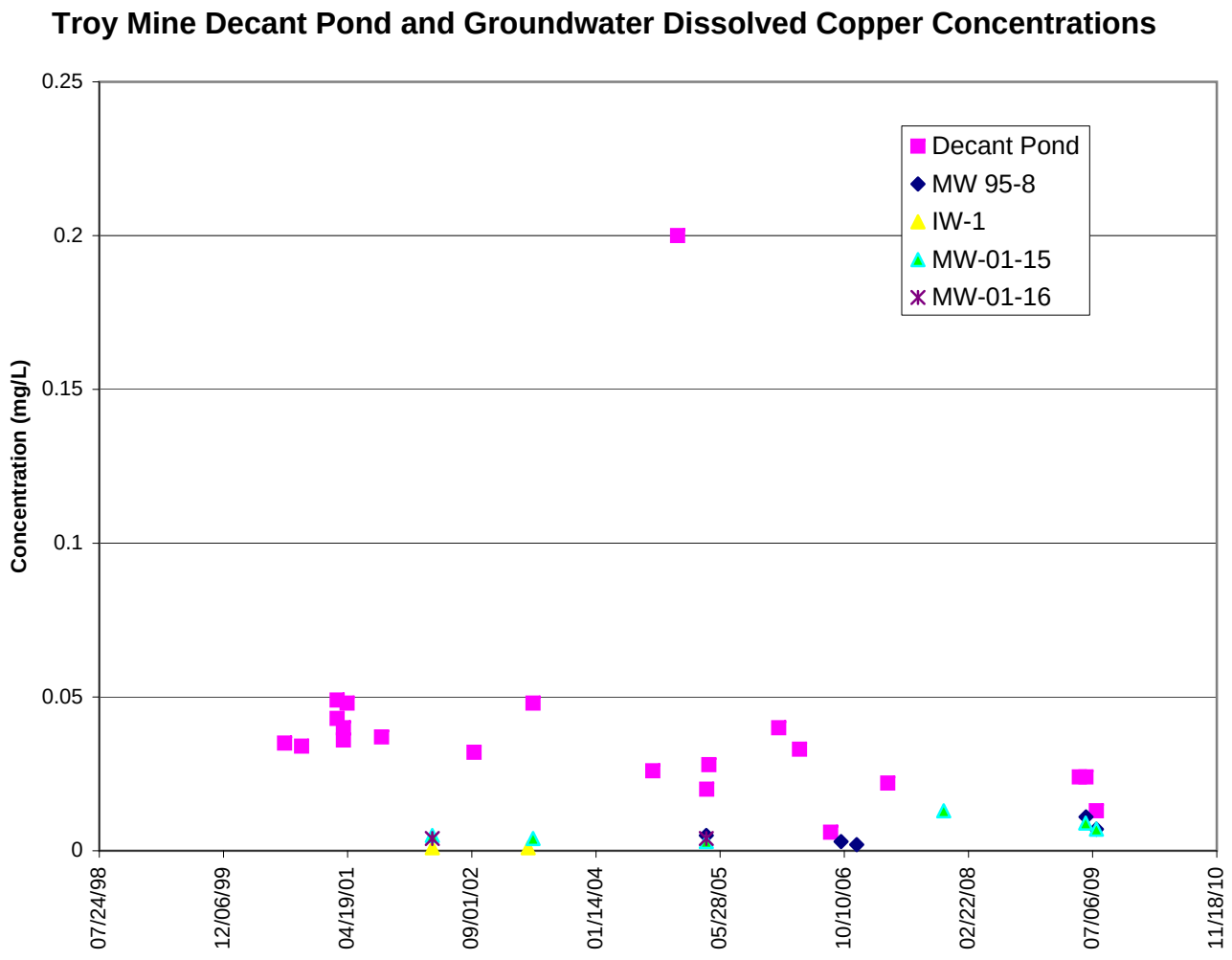
Troy Mine Decant Pond and Groundwater Dissolved Arsenic Concentrations

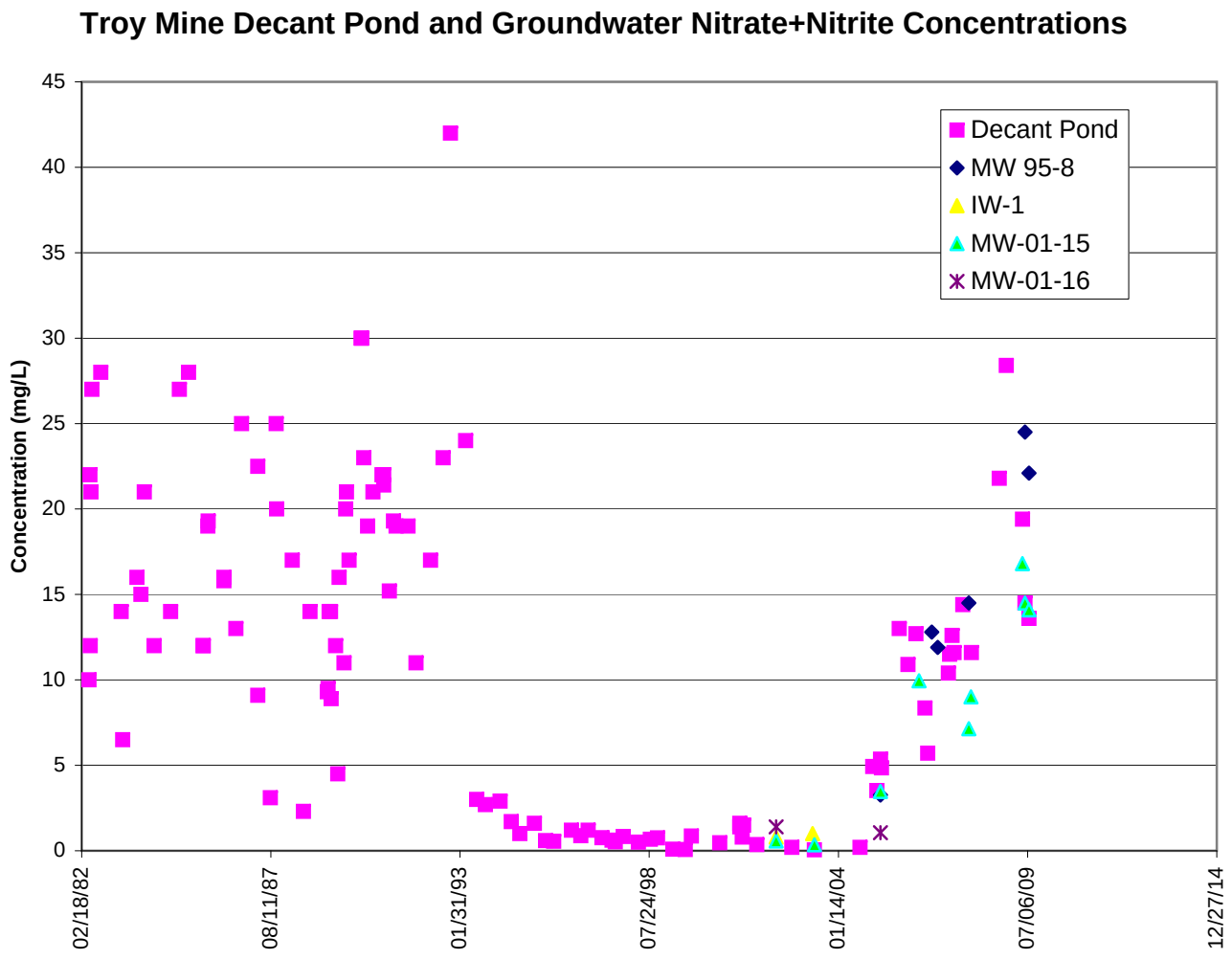


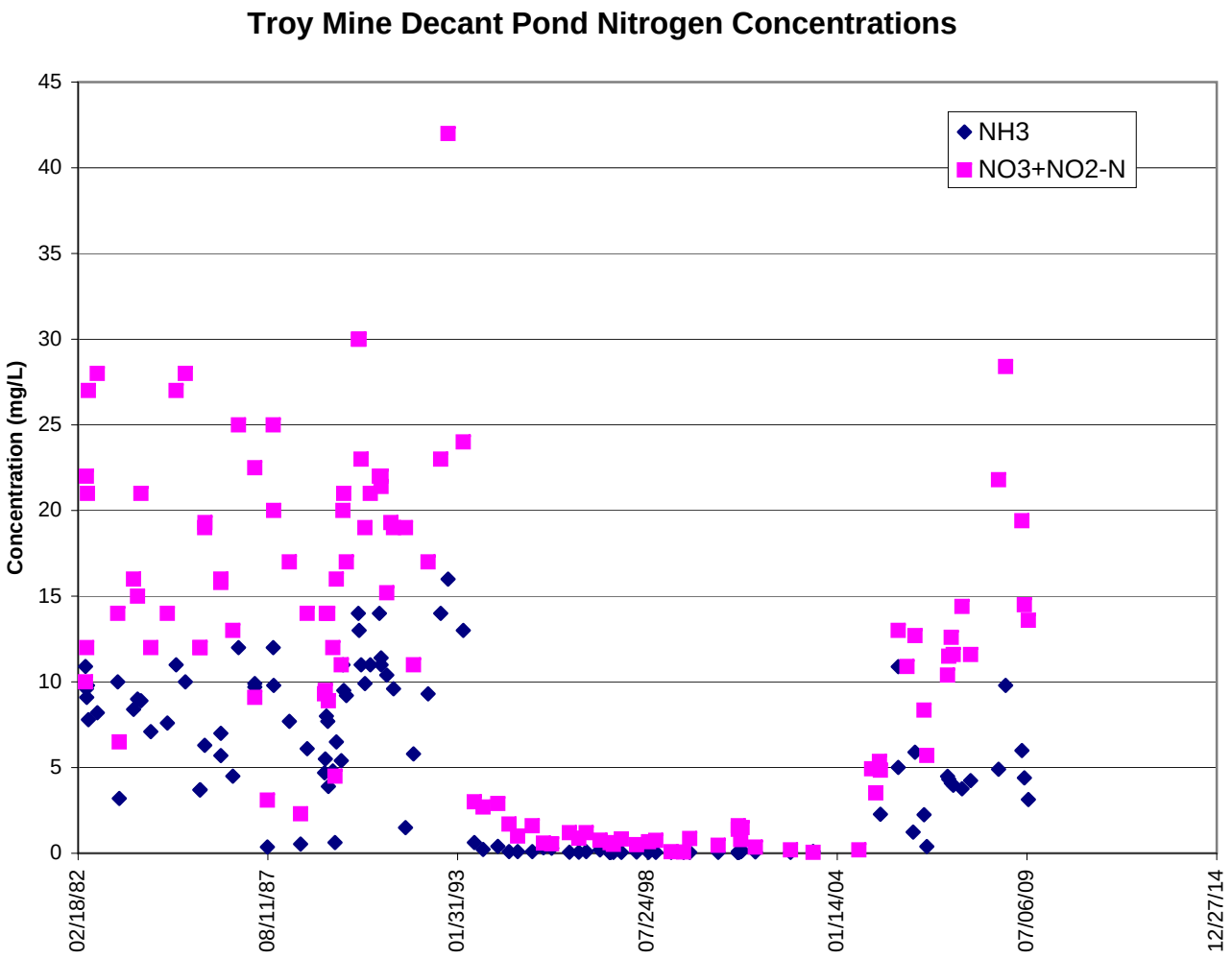

Troy Mine Decant Pond Calcium and Bicarbonate Concentrations
Concentration (mg/L)
160
140
120
100
80
60
40
20
0
02/18/82
08/11/87
01/31/93
07/24/98
01/14/04
07/06/09
12/27/14
Ca
HCO3

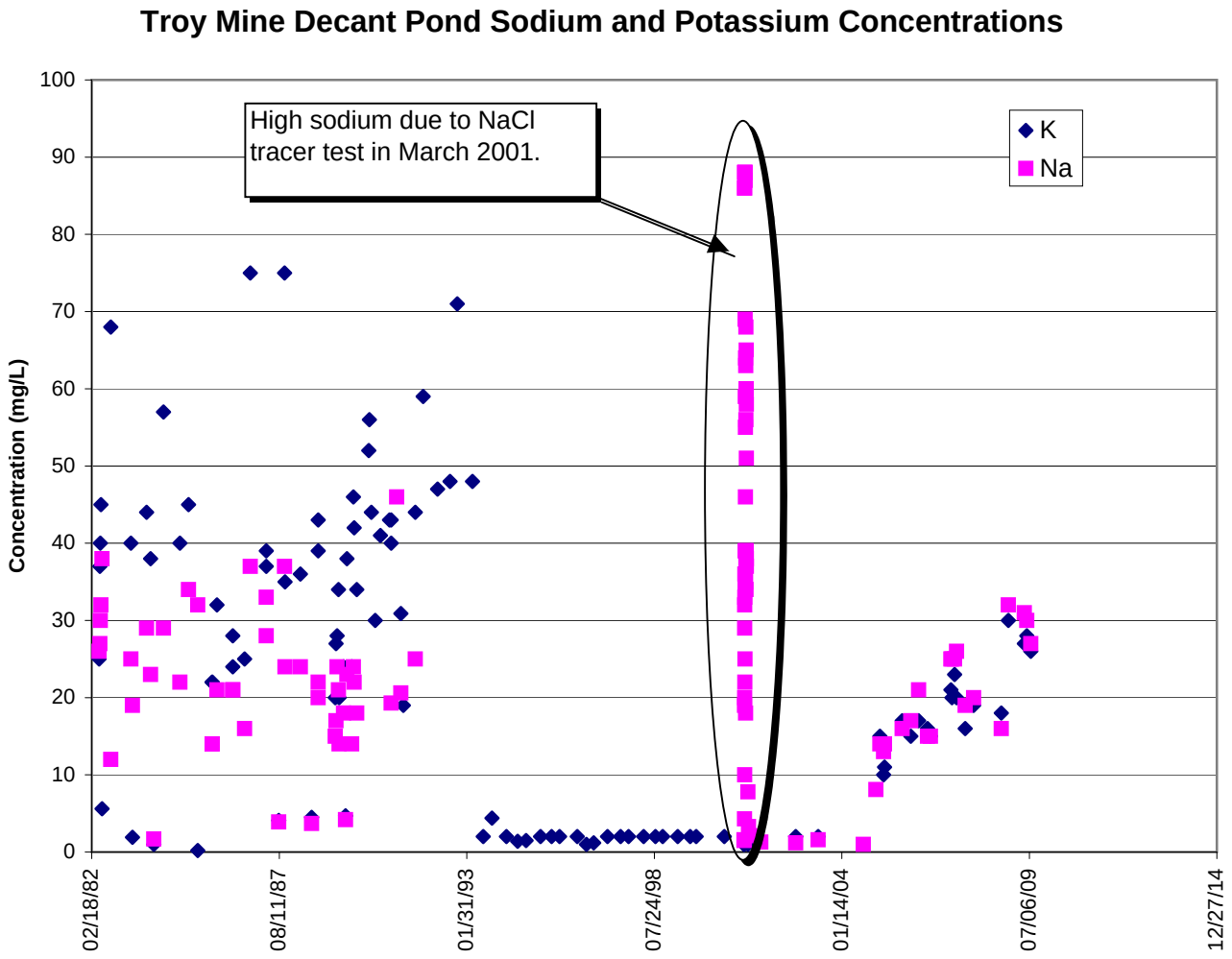
Troy Mine Decant Pond and Groundwater Dissolved Cadmium Concentrations



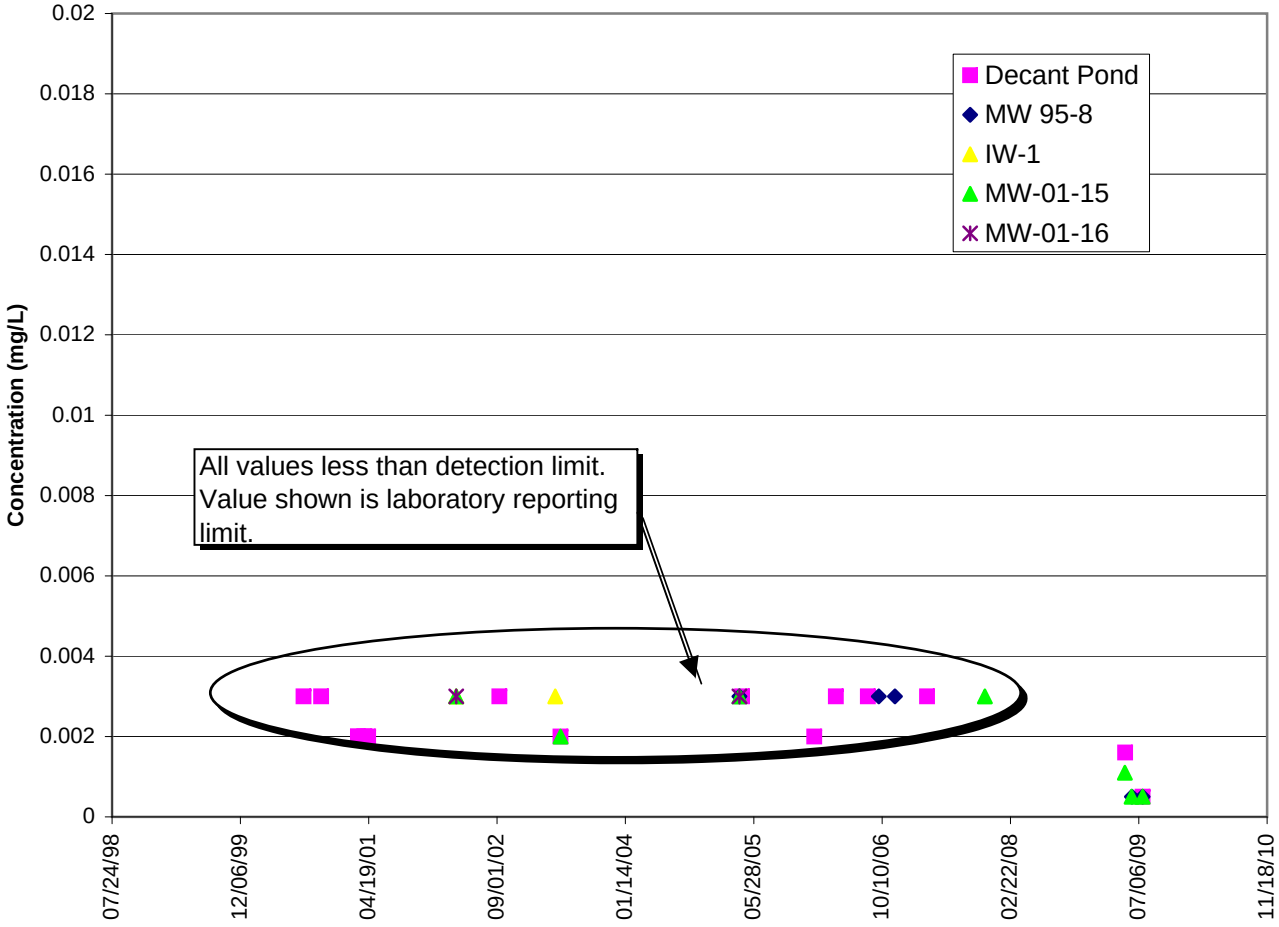

Troy Mine Decant Pond and Groundwater Dissolved Copper Concentrations
Concentration (mg/L)
0.25
0.2
0.15
0.1
0.05
0
07/24/98
12/06/99
04/19/01
09/01/02
01/14/04
05/28/05
10/10/06
02/22/08
07/06/09
11/18/10
Decant Pond
MW 95-8
IW-1
MW-01-15
MW-01-16

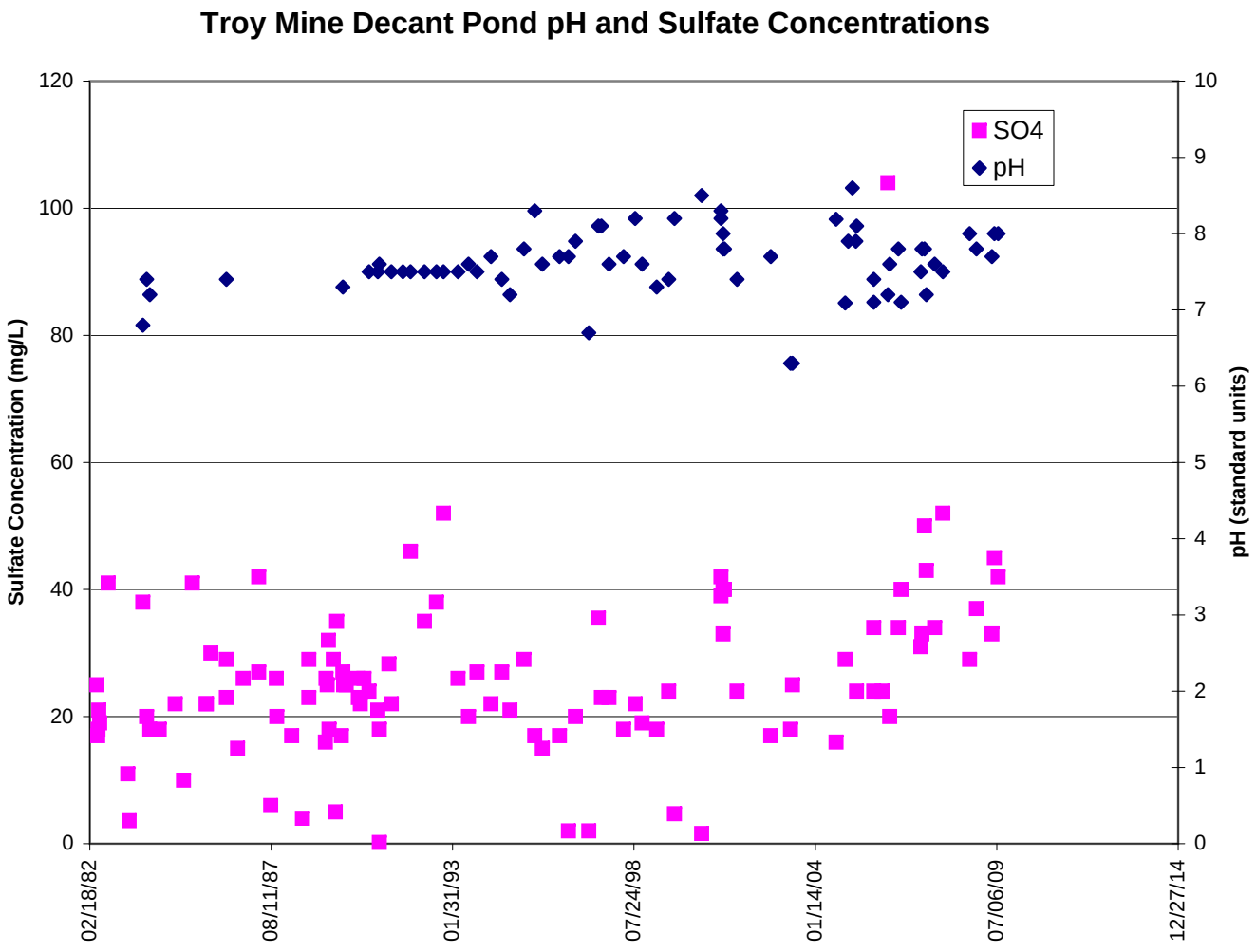

Troy Mine Decant Pond and Groundwater Nitrate+Nitrite Concentrations
Concentration (mg/L)
45
40
35
30
25
20
15
10
5
0
02/18/82
08/11/87
01/31/93
07/24/98
01/14/04
07/06/09
12/27/14
Decant Pond
MW 95-8
IW-1
MW-01-15
MW-01-16

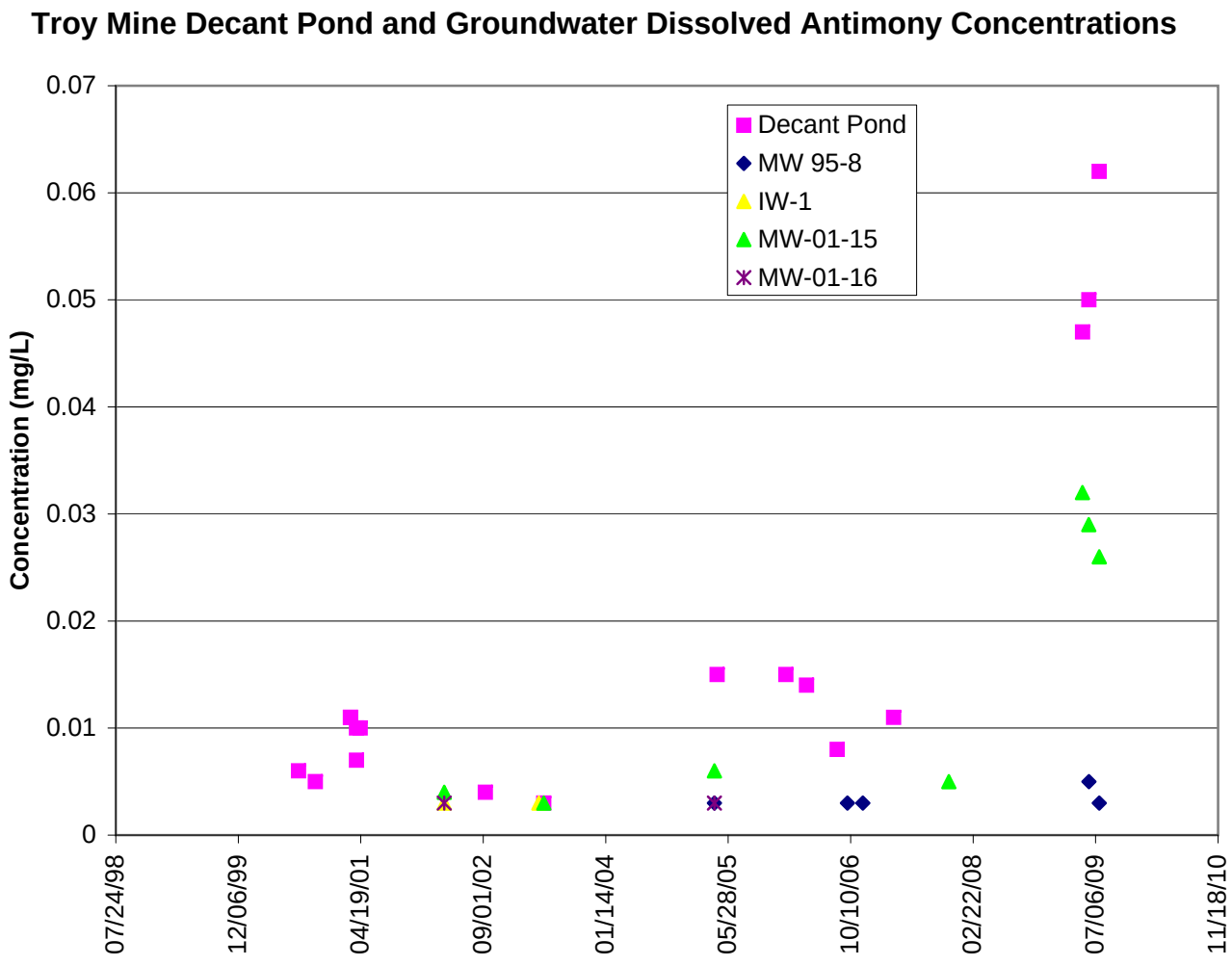

Troy Mine Decant Pond Nitrogen Concentrations
Concentration (mg/L)
45
40
35
30
25
20
15
10
5
0
NH3
NO3+NO2-N
02/18/82
08/11/87
01/31/93
07/24/98
01/14/04
07/06/09
12/27/14

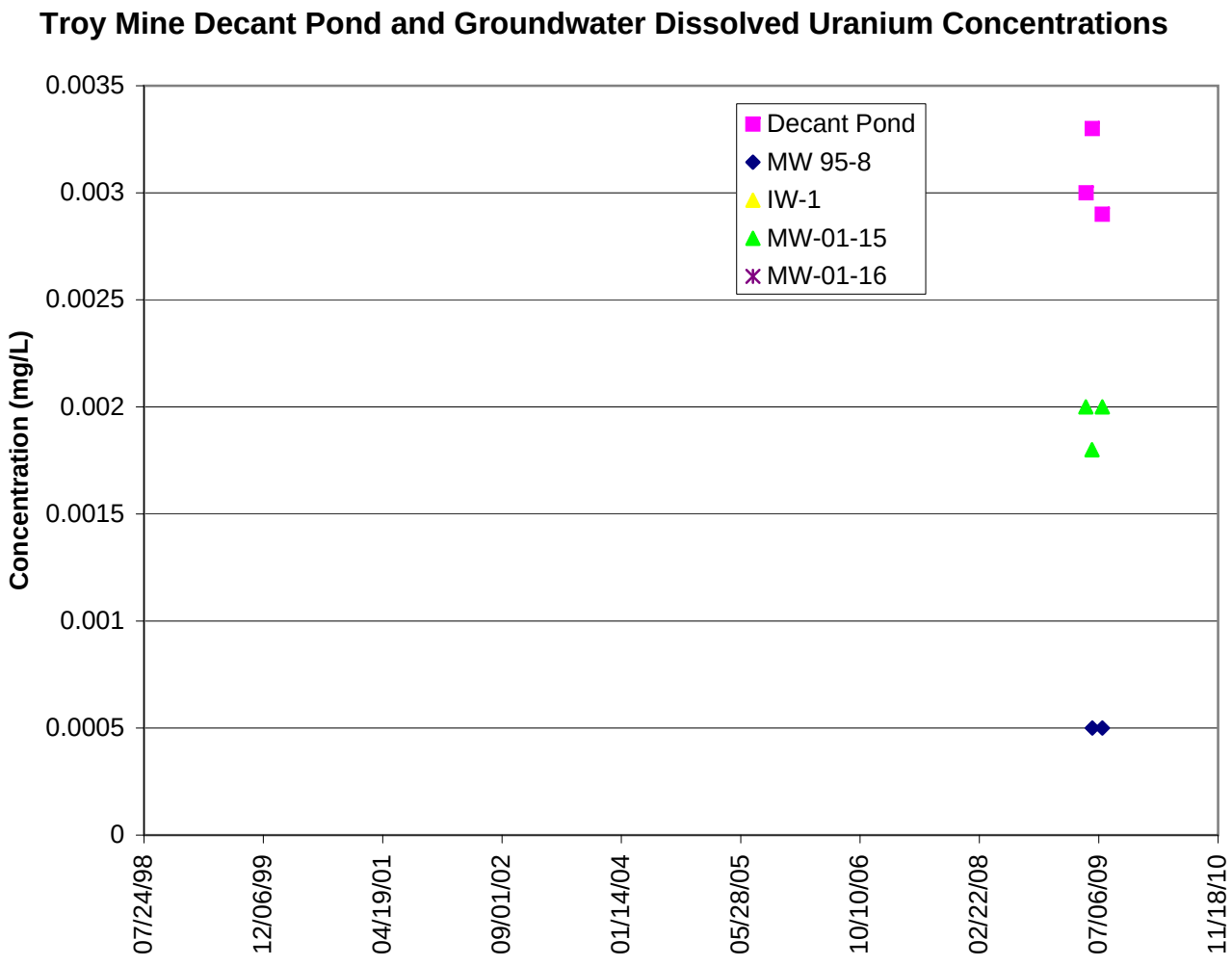

Troy Mine Decant Pond Sodium and Potassium Concentrations
High sodium due to NaCl tracer test in March 2001.
K
Na
Concentration (mg/L)
100
90
80
70
60
50
40
30
20
10
0
02/18/82
08/11/87
01/31/93
07/24/98
01/14/04
07/06/09
12/27/14

Troy Mine Decant Pond and Groundwater Dissolved Lead Concentrations




Troy Mine Decant Pond pH and Sulfate Concentrations
Sulfate Concentration (mg/L)
pH (standard units)
SO4
pH
120
100
80
60
40
20
0
10
9
8
7
6
5
4
3
2
1
0
02/18/82
08/11/87
01/31/93
07/24/98
01/14/04
07/06/09
12/27/14


Troy Mine Decant Pond and Groundwater Dissolved Antimony Concentrations
Concentration (mg/L)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
07/24/98
12/06/99
04/19/01
09/01/02
01/14/04
05/28/05
10/10/06
02/22/08
07/06/09
11/18/10
Decant Pond
MW 95-8
IW-1
MW-01-15
MW-01-16


Troy Mine Decant Pond and Groundwater Dissolved Uranium Concentrations
Concentration (mg/L)
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
07/24/98
12/06/99
04/19/01
09/01/02
01/14/04
05/28/05
10/10/06
02/22/08
07/06/09
11/18/10
Decant Pond
MW 95-8
IW-1
MW-01-15
MW-01-16

APPENDIX C

GEOCHEMICAL MODEL RESULTS

```
Temperature =  20.9 C    Pressure =  1.013 bars
pH =  8.000              log fO2 =  -22.996
Eh =   0.4280 volts      pe =   7.3361
Ionic strength      =    0.004457
Charge imbalance    =   -0.000212 eq/kg (-6.354% error)
Activity of water   =    0.999996
Solvent mass        =    1.000000 kg
Solution mass       =    1.000303 kg
Solution density    =    1.016    g/cm3
Chlorinity          =    0.000111 molal
Dissolved solids    =         303 mg/kg sol'n
Elect. conductivity =      345.82 uS/cm (or umho/cm)
Hardness            =       74.36 mg/kg sol'n as CaCO3
  carbonate         =       74.36 mg/kg sol'n as CaCO3
  non-carbonate     =        0.00 mg/kg sol'n as CaCO3
Rock mass           =    0.000000 kg
Carbonate alkalinity=       78.60 mg/kg sol'n as CaCO3
Water type          =    Na-HCO3
```

Nernst redox couples	Eh (volts)	pe
e- + .25*O2(aq) + H+ = .5*H2O	0.4280	7.3361
8*e- + 9*H+ + NO3- = 3*H2O + NH3(aq)	0.5686	9.7454

No minerals in system.

Aqueous species	molality	mg/kg sol'n	act. coef.	log act.
HCO3-	0.001538	93.82	0.9312	-2.8439
Na+	0.001154	26.52	0.9312	-2.9687
NO3-	0.0009562	59.27	0.9299	-3.0510
K+	0.0006533	25.54	0.9299	-3.2164
Ca++	0.0005140	20.60	0.7595	-3.4085
SO4--	0.0004036	38.76	0.7511	-3.5184
SiO2(aq)	0.0002188	13.14	1.0000	-3.6600
Mg++	0.0001890	4.592	0.7674	-3.8385
N2(aq)	0.0001169	3.274	1.0000	-3.9321
Cl-	0.0001111	3.936	0.9299	-3.9860
CO2(aq)	3.444e-005	1.515	1.0000	-4.4629
CaSO4(aq)	1.504e-005	2.047	1.0000	-4.8228
F-	1.031e-005	0.1959	0.9306	-5.0179
MgSO4(aq)	1.025e-005	1.233	1.0000	-4.9894
CO3--	8.015e-006	0.4808	0.7533	-5.2191
CaHCO3+	6.817e-006	0.6890	0.9312	-5.1973
CaCO3(aq)	4.634e-006	0.4637	1.0000	-5.3340
Mn++	3.567e-006	0.1959	0.7595	-5.5672
MgHCO3+	2.475e-006	0.2111	0.9312	-5.6374
NaHCO3(aq)	2.386e-006	0.2004	1.0000	-5.6223
HSiO3-	2.376e-006	0.1831	0.9312	-5.6552
KSO4-	1.506e-006	0.2035	0.9312	-5.8531
MgCO3(aq)	8.065e-007	0.06798	1.0000	-6.0934
Ba++	7.945e-007	0.1091	0.7554	-6.2218
OH-	7.732e-007	0.01315	0.9306	-6.1430
Sb(OH)3(aq)	5.014e-007	0.08661	1.0000	-6.2998
Cu++	2.015e-007	0.01280	0.7595	-6.8153
MnSO4(aq)	1.787e-007	0.02697	1.0000	-6.7480
HPO4--	1.681e-007	0.01612	0.7511	-6.8988
NaHSiO3(aq)	1.165e-007	0.01166	1.0000	-6.9336
HAsO4--	6.269e-008	0.008770	0.7511	-7.3271
MgF+	3.420e-008	0.001480	0.9312	-7.4970
NaCO3-	2.564e-008	0.002128	0.9312	-7.6220
H2PO4-	2.269e-008	0.002200	0.9312	-7.6751

CaF+	1.915e-008	0.001131	0.9312	-7.7488
NaCl(aq)	1.819e-008	0.001063	1.0000	-7.7401
MgCl+	1.219e-008	0.0007281	0.9312	-7.9450
H+	1.067e-008	1.075e-005	0.9374	-8.0000
CaCl+	8.781e-009	0.0006630	0.9312	-8.0874
Cd++	8.495e-009	0.0009547	0.7554	-8.1926
UO2(CO3)2--	6.367e-009	0.002483	0.7511	-8.3204
UO2(CO3)3----	5.581e-009	0.002511	0.3179	-8.7510
H2AsO4-	3.004e-009	0.0004233	0.9312	-8.5532
KCl(aq)	1.852e-009	0.0001380	1.0000	-8.7324
BaCO3(aq)	1.474e-009	0.0002907	1.0000	-8.8316
NaF(aq)	1.007e-009	4.228e-005	1.0000	-8.9968
MnCl+	5.536e-010	5.003e-005	0.9312	-9.2877
HSO4-	2.831e-010	2.748e-005	0.9312	-9.5789
HF(aq)	1.321e-010	2.641e-006	1.0000	-9.8792
NaOH(aq)	1.270e-010	5.079e-006	1.0000	-9.8961
UO2CO3(aq)	4.893e-011	1.615e-005	1.0000	-10.3104
Sb(OH)4-	4.654e-011	8.829e-006	0.9312	-10.3631
BaCl+	2.011e-011	3.474e-006	0.9312	-10.7275
AsO4---	1.953e-011	2.713e-006	0.5250	-10.9891
PO4---	1.034e-011	9.819e-007	0.5250	-11.2653
BaF+	3.915e-012	6.119e-007	0.9312	-11.4382
Cu+	3.531e-012	2.243e-007	0.9312	-11.4830
CdSO4(aq)	1.965e-012	4.094e-007	1.0000	-11.7067
CaCl2(aq)	1.010e-012	1.121e-007	1.0000	-11.9955
UO2OH+	8.973e-013	2.575e-007	0.9312	-12.0780
Sb(OH)2F(aq)	5.990e-013	1.047e-007	1.0000	-12.2226
HNO3(aq)	4.065e-013	2.561e-008	1.0000	-12.3909
HCl(aq)	2.128e-013	7.756e-009	1.0000	-12.6721
Sb(OH)2+	1.950e-013	3.036e-008	0.9312	-12.7410
CdCl2(aq)	1.452e-013	2.662e-008	1.0000	-12.8379
H3PO4(aq)	3.007e-014	2.946e-009	1.0000	-13.5219
KHSO4(aq)	1.049e-014	1.428e-009	1.0000	-13.9792
MgP2O7--	7.430e-015	1.473e-009	0.7511	-14.2533
H3AsO4(aq)	4.727e-015	6.708e-010	1.0000	-14.3254
UO2++	2.313e-015	6.245e-010	0.7533	-14.7588
UO2F+	2.005e-015	5.793e-010	0.9312	-14.7288
UO2SO4(aq)	5.624e-016	2.058e-010	1.0000	-15.2499
HF2-	3.137e-016	1.223e-011	0.9312	-15.5345
HP2O7---	7.509e-017	1.313e-011	0.5250	-16.4043
UO2F2(aq)	5.572e-017	1.716e-011	1.0000	-16.2540
P2O7----	7.591e-018	1.320e-012	0.3179	-17.6174
CdCl3-	3.558e-018	7.781e-013	0.9312	-17.4797
H2P2O7--	2.309e-018	4.061e-013	0.7511	-17.7609
UO2(SO4)2--	1.699e-018	7.851e-013	0.7511	-17.8940
KP2O7---	5.703e-019	1.215e-013	0.5250	-18.5238
UO2Cl+	2.658e-019	8.116e-014	0.9312	-18.6064
UO2F3-	9.968e-020	3.259e-014	0.9312	-19.0323
(UO2)2(OH)2++	7.451e-020	4.276e-014	0.7533	-19.2508
(UO2)3(OH)5+	8.158e-021	7.300e-015	0.9312	-20.1193
(UO2)3(CO3)6(6-)	4.328e-021	5.063e-015	0.0759	-21.4837
UO2+	2.410e-021	6.505e-016	0.9312	-20.6490
UO2F4--	6.889e-024	2.383e-018	0.7511	-23.2862
H3P2O7-	4.158e-024	7.356e-019	0.9312	-23.4120
Mn+++	2.126e-024	1.167e-019	0.5317	-23.9469
UO2Cl2(aq)	1.289e-024	4.394e-019	1.0000	-23.8897
NO2-	1.449e-025	6.664e-021	0.9299	-24.8705
U(OH)4(aq)	1.336e-025	4.087e-020	1.0000	-24.8742
HAsO2(aq)	5.108e-026	5.511e-021	1.0000	-25.2918
As(OH)3(aq)	4.414e-026	5.558e-021	1.0000	-25.3551
O2(aq)	1.391e-026	4.449e-022	1.0000	-25.8567
AsO2-	2.552e-027	2.728e-022	0.9312	-26.6240
H2AsO3-	2.522e-027	3.150e-022	0.9312	-26.6292

HNO2(aq)	2.615e-030	1.229e-025	1.0000	-29.5824
AsO2OH--	2.529e-030	3.133e-025	0.7511	-29.7214
H4P2O7(aq)	1.154e-030	2.053e-025	1.0000	-29.9378
MnO4--	7.769e-033	9.238e-028	0.7511	-32.2339
ClO-	6.945e-033	3.572e-028	0.9312	-32.1893
Formate	4.587e-034	2.064e-029	0.9306	-33.3697
HO2-	2.881e-034	9.507e-030	0.9312	-33.5714
H2(aq)	1.373e-034	2.766e-031	1.0000	-33.8625
MnO4-	3.368e-035	4.005e-030	0.9306	-34.5039
Ca(For)+	5.014e-036	4.266e-031	0.9312	-35.3307
Mg(For)+	1.971e-036	1.366e-031	0.9312	-35.7363
Na(For)(aq)	5.277e-037	3.588e-032	1.0000	-36.2776
K(For)(aq)	2.767e-037	2.327e-032	1.0000	-36.5580
Mn(For)+	6.631e-038	6.626e-033	0.9312	-37.2094
Formic_acid(aq)	2.451e-038	1.128e-033	1.0000	-37.6107
SO3--	1.733e-038	1.387e-033	0.7533	-37.8843
Cu(For)+	7.300e-039	7.923e-034	0.9312	-38.1676
Ba(For)+	6.564e-039	1.197e-033	0.9312	-38.2138
HSO3-	2.191e-039	1.776e-034	0.9312	-38.6902
SiF6--	7.276e-040	1.033e-034	0.7511	-39.2624
Cd(For)+	2.178e-040	3.427e-035	0.9312	-39.6930
NH4+	5.474e-041	9.872e-037	0.9292	-40.2936
CO(aq)	5.096e-041	1.427e-036	1.0000	-40.2927
Oxalate	1.725e-041	1.518e-036	0.7511	-40.8875
NH3(aq)	2.163e-042	3.682e-038	1.0000	-41.6650
HSO5-	9.080e-043	1.026e-037	0.9312	-42.0729
U(CO3)5(6-)	8.077e-044	4.345e-038	0.0759	-44.2128
UOH+++	3.124e-045	7.965e-040	0.5317	-44.7796
H-Oxalate	2.464e-045	2.193e-040	0.9312	-44.6393
SO2(aq)	1.368e-045	8.763e-041	1.0000	-44.8638
UF3+	2.245e-046	6.623e-041	0.9312	-45.6796
UF2++	1.377e-046	3.801e-041	0.7533	-45.9840
UF4(aq)	1.867e-047	5.860e-042	1.0000	-46.7289
UF+++	2.516e-048	6.466e-043	0.5317	-47.8736
U(SO4)2(aq)	1.329e-049	5.715e-044	1.0000	-48.8765
USO4++	9.484e-050	3.168e-044	0.7533	-49.1460
Oxalic_acid(aq)	4.240e-052	3.816e-047	1.0000	-51.3726
U++++	2.345e-052	5.580e-047	0.3288	-52.1130
ClO2-	6.132e-054	4.135e-049	0.9312	-53.2433
UCl+++	8.519e-055	2.329e-049	0.5317	-54.3440
S2O8--	1.538e-059	2.954e-054	0.7511	-58.9373
ClO3-	6.091e-061	5.082e-056	0.9306	-60.2465
S2O6--	5.262e-063	8.424e-058	0.7511	-62.4031
Ca(For)2(aq)	1.569e-068	2.041e-063	1.0000	-67.8042
Mg(For)2(aq)	6.558e-069	7.496e-064	1.0000	-68.1832
U+++	1.465e-069	3.487e-064	0.5317	-69.1084
Mn(For)2(aq)	3.523e-070	5.105e-065	1.0000	-69.4531
Na(For)2-	1.403e-070	1.585e-065	0.9312	-69.8839
K(For)2-	6.758e-071	8.725e-066	0.9312	-70.2011
Cu(For)2(aq)	6.743e-071	1.035e-065	1.0000	-70.1712
N3-	5.954e-071	2.501e-066	0.9312	-70.2561
Ba(For)2(aq)	1.775e-071	4.035e-066	1.0000	-70.7508
Cd(For)2(aq)	9.697e-072	1.963e-066	1.0000	-71.0133
ClO4-	2.827e-072	2.811e-067	0.9306	-71.5799
Formaldehyde(aq)	1.294e-073	3.884e-069	1.0000	-72.8881
HN3(aq)	3.171e-074	1.364e-069	1.0000	-73.4988
UO2ClO3+	3.376e-075	1.193e-069	0.9312	-74.5025
S2O5--	8.522e-083	1.228e-077	0.7511	-82.1937
Cu(NH3)2++	3.527e-083	3.441e-078	0.7533	-82.5757
Cd(NH3)2++	3.559e-087	5.212e-082	0.7533	-86.5717
HCN(aq)	7.301e-088	1.973e-083	1.0000	-87.1366
Urea(aq)	3.579e-088	2.149e-083	1.0000	-87.4462
CN-	3.452e-089	8.978e-085	0.9299	-88.4936

Methanol(aq)	1.840e-092	5.894e-088	1.0000	-91.7352
Glycolate	1.466e-098	1.100e-093	0.9312	-97.8647
Ca(Glyc)+	2.701e-100	3.109e-095	0.9312	-99.5993
HS-	5.647e-101	1.867e-096	0.9306	-100.2794
Mg(Glyc)+	4.776e-101	4.743e-096	0.9312	-100.3519
Na(Glyc)(aq)	1.701e-101	1.667e-096	1.0000	-100.7693
K(Glyc)(aq)	8.918e-102	1.018e-096	1.0000	-101.0497
H2S(aq)	5.951e-102	2.028e-097	1.0000	-101.2254
Cu(Glyc)+	1.973e-102	2.733e-097	0.9312	-101.7359
Mn(Glyc)+	1.623e-102	2.108e-097	0.9312	-101.8207
Glycolic_acid(aq	9.419e-103	7.161e-098	1.0000	-102.0260
Ba(Glyc)+	9.023e-104	1.916e-098	0.9312	-103.0756
Cd(Glyc)+	7.530e-105	1.411e-099	0.9312	-104.1541
S2O4--	3.383e-105	4.333e-100	0.7554	-104.5925
S--	6.050e-106	1.939e-101	0.7554	-105.3401
Methane(aq)	3.863e-106	6.196e-102	1.0000	-105.4131
S2O3--	1.387e-107	1.555e-102	0.7511	-106.9821
Acetate	1.393e-111	8.221e-107	0.9319	-110.8868
CaCH3COO+	4.766e-114	4.722e-109	0.9312	-113.3528
MgCH3COO+	4.194e-114	3.495e-109	0.9312	-113.4083
NaCH3COO(aq)	1.130e-114	9.268e-110	1.0000	-113.9469
Acetic_acid(aq)	7.443e-115	4.468e-110	1.0000	-114.1283
KCH3COO(aq)	4.264e-115	4.183e-110	1.0000	-114.3702
MnCH3COO+	6.573e-116	7.490e-111	0.9312	-115.2132
CuCH3COO+	4.028e-116	4.937e-111	0.9312	-115.4258
BaCH3COO+	8.068e-117	1.584e-111	0.9312	-116.1242
CdCH3COO+	8.189e-118	1.404e-112	0.9312	-117.1177
Malonate	2.581e-120	2.633e-115	0.7511	-119.7125
Cu(NH3)3++	5.739e-122	6.577e-117	0.7533	-121.3642
H-Malonate	1.013e-122	1.044e-117	0.9312	-122.0253
CuCH3COO(aq)	9.601e-123	1.177e-117	1.0000	-122.0177
AsH3(aq)	4.362e-123	3.399e-118	1.0000	-122.3603
Malonic_acid(aq)	6.757e-128	7.029e-123	1.0000	-127.1703
Methanamine(aq)	1.057e-131	3.283e-127	1.0000	-130.9757
Glycine(aq)	4.580e-135	3.437e-130	1.0000	-134.3391
Cu(Gly)+	4.286e-135	5.896e-130	0.9312	-134.3988
Mg(Gly)+	2.785e-137	2.739e-132	0.9312	-136.5861
Mn(Gly)+	8.271e-139	1.067e-133	0.9312	-138.1134
Ca(Gly)+	5.249e-139	5.989e-134	0.9312	-138.3109
S3O6--	6.336e-140	1.217e-134	0.7511	-139.3225
Cd(Gly)+	2.144e-140	3.996e-135	0.9312	-139.6998
Ba(Gly)+	1.070e-141	2.261e-136	0.9312	-141.0016
Acetaldehyde(aq)	5.669e-149	2.497e-144	1.0000	-148.2465
SCN-	1.708e-150	9.920e-146	0.9306	-149.7987
NH4CH3COO(aq)	1.090e-151	8.398e-147	1.0000	-150.9626
Acetamide(aq)	1.017e-151	6.007e-147	1.0000	-150.9926
UO2SCN+	7.487e-164	2.456e-158	0.9312	-163.1566
Cd(NH3)4++	4.911e-168	8.863e-163	0.7533	-167.4319
Ethyne(aq)	2.511e-170	6.536e-166	1.0000	-169.6002
Ethanol(aq)	2.532e-172	1.166e-167	1.0000	-171.5965
Ethylene(aq)	7.077e-177	1.985e-172	1.0000	-176.1502
Lactate	2.276e-178	2.027e-173	0.9312	-177.6737
Ca(Lac)+	2.481e-180	3.203e-175	0.9312	-179.6363
Mg(Lac)+	7.986e-181	9.052e-176	0.9312	-180.1286
Na(Lac)(aq)	2.670e-181	2.991e-176	1.0000	-180.5735
K(Lac)(aq)	1.400e-181	1.794e-176	1.0000	-180.8538
Mn(Lac)+	1.787e-182	2.573e-177	0.9312	-181.7787
Lactic_acid(aq)	1.558e-182	1.403e-177	1.0000	-181.8074
Cu(Lac)+	1.431e-182	2.183e-177	0.9312	-181.8753
Ba(Lac)+	6.055e-184	1.370e-178	0.9312	-183.2488
Cd(Lac)+	7.946e-185	1.601e-179	0.9312	-184.1308
Ethane(aq)	3.432e-190	1.032e-185	1.0000	-189.4644
Propanoate	1.643e-193	1.200e-188	0.9312	-192.8152

Ca(Prop)+	3.133e-196	3.544e-191	0.9312	-195.5350
Na(Prop)(aq)	1.900e-196	1.825e-191	1.0000	-195.7213
Mg(Prop)+	1.351e-196	1.315e-191	0.9312	-195.9003
Propanoic_acid(a	1.187e-196	8.793e-192	1.0000	-195.9254
K(Prop)(aq)	9.962e-197	1.117e-191	1.0000	-196.0016
Ca(Glyc)2(aq)	6.460e-197	1.228e-191	1.0000	-196.1898
Mn(Prop)+	8.953e-198	1.146e-192	0.9312	-197.0790
Mg(Glyc)2(aq)	6.364e-198	1.109e-192	1.0000	-197.1963
Cu(Prop)+	4.609e-198	6.295e-193	0.9312	-197.3673
Cu(Glyc)2(aq)	1.675e-198	3.577e-193	1.0000	-197.7760
USCN+++	2.559e-199	7.575e-194	0.5317	-198.8663
Na(Glyc)2-	2.254e-199	3.900e-194	0.9312	-198.6779
Mn(Glyc)2(aq)	1.577e-199	3.232e-194	1.0000	-198.8022
Ba(Prop)+	1.336e-199	2.811e-194	0.9312	-198.9050
K(Glyc)2-	1.094e-199	2.069e-194	0.9312	-198.9920
Cd(Prop)+	8.809e-200	1.633e-194	0.9312	-199.0860
Succinate	1.119e-200	1.299e-195	0.7511	-200.0753
S4O6--	8.713e-201	1.953e-195	0.7511	-200.1841
Ba(Glyc)2(aq)	5.866e-201	1.686e-195	1.0000	-200.2316
Cd(Glyc)2(aq)	2.781e-201	7.298e-196	1.0000	-200.5558
Serine(aq)	2.014e-202	2.115e-197	1.0000	-201.6960
H-Succinate	3.882e-203	4.543e-198	0.9312	-202.4419
Succinic_acid(aq	5.978e-207	7.057e-202	1.0000	-206.2235
Ethanamine(aq)	1.887e-213	8.506e-209	1.0000	-212.7242
Alanine(aq)	9.728e-216	8.665e-211	1.0000	-215.0120
Cu(Ala)+	2.068e-216	3.135e-211	0.9312	-215.7154
Mg(Ala)+	4.701e-220	5.282e-215	0.9312	-219.3588
Ca(Ala)+	2.225e-220	2.851e-215	0.9312	-219.6835
Mn(Ala)+	1.673e-220	2.392e-215	0.9312	-219.8074
Cd(Ala)+	2.591e-221	5.194e-216	0.9312	-220.6174
Ba(Ala)+	1.739e-223	3.920e-218	0.9312	-222.7905
Ca(CH3COO)2(aq)	1.002e-223	1.584e-218	1.0000	-222.9993
Mg(CH3COO)2(aq)	3.348e-224	4.766e-219	1.0000	-223.4752
Cu(CH3COO)2(aq)	1.389e-225	2.522e-220	1.0000	-224.8574
Na(CH3COO)2-	7.289e-226	1.028e-220	0.9312	-225.1683
Mn(CH3COO)2(aq)	6.072e-226	1.050e-220	1.0000	-225.2167
Acetone(aq)	4.530e-226	2.630e-221	1.0000	-225.3439
K(CH3COO)2-	1.959e-226	3.079e-221	0.9312	-225.7388
Aspartic_acid(aq	1.336e-226	1.777e-221	1.0000	-225.8743
Ba(CH3COO)2(aq)	3.227e-227	8.239e-222	1.0000	-226.4913
Cd(CH3COO)2(aq)	1.842e-227	4.245e-222	1.0000	-226.7347
Propanal(aq)	2.405e-230	1.396e-225	1.0000	-229.6189
Cu(CH3COO)2-	1.430e-233	2.596e-228	0.9312	-232.8757
1-Propyne(aq)	3.629e-248	1.453e-243	1.0000	-247.4402
1-Propanol(aq)	3.379e-254	2.030e-249	1.0000	-253.4712
S3--	1.084e-254	1.042e-249	0.7511	-254.0894
1-Propene(aq)	1.476e-256	6.211e-252	1.0000	-255.8308
2-Hydroxybutanoa	1.153e-260	1.188e-255	0.9312	-259.9692
NH4(CH3COO)2-	1.226e-262	1.669e-257	0.9312	-261.9423
Asparagine(aq)	2.301e-263	3.039e-258	1.0000	-262.6381
Cu(Gly)2(aq)	5.266e-264	1.114e-258	1.0000	-263.2785
2-Hydroxybutanoi	7.017e-265	7.303e-260	1.0000	-264.1538
Mg(Gly)2(aq)	1.725e-270	2.973e-265	1.0000	-269.7633
Diglycine(aq)	5.237e-272	6.916e-267	1.0000	-271.2810
Mn(Gly)2(aq)	4.483e-272	9.101e-267	1.0000	-271.3484
Propane(aq)	1.927e-272	8.497e-268	1.0000	-271.7150
Cd(Gly)2(aq)	6.626e-273	1.726e-267	1.0000	-272.1787
Diketopiperazine	3.291e-274	3.754e-269	1.0000	-273.4826
Ca(Gly)2(aq)	1.598e-274	3.007e-269	1.0000	-273.7963
Butanoate	6.496e-276	5.656e-271	0.9312	-275.2183
Ba(Gly)2(aq)	4.091e-277	1.167e-271	1.0000	-276.3881
Ca(But)+	8.547e-279	1.087e-273	0.9312	-278.0991
Na(But)(aq)	7.187e-279	7.910e-274	1.0000	-278.1434

Butanoic_acid(aq	3.867e-279	3.406e-274	1.0000	-278.4126
K(But)(aq)	3.769e-279	4.755e-274	1.0000	-278.4238
Mg(But)+	3.519e-279	3.919e-274	0.9312	-278.4845
Mn(But)+	3.015e-280	4.281e-275	0.9312	-279.5517
Cu(But)+	1.444e-280	2.175e-275	0.9312	-279.8713
Ba(But)+	3.558e-282	7.983e-277	0.9312	-281.4797
Glutarate	3.533e-282	4.596e-277	0.7511	-281.5761
Cd(But)+	1.508e-282	3.009e-277	0.9312	-281.8524
Threonine(aq)	8.315e-285	9.902e-280	1.0000	-284.0801
H-Glutarate	7.403e-285	9.703e-280	0.9312	-284.1615
Ethylacetate(aq)	5.529e-288	4.870e-283	1.0000	-287.2574
Glutaric_acid(aq	1.518e-288	2.006e-283	1.0000	-287.8186
S5O6--	8.593e-291	2.202e-285	0.7511	-290.1902
1-Propanamine(aq	8.385e-295	4.955e-290	1.0000	-294.0765
a-Aminobutyric_a	8.241e-298	8.495e-293	1.0000	-297.0840
Glutamic_acid(aq	5.243e-307	7.712e-302	1.0000	-300.0000
UO2(SCN)2(aq)	7.148e-314	2.760e-308	1.0000	-300.0000
Butanal(aq)	3.779e-314	2.724e-309	1.0000	-300.0000
Cd(CH3COO)3-	0.0000	0.0000	0.9312	-300.0000
Azelaic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Cd(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
K(But)2-	0.0000	0.0000	0.9312	-300.0000
Isoleucine(aq)	0.0000	0.0000	1.0000	-300.0000
Hexanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Cd(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Hexanoate	0.0000	0.0000	0.9312	-300.0000
Hexanal(aq)	0.0000	0.0000	1.0000	-300.0000
Heptanoic_acid(a	0.0000	0.0000	1.0000	-300.0000
Heptanoate	0.0000	0.0000	0.9312	-300.0000
Heptanal(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hexanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexyne(aq)	0.0000	0.0000	1.0000	-300.0000
HSb2S4-	0.0000	0.0000	0.9312	-300.0000
p-Toluate	0.0000	0.0000	0.9312	-300.0000
o-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
o-Toluate	0.0000	0.0000	0.9312	-300.0000
2-Heptanone(aq)	0.0000	0.0000	1.0000	-300.0000
n-Propylbenzene(	0.0000	0.0000	1.0000	-300.0000
n-Pentylbenzene(	0.0000	0.0000	1.0000	-300.0000
n-Pentane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Octane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Hexylbenzene(a	0.0000	0.0000	1.0000	-300.0000
n-Hexane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Heptane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Butane(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
m-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
m-Toluate	0.0000	0.0000	0.9312	-300.0000
Valine(aq)	0.0000	0.0000	1.0000	-300.0000
2-Butanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Butyne(aq)	0.0000	0.0000	1.0000	-300.0000
Undecanoic_acid(	0.0000	0.0000	1.0000	-300.0000
Undecanoate	0.0000	0.0000	0.9312	-300.0000
Ca(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(Pent)+	0.0000	0.0000	0.9312	-300.0000
Alanylglycine(aq	0.0000	0.0000	1.0000	-300.0000
Ca(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
UO2(SCN)3-	0.0000	0.0000	0.9312	-300.0000
Adipic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
H-Suberate	0.0000	0.0000	0.9312	-300.0000
H-Sebacate	0.0000	0.0000	0.9312	-300.0000
H-Pimelate	0.0000	0.0000	0.9312	-300.0000

Adipate	0.0000	0.0000	0.7511	-300.0000
1-Hexanol(aq)	0.0000	0.0000	1.0000	-300.0000
U(SCN)2++	0.0000	0.0000	0.7533	-300.0000
Tyrosine(aq)	0.0000	0.0000	1.0000	-300.0000
Tryptophan(aq)	0.0000	0.0000	1.0000	-300.0000
Toluene(aq)	0.0000	0.0000	1.0000	-300.0000
H-Azelate	0.0000	0.0000	0.9312	-300.0000
H-Adipate	0.0000	0.0000	0.9312	-300.0000
Suberate	0.0000	0.0000	0.7511	-300.0000
Sebacic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Sebacate	0.0000	0.0000	0.7511	-300.0000
Ca(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Sb2S4--	0.0000	0.0000	0.7511	-300.0000
Glutamine(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
S5--	0.0000	0.0000	0.7511	-300.0000
S4--	0.0000	0.0000	0.7511	-300.0000
1-Hexanamine(aq)	0.0000	0.0000	1.0000	-300.0000
1-Butene(aq)	0.0000	0.0000	1.0000	-300.0000
Ethylbenzene(aq)	0.0000	0.0000	1.0000	-300.0000
Pimelic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Pimelate	0.0000	0.0000	0.7511	-300.0000
Phenylalanine(aq	0.0000	0.0000	1.0000	-300.0000
Phenol(aq)	0.0000	0.0000	1.0000	-300.0000
Pentanoic_acid(a	0.0000	0.0000	1.0000	-300.0000
Pentanoate	0.0000	0.0000	0.9312	-300.0000
Pentanal(aq)	0.0000	0.0000	1.0000	-300.0000
2-Pentanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Pentyne(aq)	0.0000	0.0000	1.0000	-300.0000
Dodecanoic_acid(	0.0000	0.0000	1.0000	-300.0000
Dodecanoate	0.0000	0.0000	0.9312	-300.0000
Octanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Octanoate	0.0000	0.0000	0.9312	-300.0000
Octanal(aq)	0.0000	0.0000	1.0000	-300.0000
2-Octanone(aq)	0.0000	0.0000	1.0000	-300.0000
Nonanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Decanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Nonanoate	0.0000	0.0000	0.9312	-300.0000
Nonanal(aq)	0.0000	0.0000	1.0000	-300.0000
Decanoate	0.0000	0.0000	0.9312	-300.0000
Benzoic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Decanal(aq)	0.0000	0.0000	1.0000	-300.0000
Benzoate	0.0000	0.0000	0.9338	-300.0000
2-Hydroxypentano	0.0000	0.0000	1.0000	-300.0000
1-Pentene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptyne(aq)	0.0000	0.0000	1.0000	-300.0000
Benzene(aq)	0.0000	0.0000	1.0000	-300.0000
Na(Prop)2-	0.0000	0.0000	0.9312	-300.0000
Na(Pent)2-	0.0000	0.0000	0.9312	-300.0000
Na(Pent)(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxypentano	0.0000	0.0000	0.9312	-300.0000
Na(Lac)2-	0.0000	0.0000	0.9312	-300.0000
Cu(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Pent)+	0.0000	0.0000	0.9312	-300.0000
Na(But)2-	0.0000	0.0000	0.9312	-300.0000
Suberic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyoctanoi	0.0000	0.0000	1.0000	-300.0000
1-Pentanol(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyoctanoa	0.0000	0.0000	0.9312	-300.0000
Ba(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxynonanoi	0.0000	0.0000	1.0000	-300.0000

1-Pentanamine(aq	0.0000	0.0000	1.0000	-300.0000
1-Heptene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Butanol(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Pent)+	0.0000	0.0000	0.9312	-300.0000
Cu(CH3COO)3-	0.0000	0.0000	0.9312	-300.0000
Ba(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Pent)+	0.0000	0.0000	0.9312	-300.0000
2-Hydroxynonanoa	0.0000	0.0000	0.9312	-300.0000
Cu(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(CH3COO)3-	0.0000	0.0000	0.9312	-300.0000
Cu(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyhexanoi	0.0000	0.0000	1.0000	-300.0000
1-Octyne(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyhexanoa	0.0000	0.0000	0.9312	-300.0000
Mg(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Pent)+	0.0000	0.0000	0.9312	-300.0000
Mg(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyheptano	0.0000	0.0000	1.0000	-300.0000
1-Octene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptanol(aq)	0.0000	0.0000	1.0000	-300.0000
Cd(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyheptano	0.0000	0.0000	0.9312	-300.0000
Mg(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cd(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Methionine(aq)	0.0000	0.0000	1.0000	-300.0000
Cd(Pent)+	0.0000	0.0000	0.9312	-300.0000
Ba(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxydecanoi	0.0000	0.0000	1.0000	-300.0000
1-Octanol(aq)	0.0000	0.0000	1.0000	-300.0000
Leucylglycine(aq	0.0000	0.0000	1.0000	-300.0000
Cd(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Leucine(aq)	0.0000	0.0000	1.0000	-300.0000
n-Butylbenzene(a	0.0000	0.0000	1.0000	-300.0000
Ba(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
n-Heptylbenzene(	0.0000	0.0000	1.0000	-300.0000
2-Hydroxydecanoa	0.0000	0.0000	0.9312	-300.0000
K(Prop)2-	0.0000	0.0000	0.9312	-300.0000
K(Pent)2-	0.0000	0.0000	0.9312	-300.0000
n-Octylbenzene(a	0.0000	0.0000	1.0000	-300.0000
K(Pent)(aq)	0.0000	0.0000	1.0000	-300.0000
K(Lac)2-	0.0000	0.0000	0.9312	-300.0000
Azelate	0.0000	0.0000	0.7511	-300.0000
o-Phthalate	0.0000	0.0000	0.7511	-300.0000
1-Octanamine(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptanamine(aq	0.0000	0.0000	1.0000	-300.0000
1-Butanamine(aq)	0.0000	0.0000	1.0000	-300.0000
p-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
(NH4)2Sb2S4(aq)	0.0000	0.0000	1.0000	-300.0000

Mineral saturation states

	log Q/K		log Q/K
Fluorapatite	6.0547s/sat	UO2SO4:3H2O	-16.9565
Witherite	1.9760s/sat	CdF2	-17.1899
Malachite	1.3998s/sat	UO2F2:3H2O	-17.4547

Brochantite	1.3884s/sat	Larnite	-17.4812
Tenorite	1.3681s/sat	MnCl2:2H2O	-17.6270
Bixbyite	0.5891s/sat	UO2F2	-17.6467
Talc	0.4616s/sat	Autunite-H	-18.0475
Quartz	0.4527s/sat	CuCl2	-18.6326
Dolomite	0.4114s/sat	Na2UO4(alpha)	-19.1563
Dolomite-ord	0.4114s/sat	MnCl2:H2O	-19.2114
Barite	0.3110s/sat	MgCl2:4H2O	-19.2714
Tridymite	0.2556s/sat	UO2SO4	-20.4433
Chalcedony	0.1776s/sat	Lime	-20.4701
Cristobalite(alp	-0.1073	UO2.3333(beta)	-21.2558
Ice	-0.1228	Rankinite	-22.1481
Calcite	-0.1612	Scacchite	-22.4912
Rhodochrosite	-0.2670	UO2(NO3)2:6H2O	-23.1265
Hausmannite	-0.2981	Tobermorite-14A	-23.2499
Aragonite	-0.3057	Hydrophilite	-23.3662
Coesite	-0.3682	K2UO4	-23.4915
Cristobalite(bet	-0.5628	Ningyoite	-23.6153
Dioptase	-0.6041	UOFOH:.5H2O	-23.9159
SiO2(am)	-0.8683	UO2Cl	-24.1663
Monohydrocalcite	-0.9842	UOFOH	-24.3863
Pyrolusite	-1.0428	UO2(NO3)2:3H2O	-24.5959
Magnesite	-1.0819	MgCl2:2H2O	-24.8075
Dolomite-dis	-1.1638	Tobermorite-11A	-25.1512
Atacamite	-1.8371	Antigorite	-25.2114
Gypsum	-2.4365	UO2(NO3)2:2H2O	-25.8634
CaUO4	-2.4404	Merwinite	-26.9112
Chrysotile	-2.4423	Foshagite	-27.3448
Anhydrite	-2.6524	UOF2:H2O	-27.5295
Enstatite	-3.0003	UOF2	-28.1118
Rhodonite	-3.0880	MgCl2:H2O	-28.2176
Hydroxylapatite	-3.1069	UO2(PO3)2	-28.4008
Bassanite	-3.2986	(UO2)3(PO4)2	-28.4084
Fluorite	-3.3649	UO2Cl2:3H2O	-28.4579
CaSO4:0.5H2O(bet	-3.4720	Tobermorite-9A	-28.7244
CdSiO3	-3.4787	(UO2)2P2O7	-28.8730
Sb2O3	-3.4801	Ba2SiO4	-29.2578
Azurite	-3.5906	UO2(NO3)2:H2O	-29.5024
Schoepite	-3.7199	Afwillite	-30.3236
UO3:2H2O	-3.7226	UO2Cl2:H2O	-31.2100
Diopside	-3.8032	U(HPO4)2:4H2O	-32.9886
UO2(OH)2(beta)	-3.8496	UP2O7	-32.9933
UO3:.9H2O(alpha)	-3.9137	UO2(NO3)2	-33.0179
Schoepite-dehy(.	-3.9178	KMgCl3:2H2O	-33.1710
Sepiolite	-3.9650	Chloromagnesite	-34.0577
Schoepite-dehy(.	-3.9954	UO2Cl2	-35.1379
Schoepite-dehy(1	-4.0043	As2O5	-35.3509
Whitlockite	-4.0640	UO2SO3	-36.6375
Nesquehonite	-4.0952	Cd	-36.7582
Brucite	-4.4148	(UO2)2As2O7	-38.6912
Sellaite	-4.5085	BaO	-38.7016
Wollastonite	-4.9897	UF4:2.5H2O	-38.7406
Cuprite	-4.9946	UO2(AsO3)2	-39.0729
Huntite	-5.0083	(UO2)3(AsO4)2	-39.1677
Okenite	-5.1017	Xonotlite	-39.3890
Mn(OH)2(am)	-5.1163	BaSiF6	-39.5524
Schoepite-dehy(.	-5.1268	Hatrurite	-40.3493
Pseudowollastoni	-5.2362	KMgCl3	-40.5932
Tremolite	-5.2897	Ba2U2O7	-42.7918
UO2CO3	-5.5224	UF4	-43.0148
Rutherfordine	-5.5432	U(SO4)2:8H2O	-46.6820
Schoepite-dehy(.	-5.6540	U(SO4)2:4H2O	-47.7949
Nahcolite	-5.6583	U(SO4)2	-47.8773

Niter	-5.9668	Arsenolite	-49.2152
Cd(OH)2	-6.1448	Claudetite	-49.2792
Tephroite	-6.2428	U(CO3)2	-49.7485
Artinite	-6.4989	UOCl2	-49.8935
UO3(gamma)	-6.6713	C	-50.1332
Sanbornite	-7.0316	UClF3	-53.8119
UO3(beta)	-7.2827	Na3UO4	-54.5471
BaUO4	-7.5191	Na4SiO4	-54.9700
Monteponite	-7.5433	UOF4	-55.7630
UO3(alpha)	-7.6191	U5O12Cl	-56.4523
Forsterite	-7.6808	Na	-56.8340
Chalcanthite	-7.6936	Na2O	-58.2460
Manganosite	-7.7941	As	-58.6301
Cd(OH)Cl	-7.7945	(UO2)2Cl3	-60.4397
Sylvite	-7.9988	K	-60.7147
Arcanite	-8.0764	Mn	-60.8400
Mirabilite	-8.1227	UOCl3	-61.4804
Halite	-8.5256	UF5(beta)	-64.6562
UO2HPO4:4H2O	-8.5947	UF3	-64.7234
Nantokite	-8.6021	UF5(alpha)	-65.0101
Gyrolite	-8.8246	Ba3UO6	-65.1802
Monticellite	-8.9497	UCl2F2	-66.9242
Thenardite	-9.1377	UOCl	-67.7537
UO2FOH:2H2O	-9.1696	U2O3F6	-73.5592
Periclase	-9.5485	S	-75.4469
UO2FOH:H2O	-9.5695	K2O	-75.5429
Nitrobarite	-9.7579	Covellite	-76.0017
Mg1.25SO4(OH)0.5	-9.8048	UCl3F	-79.8588
Cu	-9.9309	Na6Si2O7	-79.8729
CdSO4:2.667H2O	-9.9510	Chalcocite	-79.9940
UO2FOH	-10.0350	CdS	-84.3946
MgUO4	-10.0995	CdCl2(NH3)2	-90.5493
CdSO4:H2O	-10.1305	UCl4	-90.6249
BaU2O7	-10.1786	U(SO3)2	-91.0717
Natron	-10.2680	UCl3	-94.3816
Portlandite	-10.2868	UF6	-94.9222
Na2U2O7	-10.4832	Alabandite	-97.5044
Na2CO3:7H2O	-10.6626	As4O6(mono)	-98.0748
Mg1.5SO4(OH)	-10.8309	U3O5F8	-98.2947
UO2.25	-11.6565	As4O6(cubi)	-98.3116
UO2.25(beta)	-11.7195	Mg	-99.3120
CdSO4	-11.7269	U2F9	-104.4943
Thermonatrite	-11.8093	UCl5	-110.4951
MnSO4	-11.8901	U2O2Cl5	-112.5860
Anthophyllite	-11.8998	UN1.73(alpha)	-113.6605
Saleeite	-11.9581	BaS	-114.9882
Na2CO3	-12.0582	UN1.59(alpha)	-116.3777
UO2SO4:H2O	-12.3420	Ca	-116.3870
MgSO4	-12.4471	Ba	-120.5856
UO2ClOH:2H2O	-13.1328	P	-124.7877
Chalcocyanite	-13.4296	Si	-128.8429
Ca3(AsO4)2	-13.5119	UCl6	-129.1989
UO2.6667	-13.7527	UN	-129.2412
Uranocircite	-13.8988	CdCl2(NH3)4	-175.8183
Torbernite	-14.0373	U	-175.9735
Hydromagnesite	-14.1553	U4F17	-189.6476
BaCl2:2H2O	-14.3883	UAs	-192.3358
CdCl2:H2O	-14.5041	US	-194.3875
Ba(OH)2:8H2O	-14.8546	UC	-208.5342
Ba2Si3O8	-14.8950	UH3(beta)	-209.0686
BaCl2:H2O	-15.0365	US1.9	-228.7876
(UO2)3(PO4)2:4H2	-15.1445	US2	-234.5942
Natrosilite	-15.4595	UAs2	-248.3141

Uraninite	-15.4773	UP	-253.4965
CdCl2	-15.5579	UC1.94(alpha)	-257.7055
Hillebrandite	-15.7749	CdCl2(NH3)6	-261.1641
Coffinite	-15.8395	Stibnite	-283.4737
UPO5	-15.8768	US3	-306.8374
Akermanite	-15.9534	Orpiment	-313.6382
Na2SiO3	-16.0157	UP2	-373.1818
MgOHCl	-16.0301	U2S3	-421.9494
NaUO3	-16.0940	o-Phthalic_acid	-433.8985
Dicalcium_silica	-16.1636	U2C3	-468.7190
MnCl2:4H2O	-16.3198	U3As4	-633.5510
BaCl2	-16.4863	U3S5	-651.9311
UO2SO4:3.5H2O	-16.8613	U3P4	-880.1697
UO2SO4:2.5H2O	-16.8715		

Gases	fugacity	log fug.
N2(g)	0.1662	-0.779
H2O(g)	0.02011	-1.697
CO2(g)	0.0008846	-3.053
NO2(g)	7.243e-014	-13.140
HF(g)	5.240e-015	-14.281
HCl(g)	3.365e-019	-18.473
O2(g)	1.009e-023	-22.996
NO(g)	5.500e-028	-27.260
H2(g)	1.689e-031	-30.772
CO(g)	4.755e-038	-37.323
Cl2(g)	9.527e-041	-40.021
SiF4(g)	2.527e-041	-40.597
NH3(g)	2.813e-044	-43.551
SO2(g)	7.821e-046	-45.107
Cd(g)	2.779e-051	-50.556
UO2F2(g)	5.011e-061	-60.300
Cu(g)	1.229e-063	-62.910
Na(g)	2.693e-071	-70.570
UO3(g)	1.052e-071	-70.978
K(g)	3.030e-072	-71.519
UO2Cl2(g)	2.269e-072	-71.644
UOF4(g)	1.316e-076	-75.881
UF5(g)	2.274e-085	-84.643
UF4(g)	2.519e-088	-87.599
F2(g)	2.346e-096	-95.630
UF6(g)	1.348e-096	-95.870
H2S(g)	5.150e-101	-100.288
CH4(g)	2.483e-103	-102.605
UO2(g)	3.223e-114	-113.492
UCl4(g)	2.814e-116	-115.551
Mg(g)	4.379e-120	-119.359
UCl5(g)	7.856e-129	-128.105
UF3(g)	3.223e-133	-132.492
UCl6(g)	5.153e-136	-135.288
UCl3(g)	1.483e-141	-140.829
Ca(g)	9.505e-143	-142.022
U2F10(g)	1.852e-144	-143.732
S2(g)	7.788e-166	-165.109
C(g)	3.193e-170	-169.496
C2H4(g)	1.329e-174	-173.876
UF2(g)	6.948e-175	-174.158
UCl2(g)	2.472e-184	-183.607
UO(g)	1.330e-188	-187.876
Si(g)	1.026e-201	-200.989
UF(g)	4.812e-210	-209.318
U2Cl8(g)	3.761e-221	-220.425

UCl(g)	1.030e-224	-223.987
U2Cl10(g)	3.978e-230	-229.400
U(g)	1.333e-263	-262.875

		In fluid		Sorbed		Kd
Original basis	total moles	moles	mg/kg	moles	mg/kg	L/kg
Ba++	7.96e-007	7.96e-007	0.109			
Ca++	0.000541	0.000541	21.7			
Cd++	8.50e-009	8.50e-009	0.000955			
Cl-	0.000111	0.000111	3.94			
Cu++	2.01e-007	2.01e-007	0.0128			
F-	1.04e-005	1.04e-005	0.197			
H+	1.76e-005	1.76e-005	0.0177			
H2AsO4-	6.57e-008	6.57e-008	0.00926			
H2O	55.5	55.5	1.00e+006			
HCO3-	0.00160	0.00160	97.5			
HPO4--	1.91e-007	1.91e-007	0.0183			
K+	0.000655	0.000655	25.6			
Mg++	0.000203	0.000203	4.92			
Mn++	3.75e-006	3.75e-006	0.206			
NH3(aq)	0.000234	0.000234	3.98			
NO3-	0.000956	0.000956	59.3			
Na+	0.00116	0.00116	26.6			
O2(aq)	0.000175	0.000175	5.61			
SO4--	0.000431	0.000431	41.3			
Sb(OH)3(aq)	5.01e-007	5.01e-007	0.0866			
SiO2(aq)	0.000221	0.000221	13.3			
UO2++	1.20e-008	1.20e-008	0.00324			

Elemental composition		In fluid		Sorbed	
	total moles	moles	mg/kg	moles	mg/kg
Antimony	5.015e-007	5.015e-007	0.06104		
Arsenic	6.572e-008	6.572e-008	0.004922		
Barium	7.960e-007	7.960e-007	0.1093		
Cadmium	8.497e-009	8.497e-009	0.0009549		
Calcium	0.0005406	0.0005406	21.66		
Carbon	0.001598	0.001598	19.18		
Chlorine	0.0001111	0.0001111	3.938		
Copper	2.015e-007	2.015e-007	0.01280		
Fluorine	1.037e-005	1.037e-005	0.1969		
Hydrogen	111.0	111.0	1.119e+005		
Magnesium	0.0002026	0.0002026	4.922		
Manganese	3.746e-006	3.746e-006	0.2057		
Nitrogen	0.001190	0.001190	16.66		
Oxygen	55.52	55.52	8.880e+005		
Phosphorus	1.908e-007	1.908e-007	0.005907		
Potassium	0.0006548	0.0006548	25.60		
Silicon	0.0002213	0.0002213	6.212		
Sodium	0.001157	0.001157	26.58		
Sulfur	0.0004305	0.0004305	13.80		
Uranium	1.200e-008	1.200e-008	0.002855		

```
Temperature =  15.1 C    Pressure =  1.013 bars
pH =  8.000              log fO2 =  -30.606
Eh =   0.3360 volts      pe =   5.8750
Ionic strength      =    0.004609
Charge imbalance    =   -0.000231 eq/kg (-6.639% error)
Activity of water   =    0.999996
Solvent mass        =    1.000000 kg
Solution mass       =    1.000317 kg
Solution density    =    1.020    g/cm3
Chlorinity          =    0.000111 molal
Dissolved solids    =         316 mg/kg sol'n
Hardness            =       71.62 mg/kg sol'n as CaCO3
  carbonate         =       71.62 mg/kg sol'n as CaCO3
  non-carbonate     =        0.00 mg/kg sol'n as CaCO3
Rock mass           =    0.000000 kg
Carbonate alkalinity=       79.64 mg/kg sol'n as CaCO3
Water type          =    Na-HCO3
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Nernst redox couples	Eh (volts)	pe
e- + .25*O2(aq) + H+ = .5*H2O	0.3360	5.8750
8*e- + 9*H+ + NO3- = 3*H2O + NH3(aq)	0.5400	9.4422

No minerals in system.

Aqueous species	molality	mg/kg sol'n	act. coef.	log act.
HCO3-	0.001562	95.26	0.9308	-2.8376
Na+	0.001277	29.35	0.9308	-2.9250
NO3-	0.001015	62.94	0.9294	-3.0252
K+	0.0007008	27.39	0.9294	-3.1862
Ca++	0.0004890	19.59	0.7581	-3.4309
SO4--	0.0004331	41.60	0.7495	-3.4886
SiO2(aq)	0.0002135	12.82	1.0000	-3.6706
Mg++	0.0001891	4.595	0.7661	-3.8390
N2(aq)	0.0001632	4.570	1.0000	-3.7873
Cl-	0.0001106	3.921	0.9294	-3.9879
CO2(aq)	3.861e-005	1.699	1.0000	-4.4133
CaSO4(aq)	1.482e-005	2.017	1.0000	-4.8291
F-	1.027e-005	0.1951	0.9301	-5.0198
MgSO4(aq)	9.432e-006	1.135	1.0000	-5.0254
Mn++	7.785e-006	0.4275	0.7581	-5.2290
CO3--	7.115e-006	0.4269	0.7517	-5.2717
CaHCO3+	6.612e-006	0.6682	0.9308	-5.2109
AlO2-	6.258e-006	0.3690	0.9308	-5.2347
CaCO3(aq)	3.470e-006	0.3472	1.0000	-5.4597
NaHCO3(aq)	2.996e-006	0.2516	1.0000	-5.5235
MgHCO3+	2.514e-006	0.2144	0.9308	-5.6308
HPO4--	2.303e-006	0.2210	0.7495	-5.7629
HSiO3-	1.888e-006	0.1455	0.9308	-5.7553
KSO4-	1.712e-006	0.2313	0.9308	-5.7977
Fe++	8.754e-007	0.04887	0.7581	-6.1781
Ba++	8.345e-007	0.1146	0.7539	-6.2013
MgCO3(aq)	6.715e-007	0.05660	1.0000	-6.1730
OH-	4.830e-007	0.008213	0.9301	-6.3475
Sb(OH)3(aq)	4.028e-007	0.06957	1.0000	-6.3949
MnSO4(aq)	3.918e-007	0.05914	1.0000	-6.4070
Cu++	3.703e-007	0.02352	0.7581	-6.5517
H2PO4-	3.255e-007	0.03156	0.9308	-6.5186
HAlO2(aq)	2.808e-007	0.01684	1.0000	-6.5516
NaHSiO3(aq)	1.160e-007	0.01161	1.0000	-6.9354
MgF+	3.398e-008	0.001471	0.9308	-7.4999

NaCO3-	2.955e-008	0.002452	0.9308	-7.5605
HAsO4--	2.494e-008	0.003488	0.7495	-7.7283
NaCl(aq)	1.937e-008	0.001132	1.0000	-7.7129
Pb++	1.795e-008	0.003718	0.7517	-7.8699
CaF+	1.758e-008	0.001038	0.9308	-7.7863
MgCl+	1.242e-008	0.0007418	0.9308	-7.9371
Cd++	1.099e-008	0.001235	0.7539	-8.0816
H+	1.067e-008	1.075e-005	0.9370	-8.0000
CaCl+	8.286e-009	0.0006256	0.9308	-8.1128
UO2(CO3)3----	7.593e-009	0.003416	0.3152	-8.6210
UO2(CO3)2--	5.949e-009	0.002320	0.7495	-8.3508
Al(OH)2+	3.951e-009	0.0002409	0.9308	-8.4344
FeCO3+	2.748e-009	0.0003183	0.9308	-8.5921
KCl(aq)	1.766e-009	0.0001316	1.0000	-8.7530
H2AsO4-	1.240e-009	0.0001747	0.9308	-8.9377
BaCO3(aq)	1.208e-009	0.0002383	1.0000	-8.9180
NaAlO2(aq)	1.129e-009	9.248e-005	1.0000	-8.9475
NaF(aq)	1.054e-009	4.425e-005	1.0000	-8.9771
MnCl+	1.051e-009	9.494e-005	0.9308	-9.0097
HSO4-	2.609e-010	2.531e-005	0.9308	-9.6148
Cu+	1.529e-010	9.710e-006	0.9308	-9.8469
PO4---	1.247e-010	1.184e-005	0.5225	-10.1861
HF(aq)	1.185e-010	2.371e-006	1.0000	-9.9261
NaOH(aq)	9.068e-011	3.626e-006	1.0000	-10.0425
UO2CO3(aq)	5.659e-011	1.867e-005	1.0000	-10.2473
FeCl+	5.028e-011	4.589e-006	0.9308	-10.3298
AlOH++	4.175e-011	1.836e-006	0.7517	-10.5033
PbCl+	3.935e-011	9.545e-006	0.9308	-10.4362
Sb(OH)4-	2.427e-011	4.605e-006	0.9308	-10.6460
BaCl+	1.940e-011	3.351e-006	0.9308	-10.7434
AsO4---	6.682e-012	9.280e-007	0.5225	-11.4570
BaF+	3.847e-012	6.011e-007	0.9308	-11.4461
CdSO4(aq)	2.716e-012	5.661e-007	1.0000	-11.5660
MgP2O7--	1.033e-012	2.047e-007	0.7495	-12.1111
CaCl2(aq)	1.023e-012	1.135e-007	1.0000	-11.9900
UO2OH+	8.362e-013	2.400e-007	0.9308	-12.1088
Sb(OH)2F(aq)	6.436e-013	1.124e-007	1.0000	-12.1914
H3PO4(aq)	4.068e-013	3.985e-008	1.0000	-12.3907
HNO3(aq)	3.793e-013	2.390e-008	1.0000	-12.4210
HCl(aq)	2.150e-013	7.837e-009	1.0000	-12.6676
Sb(OH)2+	1.958e-013	3.048e-008	0.9308	-12.7394
CdCl2(aq)	1.794e-013	3.287e-008	1.0000	-12.7463
Al+++	1.009e-013	2.722e-009	0.5549	-13.2519
Fe+++	6.235e-014	3.481e-009	0.5549	-13.4610
PbCl2(aq)	1.335e-014	3.712e-009	1.0000	-13.8745
HP2O7---	1.211e-014	2.118e-009	0.5225	-14.1988
KHSO4(aq)	9.668e-015	1.316e-009	1.0000	-14.0147
FeF++	5.158e-015	3.859e-010	0.7517	-14.4115
UO2++	3.086e-015	8.330e-010	0.7517	-14.6345
UO2F+	2.646e-015	7.646e-010	0.9308	-14.6086
H3AsO4(aq)	1.842e-015	2.614e-010	1.0000	-14.7346
P2O7----	1.174e-015	2.042e-010	0.3152	-15.4315
FeSO4+	7.451e-016	1.131e-010	0.9308	-15.1590
UO2SO4(aq)	6.905e-016	2.527e-010	1.0000	-15.1609
FeF2+	5.762e-016	5.406e-011	0.9308	-15.2706
H2P2O7--	3.759e-016	6.613e-011	0.7495	-15.5501
HF2-	2.637e-016	1.028e-011	0.9308	-15.6100
KP2O7---	8.970e-017	1.910e-011	0.5225	-16.3291
UO2F2(aq)	7.348e-017	2.263e-011	1.0000	-16.1339
FeCl2(aq)	2.388e-017	3.026e-012	1.0000	-16.6219
CdCl3-	4.041e-018	8.838e-013	0.9308	-17.4247
UO2(SO4)2--	2.003e-018	9.253e-013	0.7495	-17.8236
PbCl3-	7.228e-019	2.266e-013	0.9308	-18.1721

FeCl++	4.587e-019	4.187e-014	0.7517	-18.4624
UO2Cl+	3.332e-019	1.018e-013	0.9308	-18.5085
UO2F3-	1.304e-019	4.261e-014	0.9308	-18.9160
(UO2)2(OH)2++	9.619e-020	5.520e-014	0.7517	-19.1408
UO2+	8.349e-020	2.254e-014	0.9308	-19.1095
(UO2)3(CO3)6(6-)	9.620e-021	1.125e-014	0.0744	-21.1451
(UO2)3(OH)5+	8.489e-021	7.597e-015	0.9308	-20.1023
H3P2O7-	6.759e-022	1.196e-016	0.9308	-21.2013
U(OH)4(aq)	1.899e-022	5.811e-017	1.0000	-21.7214
PbCl4--	7.486e-023	2.612e-017	0.7495	-22.2509
HAsO2(aq)	3.408e-023	3.677e-018	1.0000	-22.4674
As(OH)3(aq)	2.977e-023	3.748e-018	1.0000	-22.5262
UO2F4--	9.237e-024	3.195e-018	0.7495	-23.1597
UO2Cl2(aq)	1.510e-024	5.147e-019	1.0000	-23.8210
AsO2-	1.350e-024	1.443e-019	0.9308	-23.9007
H2AsO3-	1.345e-024	1.680e-019	0.9308	-23.9025
FeCl4--	1.030e-024	2.036e-019	0.7495	-24.1122
Mn+++	1.026e-025	5.633e-021	0.5293	-25.2653
AsO2OH--	1.083e-027	1.342e-022	0.7495	-27.0904
H4P2O7(aq)	1.748e-028	3.111e-023	1.0000	-27.7573
Formate	3.386e-031	1.524e-026	0.9301	-30.5019
NO2-	2.318e-031	1.066e-026	0.9294	-30.6668
H2(aq)	8.716e-032	1.756e-028	1.0000	-31.0597
Ca(For)+	3.631e-033	3.089e-028	0.9308	-32.4711
Mg(For)+	1.616e-033	1.120e-028	0.9308	-32.8228
Na(For)(aq)	4.370e-034	2.971e-029	1.0000	-33.3595
O2(aq)	3.821e-034	1.222e-029	1.0000	-33.4178
K(For)(aq)	2.144e-034	1.803e-029	1.0000	-33.6688
Mn(For)+	1.134e-034	1.133e-029	0.9308	-33.9766
Formic_acid(aq)	1.828e-035	8.409e-031	1.0000	-34.7381
Fe(For)+	1.821e-035	1.836e-030	0.9308	-34.7708
SO3--	1.248e-035	9.993e-031	0.7517	-35.0276
Cu(For)+	1.086e-035	1.179e-030	0.9308	-34.9952
Ba(For)+	4.930e-036	8.986e-031	0.9308	-35.3384
HNO2(aq)	4.705e-036	2.211e-031	1.0000	-35.3275
NH4+	2.772e-036	5.000e-032	0.9286	-35.5893
HSO3-	1.488e-036	1.206e-031	0.9308	-35.8585
ClO-	6.622e-037	3.406e-032	0.9308	-36.2102
Pb(For)+	3.523e-037	8.884e-032	0.9308	-36.4842
Cd(For)+	2.221e-037	3.495e-032	0.9308	-36.6847
NH3(aq)	7.163e-038	1.220e-033	1.0000	-37.1449
CO(aq)	3.323e-038	9.306e-034	1.0000	-37.4784
HO2-	1.593e-038	5.257e-034	0.9308	-37.8289
Oxalate	1.237e-038	1.089e-033	0.7495	-38.0328
SiF6--	1.314e-039	1.867e-034	0.7495	-39.0065
U(CO3)5(6-)	1.543e-040	8.301e-035	0.0744	-40.9398
MnO4--	1.310e-040	1.558e-035	0.7495	-40.0078
UOH+++	5.651e-042	1.441e-036	0.5293	-41.5242
H-Oxalate	1.691e-042	1.505e-037	0.9308	-41.8030
SO2(aq)	8.219e-043	5.264e-038	1.0000	-42.0852
UF3+	6.022e-043	1.776e-037	0.9308	-42.2514
UF2++	3.806e-043	1.050e-037	0.7517	-42.5435
UF4(aq)	5.288e-044	1.660e-038	1.0000	-43.2767
MnO4-	9.258e-045	1.101e-039	0.9301	-44.0650
UF+++	7.063e-045	1.815e-039	0.5293	-44.4273
U(SO4)2(aq)	3.189e-046	1.371e-040	1.0000	-45.4964
USO4++	2.581e-046	8.621e-041	0.7517	-45.7121
HSO5-	5.194e-047	5.871e-042	0.9308	-46.3157
U++++	6.283e-049	1.495e-043	0.3262	-48.6883
Oxalic_acid(aq)	2.873e-049	2.585e-044	1.0000	-48.5417
UCl+++	2.676e-051	7.316e-046	0.5293	-50.8488
S2O6--	2.015e-060	3.226e-055	0.7495	-59.8209
ClO2-	6.566e-062	4.428e-057	0.9308	-61.2139

Ca(For)2(aq)	8.903e-063	1.158e-057	1.0000	-62.0504
Mg(For)2(aq)	4.586e-063	5.241e-058	1.0000	-62.3386
S2O8--	6.074e-064	1.167e-058	0.7495	-63.3418
Mn(For)2(aq)	4.861e-064	7.045e-059	1.0000	-63.3133
Fe(For)2(aq)	1.044e-064	1.523e-059	1.0000	-63.9812
Na(For)2-	9.626e-065	1.088e-059	0.9308	-64.0477
Cu(For)2(aq)	8.379e-065	1.286e-059	1.0000	-64.0768
U+++	4.174e-065	9.933e-060	0.5293	-64.6557
K(For)2-	4.131e-065	5.333e-060	0.9308	-64.4151
Ba(For)2(aq)	9.714e-066	2.208e-060	1.0000	-65.0126
Cd(For)2(aq)	8.323e-066	1.685e-060	1.0000	-65.0797
Pb(For)2(aq)	1.865e-066	5.541e-061	1.0000	-65.7294
Formaldehyde(aq)	6.149e-068	1.846e-063	1.0000	-67.2112
N3-	2.171e-070	9.118e-066	0.9308	-69.6946
ClO3-	1.396e-072	1.164e-067	0.9301	-71.8867
HN3(aq)	1.301e-073	5.597e-069	1.0000	-72.8857
Cu(NH3)2++	1.016e-073	9.910e-069	0.7517	-73.1172
S2O5--	4.029e-077	5.806e-072	0.7495	-76.5200
Cd(NH3)2++	6.249e-078	9.150e-073	0.7517	-77.3281
Urea(aq)	5.440e-079	3.266e-074	1.0000	-78.2644
HCN(aq)	1.283e-080	3.465e-076	1.0000	-79.8919
CN-	4.166e-082	1.084e-077	0.9294	-81.4121
Methanol(aq)	1.225e-083	3.923e-079	1.0000	-82.9120
UO2ClO3+	1.068e-086	3.774e-081	0.9308	-86.0026
ClO4-	1.251e-087	1.244e-082	0.9301	-86.9342
HS-	6.639e-089	2.195e-084	0.9301	-88.2094
Glycolate	9.678e-090	7.260e-085	0.9308	-89.0454
H2S(aq)	8.568e-090	2.919e-085	1.0000	-89.0671
Ca(Glyc)+	1.778e-091	2.046e-086	0.9308	-90.7812
Mg(Glyc)+	3.260e-092	3.238e-087	0.9308	-91.5179
Na(Glyc)(aq)	1.267e-092	1.242e-087	1.0000	-91.8971
K(Glyc)(aq)	6.217e-093	7.094e-088	1.0000	-92.2064
Cu(Glyc)+	2.756e-093	3.819e-088	0.9308	-92.5908
Mn(Glyc)+	2.482e-093	3.226e-088	0.9308	-92.6363
Fe(Glyc)+	1.215e-093	1.590e-088	0.9308	-92.9467
Glycolic_acid(aq	6.317e-094	4.803e-089	1.0000	-93.1995
S--	4.783e-094	1.533e-089	0.7539	-93.4430
Methane(aq)	4.517e-094	7.244e-090	1.0000	-93.3452
Ba(Glyc)+	6.307e-095	1.339e-089	0.9308	-94.2314
Pb(Glyc)+	2.716e-095	7.664e-090	0.9308	-94.5972
S2O3--	1.960e-095	2.198e-090	0.7495	-94.8328
Cd(Glyc)+	6.918e-096	1.296e-090	0.9308	-95.1912
S2O4--	1.716e-096	2.198e-091	0.7539	-95.8882
Acetate	1.562e-099	9.221e-095	0.9314	-98.8371
MgCH3COO+	5.135e-102	4.279e-097	0.9308	-101.3206
CaCH3COO+	5.122e-102	5.076e-097	0.9308	-101.3217
NaCH3COO(aq)	1.421e-102	1.165e-097	1.0000	-101.8474
Acetic_acid(aq)	8.388e-103	5.035e-098	1.0000	-102.0764
KCH3COO(aq)	4.980e-103	4.886e-098	1.0000	-102.3027
MnCH3COO+	1.680e-103	1.914e-098	0.9308	-102.8058
CuCH3COO+	9.271e-104	1.136e-098	0.9308	-103.0640
FeCH3COO+	2.245e-104	2.579e-099	0.9308	-103.6799
BaCH3COO+	9.090e-105	1.784e-099	0.9308	-104.0726
PbCH3COO+	5.527e-105	1.471e-099	0.9308	-104.2887
CdCH3COO+	1.282e-105	2.197e-100	0.9308	-104.9234
Cu(NH3)3++	6.515e-108	7.466e-103	0.7517	-107.3100
Malonate	2.561e-108	2.613e-103	0.7495	-107.7167
CuCH3COO(aq)	4.888e-109	5.990e-104	1.0000	-108.3109
AlCH3COO++	1.755e-110	1.510e-105	0.7517	-109.8796
H-Malonate	9.791e-111	1.009e-105	0.9308	-110.0403
AsH3(aq)	1.147e-111	8.934e-107	1.0000	-110.9406
Malonic_acid(aq)	6.601e-116	6.867e-111	1.0000	-115.1804
Methanamine(aq)	2.905e-118	9.021e-114	1.0000	-117.5368

Cu(Gly)+	2.658e-121	3.656e-116	0.9308	-120.6067
Glycine(aq)	1.796e-121	1.348e-116	1.0000	-120.7457
Mg(Gly)+	8.118e-124	7.983e-119	0.9308	-123.1217
Mn(Gly)+	5.129e-125	6.614e-120	0.9308	-124.3212
Fe(Gly)+	2.627e-125	3.411e-120	0.9308	-124.6117
Ca(Gly)+	1.225e-125	1.398e-120	0.9308	-124.9430
Pb(Gly)+	7.272e-126	2.045e-120	0.9308	-125.1695
Cd(Gly)+	8.119e-127	1.514e-121	0.9308	-126.1216
S3O6--	4.043e-128	7.768e-123	0.7495	-127.5185
Ba(Gly)+	2.613e-128	5.522e-123	0.9308	-127.6140
SCN-	6.456e-134	3.749e-129	0.9301	-133.2215
Acetaldehyde(aq)	4.268e-134	1.879e-129	1.0000	-133.3698
NH4CH3COO(aq)	6.128e-135	4.722e-130	1.0000	-134.2127
Acetamide(aq)	5.361e-135	3.166e-130	1.0000	-134.2707
UO2SCN+	3.699e-147	1.213e-141	0.9308	-146.4631
Cd(NH3)4++	1.110e-149	2.004e-144	0.7517	-149.0786
Ethanol(aq)	2.189e-154	1.008e-149	1.0000	-153.6598
Ethyne(aq)	6.190e-156	1.611e-151	1.0000	-155.2083
Ethylene(aq)	4.523e-159	1.268e-154	1.0000	-158.3446
Lactate	1.915e-160	1.705e-155	0.9308	-159.7491
Ca(Lac)+	2.072e-162	2.675e-157	0.9308	-161.7148
Mg(Lac)+	6.690e-163	7.582e-158	0.9308	-162.2057
Na(Lac)(aq)	2.546e-163	2.852e-158	1.0000	-162.5941
K(Lac)(aq)	1.249e-163	1.601e-158	1.0000	-162.9034
Mn(Lac)+	3.475e-164	5.003e-159	0.9308	-163.4902
Cu(Lac)+	2.519e-164	3.844e-159	0.9308	-163.6299
Fe(Lac)+	2.119e-164	3.070e-159	0.9308	-163.7050
Lactic_acid(aq)	1.320e-164	1.189e-159	1.0000	-163.8793
Ba(Lac)+	5.255e-166	1.189e-160	0.9308	-165.3106
Pb(Lac)+	5.197e-166	1.539e-160	0.9308	-165.3154
Cd(Lac)+	9.269e-167	1.867e-161	0.9308	-166.0641
Ethane(aq)	4.202e-169	1.263e-164	1.0000	-168.3766
Propanoate	2.128e-172	1.555e-167	0.9308	-171.7031
Ca(Prop)+	3.885e-175	4.394e-170	0.9308	-174.4418
Na(Prop)(aq)	2.790e-175	2.679e-170	1.0000	-174.5544
Mg(Prop)+	1.900e-175	1.849e-170	0.9308	-174.7525
Propanoic_acid(a	1.540e-175	1.141e-170	1.0000	-174.8123
K(Prop)(aq)	1.369e-175	1.535e-170	1.0000	-174.8636
Mn(Prop)+	2.662e-176	3.406e-171	0.9308	-175.6060
Cu(Prop)+	1.230e-176	1.680e-171	0.9308	-175.9412
Fe(Prop)+	6.887e-177	8.876e-172	0.9308	-176.1931
Pb(Prop)+	6.573e-178	1.842e-172	0.9308	-177.2134
Ba(Prop)+	1.680e-178	3.534e-173	0.9308	-177.8058
Cd(Prop)+	1.597e-178	2.961e-173	0.9308	-177.8279
USCN+++	3.252e-179	9.628e-174	0.5293	-178.7641
Ca(Glyc)2(aq)	3.020e-179	5.742e-174	1.0000	-178.5199
S4O6--	1.510e-179	3.386e-174	0.7495	-178.9461
Succinate	1.365e-179	1.583e-174	0.7495	-178.9902
Mg(Glyc)2(aq)	3.245e-180	5.657e-175	1.0000	-179.4888
Cu(Glyc)2(aq)	1.779e-180	3.798e-175	1.0000	-179.7499
Fe(Glyc)2(aq)	6.281e-181	1.293e-175	1.0000	-180.2020
Mn(Glyc)2(aq)	1.715e-181	3.516e-176	1.0000	-180.7656
Na(Glyc)2-	1.242e-181	2.149e-176	0.9308	-180.9371
K(Glyc)2-	5.422e-182	1.025e-176	0.9308	-181.2970
H-Succinate	4.796e-182	5.613e-177	0.9308	-181.3503
Pb(Glyc)2(aq)	1.454e-182	5.193e-177	1.0000	-181.8375
Serine(aq)	5.921e-183	6.221e-178	1.0000	-182.2276
Ba(Glyc)2(aq)	2.689e-183	7.727e-178	1.0000	-182.5704
Cd(Glyc)2(aq)	1.865e-183	4.895e-178	1.0000	-182.7293
Succinic_acid(aq	7.628e-186	9.005e-181	1.0000	-185.1176
Ethanamine(aq)	6.202e-191	2.795e-186	1.0000	-190.2075
Alanine(aq)	4.846e-193	4.316e-188	1.0000	-192.3147
Cu(Ala)+	1.624e-193	2.461e-188	0.9308	-192.8207

Fe(Ala)+	8.192e-197	1.179e-191	0.9308	-196.1178
Mg(Ala)+	1.594e-197	1.790e-192	0.9308	-196.8288
Mn(Ala)+	1.240e-197	1.774e-192	0.9308	-196.9376
Ca(Ala)+	6.444e-198	8.256e-193	0.9308	-197.2220
Pb(Ala)+	1.623e-198	4.790e-193	0.9308	-197.8209
Cd(Ala)+	1.238e-198	2.481e-193	0.9308	-197.9385
Ca(CH3COO)2(aq)	1.318e-199	2.084e-194	1.0000	-198.8800
Mg(CH3COO)2(aq)	5.337e-200	7.597e-195	1.0000	-199.2727
Ba(Ala)+	5.170e-201	1.165e-195	0.9308	-200.3177
Cu(CH3COO)2(aq)	4.131e-201	7.502e-196	1.0000	-200.3839
Mn(CH3COO)2(aq)	1.908e-201	3.301e-196	1.0000	-200.7193
Na(CH3COO)2-	1.152e-201	1.624e-196	0.9308	-200.9698
Fe(CH3COO)2(aq)	6.387e-202	1.111e-196	1.0000	-201.1947
Acetone(aq)	4.653e-202	2.701e-197	1.0000	-201.3323
K(CH3COO)2-	2.754e-202	4.328e-197	0.9308	-201.5912
Pb(CH3COO)2(aq)	6.905e-203	2.245e-197	1.0000	-202.1608
Ba(CH3COO)2(aq)	4.026e-203	1.028e-197	1.0000	-202.3951
Cd(CH3COO)2(aq)	3.607e-203	8.311e-198	1.0000	-202.4429
Aspartic_acid(aq	6.263e-204	8.334e-199	1.0000	-203.2032
Propanal(aq)	2.125e-206	1.234e-201	1.0000	-205.6726
Al(CH3COO)2+	2.333e-207	3.384e-202	0.9308	-206.6632
Cu(CH3COO)2-	9.465e-208	1.719e-202	0.9308	-207.0550
S3--	2.591e-224	2.492e-219	0.7495	-223.7117
1-Propyne(aq)	1.236e-224	4.952e-220	1.0000	-223.9078
1-Propanol(aq)	3.392e-227	2.038e-222	1.0000	-226.4696
1-Propene(aq)	1.182e-229	4.974e-225	1.0000	-228.9272
2-Hydroxybutanoa	1.091e-233	1.124e-228	0.9308	-232.9934
NH4(CH3COO)2-	8.429e-234	1.147e-228	0.9308	-233.1054
Asparagine(aq)	4.889e-236	6.457e-231	1.0000	-235.3108
Cu(Gly)2(aq)	1.153e-236	2.440e-231	1.0000	-235.9381
2-Hydroxybutanoi	6.674e-238	6.945e-233	1.0000	-237.1756
Propane(aq)	2.665e-242	1.175e-237	1.0000	-241.5744
Mg(Gly)2(aq)	1.520e-243	2.620e-238	1.0000	-242.8182
Mn(Gly)2(aq)	7.911e-245	1.606e-239	1.0000	-244.1018
Diglycine(aq)	7.553e-245	9.976e-240	1.0000	-244.1219
Fe(Gly)2(aq)	7.508e-245	1.531e-239	1.0000	-244.1245
Pb(Gly)2(aq)	2.541e-245	9.025e-240	1.0000	-244.5950
Butanoate	9.532e-246	8.300e-241	0.9308	-245.0520
Cd(Gly)2(aq)	7.515e-246	1.957e-240	1.0000	-245.1241
Diketopiperazine	3.646e-247	4.159e-242	1.0000	-246.4382
Ca(Gly)2(aq)	9.321e-248	1.754e-242	1.0000	-247.0305
Na(But)(aq)	1.198e-248	1.319e-243	1.0000	-247.9214
Ca(But)+	1.195e-248	1.520e-243	0.9308	-247.9537
K(But)(aq)	5.880e-249	7.418e-244	1.0000	-248.2306
Butanoic_acid(aq	5.593e-249	4.926e-244	1.0000	-248.2524
Mg(But)+	5.576e-249	6.210e-244	0.9308	-248.2848
Mn(But)+	1.015e-249	1.442e-244	0.9308	-249.0245
Cu(But)+	4.360e-250	6.566e-245	0.9308	-249.3916
Fe(But)+	3.178e-250	4.541e-245	0.9308	-249.5290
Ba(Gly)2(aq)	2.340e-250	6.676e-245	1.0000	-249.6309
Pb(But)+	8.388e-252	2.468e-246	0.9308	-251.1075
Ba(But)+	5.044e-252	1.132e-246	0.9308	-251.3284
Glutarate	5.016e-252	6.524e-247	0.7495	-251.4249
Cd(But)+	3.056e-252	6.094e-247	0.9308	-251.5461
H-Glutarate	1.044e-254	1.368e-249	0.9308	-254.0126
Threonine(aq)	2.741e-256	3.263e-251	1.0000	-255.5622
Ethylacetate(aq)	5.479e-258	4.825e-253	1.0000	-257.2613
Glutaric_acid(aq	2.153e-258	2.844e-253	1.0000	-257.6669
S5O6--	1.729e-260	4.430e-255	0.7495	-259.8875
1-Propanamine(aq	3.222e-263	1.904e-258	1.0000	-262.4918
a-Aminobutyric_a	4.664e-266	4.808e-261	1.0000	-265.3312
Glutamic_acid(aq	2.751e-275	4.046e-270	1.0000	-274.5606
UO2(SCN)2(aq)	1.268e-280	4.897e-275	1.0000	-279.8968

Butanal(aq)	3.504e-281	2.526e-276	1.0000	-280.4555
S4--	1.056e-289	1.354e-284	0.7495	-289.1016
1-Butyne(aq)	5.259e-298	2.844e-293	1.0000	-297.2791
Cu(CH3COO)3-	1.863e-298	4.481e-293	0.9308	-297.7611
Pb(CH3COO)3-	1.096e-299	4.212e-294	0.9308	-298.9912
Mn(CH3COO)3-	9.148e-300	2.122e-294	0.9308	-299.0699
1-Butanol(aq)	2.944e-301	2.181e-296	1.0000	-300.0000
Cd(CH3COO)3-	1.454e-301	4.208e-296	0.9308	-300.0000
1-Butene(aq)	3.250e-303	1.823e-298	1.0000	-300.0000
2-Hydroxypentano	9.287e-307	1.087e-301	0.9308	-300.0000
Glutamine(aq)	2.460e-309	3.595e-304	1.0000	-300.0000
2-Hydroxypentano	3.373e-311	3.983e-306	1.0000	-300.0000
U(SCN)2++	2.434e-311	8.617e-306	0.7517	-300.0000
n-Butane(aq)	1.479e-315	8.592e-311	1.0000	-300.0000
Alanylglycine(aq	9.867e-317	1.442e-311	1.0000	-300.0000
Pentanoate	5.093e-319	5.148e-314	0.9308	-300.0000
Ca(Lac)2(aq)	4.511e-321	9.840e-316	1.0000	-300.0000
Mg(Lac)2(aq)	1.443e-321	2.920e-316	1.0000	-300.0000
Na(Pent)(aq)	6.719e-322	8.337e-317	1.0000	-300.0000
Ca(Pent)+	3.755e-322	5.300e-317	0.9308	-300.0000
K(Pent)(aq)	3.310e-322	4.640e-317	1.0000	-300.0000
Pentanoic_acid(a	3.261e-322	3.329e-317	1.0000	-300.0000
Cu(Lac)2(aq)	2.075e-322	5.014e-317	1.0000	-300.0000
Fe(Lac)2(aq)	1.976e-322	4.623e-317	1.0000	-300.0000
Mg(Pent)+	1.680e-322	2.106e-317	0.9308	-300.0000
Mn(Lac)2(aq)	7.905e-323	1.842e-317	1.0000	-300.0000
Na(Lac)2-	5.435e-323	1.093e-317	0.9308	-300.0000
Mn(Pent)+	4.447e-323	6.937e-318	0.9308	-300.0000
Cu(Pent)+	1.976e-323	3.253e-318	0.9308	-300.0000
K(Lac)2-	1.976e-323	4.292e-318	0.9308	-300.0000
Fe(Pent)+	1.482e-323	2.326e-318	0.9308	-300.0000
Pb(Lac)2(aq)	4.941e-324	1.903e-318	1.0000	-300.0000
m-Toluate	0.0000	0.0000	0.9308	-300.0000
Valine(aq)	0.0000	0.0000	1.0000	-300.0000
Undecanoic_acid(	0.0000	0.0000	1.0000	-300.0000
Undecanoate	0.0000	0.0000	0.9308	-300.0000
H-Suberate	0.0000	0.0000	0.9308	-300.0000
UO2(SCN)3-	0.0000	0.0000	0.9308	-300.0000
H-Sebacate	0.0000	0.0000	0.9308	-300.0000
H-Pimelate	0.0000	0.0000	0.9308	-300.0000
2-Hexanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexyne(aq)	0.0000	0.0000	1.0000	-300.0000
H-Azelate	0.0000	0.0000	0.9308	-300.0000
Ca(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
H-Adipate	0.0000	0.0000	0.9308	-300.0000
Tyrosine(aq)	0.0000	0.0000	1.0000	-300.0000
Toluene(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Suberic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Suberate	0.0000	0.0000	0.7495	-300.0000
2-Heptanone(aq)	0.0000	0.0000	1.0000	-300.0000
Sebacic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Sebacate	0.0000	0.0000	0.7495	-300.0000
Sb2S4--	0.0000	0.0000	0.7495	-300.0000
S5--	0.0000	0.0000	0.7495	-300.0000
2-Butanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexene(aq)	0.0000	0.0000	1.0000	-300.0000
Pimelic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Pimelate	0.0000	0.0000	0.7495	-300.0000
Phenylalanine(aq	0.0000	0.0000	1.0000	-300.0000
Phenol(aq)	0.0000	0.0000	1.0000	-300.0000
Pentanal(aq)	0.0000	0.0000	1.0000	-300.0000
Fe(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000

Fe(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Adipic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Pb(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Pb(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Pb(Pent)+	0.0000	0.0000	0.9308	-300.0000
Ca(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Adipate	0.0000	0.0000	0.7495	-300.0000
1-Hexanol(aq)	0.0000	0.0000	1.0000	-300.0000
Pb(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Pb(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Fe(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Octanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Octanoate	0.0000	0.0000	0.9308	-300.0000
Fe(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Octanal(aq)	0.0000	0.0000	1.0000	-300.0000
Nonanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Nonanoate	0.0000	0.0000	0.9308	-300.0000
Nonanal(aq)	0.0000	0.0000	1.0000	-300.0000
Ethylbenzene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexanamine(aq)	0.0000	0.0000	1.0000	-300.0000
Na(Prop)2-	0.0000	0.0000	0.9308	-300.0000
Na(Pent)2-	0.0000	0.0000	0.9308	-300.0000
Benzoic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Dodecanoic_acid(	0.0000	0.0000	1.0000	-300.0000
Dodecanoate	0.0000	0.0000	0.9308	-300.0000
Benzoate	0.0000	0.0000	0.9334	-300.0000
Benzene(aq)	0.0000	0.0000	1.0000	-300.0000
Na(But)2-	0.0000	0.0000	0.9308	-300.0000
Decanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Decanoate	0.0000	0.0000	0.9308	-300.0000
2-Pentanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Pentyne(aq)	0.0000	0.0000	1.0000	-300.0000
Decanal(aq)	0.0000	0.0000	1.0000	-300.0000
2-Octanone(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
1-Pentene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptyne(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Pent)+	0.0000	0.0000	0.9308	-300.0000
2-Hydroxyoctanoi	0.0000	0.0000	1.0000	-300.0000
1-Pentanol(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyoctanoa	0.0000	0.0000	0.9308	-300.0000
Mg(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxynonanoi	0.0000	0.0000	1.0000	-300.0000
1-Pentanamine(aq	0.0000	0.0000	1.0000	-300.0000
1-Heptene(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Tryptophan(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxynonanoa	0.0000	0.0000	0.9308	-300.0000
Methionine(aq)	0.0000	0.0000	1.0000	-300.0000
Leucylglycine(aq	0.0000	0.0000	1.0000	-300.0000

Leucine(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyhexanoi	0.0000	0.0000	1.0000	-300.0000
1-Octyne(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyhexanoa	0.0000	0.0000	0.9308	-300.0000
K(Prop)2-	0.0000	0.0000	0.9308	-300.0000
Cd(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
K(Pent)2-	0.0000	0.0000	0.9308	-300.0000
Cd(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cd(Pent)+	0.0000	0.0000	0.9308	-300.0000
Ba(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyheptano	0.0000	0.0000	1.0000	-300.0000
1-Octene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptanol(aq)	0.0000	0.0000	1.0000	-300.0000
K(But)2-	0.0000	0.0000	0.9308	-300.0000
Isoleucine(aq)	0.0000	0.0000	1.0000	-300.0000
Cd(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Hexanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Hexanoate	0.0000	0.0000	0.9308	-300.0000
Azelate	0.0000	0.0000	0.7495	-300.0000
2-Hydroxyheptano	0.0000	0.0000	0.9308	-300.0000
Hexanal(aq)	0.0000	0.0000	1.0000	-300.0000
Heptanoic_acid(a	0.0000	0.0000	1.0000	-300.0000
Heptanoate	0.0000	0.0000	0.9308	-300.0000
Heptanal(aq)	0.0000	0.0000	1.0000	-300.0000
Azelaic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
HSb2S4-	0.0000	0.0000	0.9308	-300.0000
2-Hydroxydecanoi	0.0000	0.0000	1.0000	-300.0000
1-Octanol(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxydecanoa	0.0000	0.0000	0.9308	-300.0000
p-Toluate	0.0000	0.0000	0.9308	-300.0000
o-Toluate	0.0000	0.0000	0.9308	-300.0000
Cd(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
n-Propylbenzene(	0.0000	0.0000	1.0000	-300.0000
m-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
n-Pentylbenzene(	0.0000	0.0000	1.0000	-300.0000
n-Pentane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Octylbenzene(a	0.0000	0.0000	1.0000	-300.0000
n-Octane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Hexylbenzene(a	0.0000	0.0000	1.0000	-300.0000
n-Hexane(aq)	0.0000	0.0000	1.0000	-300.0000
Cd(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
n-Heptylbenzene(	0.0000	0.0000	1.0000	-300.0000
n-Heptane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Butylbenzene(a	0.0000	0.0000	1.0000	-300.0000
1-Octanamine(aq)	0.0000	0.0000	1.0000	-300.0000
o-Phthalate	0.0000	0.0000	0.7495	-300.0000
1-Heptanamine(aq	0.0000	0.0000	1.0000	-300.0000
o-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
1-Butanamine(aq)	0.0000	0.0000	1.0000	-300.0000
p-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
(NH4)2Sb2S4(aq)	0.0000	0.0000	1.0000	-300.0000

Mineral saturation states

	log Q/K		log Q/K
Nontronite-Ca	24.7416s/sat	BaU2O7	-10.6158
Nontronite-Mg	24.6938s/sat	MgUO4	-10.6863
Nontronite-K	24.6091s/sat	Na2U2O7	-10.7635
Nontronite-Na	24.3261s/sat	Portlandite	-10.7687
Nontronite-H	23.6719s/sat	Cotunnite	-10.8330
Hematite	20.1990s/sat	Mg1.5SO4(OH)	-11.2407
Cronstedtite-7A	19.3646s/sat	AlF3	-11.2740

Magnetite	19.1299s/sat	Torbernite	-11.5875
Ferrite-Cu	18.9411s/sat	Uranocircite	-11.6012
Delafossite	15.0009s/sat	MnSO4	-11.7434
Clinoptilolite-h	12.9113s/sat	CdSO4	-11.7635
Clinoptilolite-C	12.8547s/sat	UO2.6667	-11.7754
Andradite	12.7477s/sat	Thermonatrite	-11.8127
Clinoptilolite-K	12.5588s/sat	Na2CO3	-12.1046
Clinoptilolite-h	12.3360s/sat	UO2SO4:H2O	-12.3187
Muscovite	11.1226s/sat	Uraninite	-12.3322
Epidote-ord	11.0277s/sat	Coffinite	-12.5923
Epidote	11.0269s/sat	(UO2)3(PO4)2:4H2	-12.6577
Stilbite	10.6439s/sat	PbF2	-12.7171
Ferrite-Ca	10.5340s/sat	MgSO4	-12.7307
Ferrite-Mg	10.5025s/sat	FeSO4	-12.7412
Goethite	9.6357s/sat	Przhevalskite	-13.0273
Clinoptilolite-N	9.2525s/sat	UPO5	-13.0752
Clinoptilolite-h	9.2520s/sat	UO2ClOH:2H2O	-13.1324
Fluorapatite	9.0603s/sat	Mordenite-dehy	-13.2449
Illite	7.8871s/sat	Chalcocyanite	-13.3867
Mesolite	7.4478s/sat	Ferrite-Dicalciu	-13.4867
Paragonite	7.2510s/sat	Anthophyllite	-13.6354
Beidellite-Ca	7.2285s/sat	Bassetite	-13.9167
Beidellite-Mg	7.1806s/sat	FeF2	-14.1285
Beidellite-K	7.0961s/sat	BaCl2:2H2O	-14.3046
Beidellite-Na	6.8130s/sat	CdCl2:H2O	-14.4177
Kaolinite	6.5126s/sat	NaUO3	-14.7132
Montmor-Mg	6.4461s/sat	Ca3(AsO4)2	-14.8798
Montmor-Ca	6.4207s/sat	BaCl2:H2O	-15.0006
Montmor-K	6.3616s/sat	Ba(OH)2:8H2O	-15.0512
Beidellite-H	6.1592s/sat	Hydromagnesite	-15.1926
Montmor-Na	6.0742s/sat	Ba2Si3O8	-15.1954
Scolecite	6.0607s/sat	CdCl2	-15.5091
Pyrophyllite	5.9264s/sat	CaAl2O4	-15.5278
Jarosite	5.7104s/sat	Natrosilite	-15.5604
Smectite-low-Fe-	5.3660s/sat	Autunite-H	-15.6276
Celadonite	5.2963s/sat	MnCl2:4H2O	-16.0241
Smectite-high-Fe	4.8945s/sat	Na2SiO3	-16.2258
Maximum_Microcli	4.8082s/sat	Gehlenite	-16.2564
K-Feldspar	4.8067s/sat	MgOHCl	-16.4524
Laumontite	4.7655s/sat	BaCl2	-16.5067
Fe(OH)3	4.3770s/sat	Hillebrandite	-16.5459
Daphnite-14A	4.3055s/sat	UO2SO4:3.5H2O	-16.8052
Amesite-14A	4.1026s/sat	UO2SO4:2.5H2O	-16.8446
Margarite	4.0879s/sat	UO2SO4:3H2O	-16.9250
Sanidine_high	3.5417s/sat	Dicalcium_silica	-16.9853
Lawsonite	3.1157s/sat	Akermanite	-17.0287
Annite	3.1014s/sat	UO2.3333(beta)	-17.0952
Diaspore	2.9228s/sat	CdF2	-17.2396
Mordenite	2.5047s/sat	CaAl4O7	-17.3748
Boehmite	2.5019s/sat	UO2F2:3H2O	-17.3800
Chamosite-7A	2.4688s/sat	MnCl2:2H2O	-17.4120
Gibbsite	2.3751s/sat	UO2F2	-17.6469
Ripidolite-14A	2.3065s/sat	Pargasite	-17.9934
Witherite	2.0641s/sat	Ningyoite	-18.0591
Brochantite	1.8878s/sat	Larnite	-18.3364
Albite_low	1.8588s/sat	Alum-K	-18.4202
Albite	1.8587s/sat	CuCl2	-18.5388
Phlogopite	1.8402s/sat	MnCl2:H2O	-19.0529
Malachite	1.6640s/sat	MgCl2:4H2O	-19.4288
Corundum	1.6421s/sat	Na2UO4(alpha)	-19.5652
Tenorite	1.4015s/sat	UO2SO4	-20.5765
Saponite-Ca	1.2335s/sat	UOFOH:.5H2O	-20.7264
Analcime	1.1884s/sat	Lime	-21.1831

Saponite-Mg	1.1868s/sat	UOFOH	-21.2189
Natrolite	1.1066s/sat	Scacchite	-22.4099
Saponite-K	1.1011s/sat	UO2Cl	-22.7001
Prehnite	0.9323s/sat	UO2(NO3)2:6H2O	-22.8769
Daphnite-7A	0.8413s/sat	Rankinite	-23.2943
Saponite-Na	0.8181s/sat	Hydrophilite	-23.6738
Kyanite	0.8020s/sat	Lawrencite	-23.7427
Cerussite	0.5971s/sat	K2UO4	-23.9348
Quartz	0.5692s/sat	Pb	-24.0319
Andalusite	0.5055s/sat	Tobermorite-14A	-24.2047
Clinozoisite	0.4746s/sat	UOF2:H2O	-24.2177
Albite_high	0.4732s/sat	Clinoptilolite-d	-24.3156
Clinochlore-14A	0.4689s/sat	UO2(NO3)2:3H2O	-24.4495
Barite	0.4649s/sat	Clinoptilolite-d	-24.6367
Zoisite	0.4275s/sat	UOF2	-24.8393
Hercynite	0.3836s/sat	MgCl2:2H2O	-25.1328
Kalsilite	0.3812s/sat	UO2(NO3)2:2H2O	-25.7726
Tridymite	0.3694s/sat	UO2(PO3)2	-26.1925
Minnesotaite	0.3298s/sat	(UO2)3(PO4)2	-26.2777
Chalcedony	0.2886s/sat	Tobermorite-11A	-26.2974
Dolomite-ord	0.1955s/sat	Ettringite	-26.4377
Dolomite	0.1955s/sat	(UO2)2P2O7	-26.7018
Dawsonite	0.1816s/sat	U(HPO4)2:4H2O	-27.2183
Saponite-H	0.1641s/sat	UP2O7	-27.4111
Sillimanite	0.1223s/sat	KAl(SO4)2	-27.5736
Wairakite	0.0357s/sat	Clinoptilolite-d	-27.9270
Rhodochrosite	0.0052s/sat	UO2Cl2:3H2O	-28.5012
Cristobalite(alp	-0.0041	Merwinite	-28.5130
Talc	-0.0747	MgCl2:H2O	-28.6391
Strengite	-0.0793	Foshagite	-28.7218
Ice	-0.1008	UO2(NO3)2:H2O	-29.5197
Calcite	-0.2647	Tobermorite-9A	-30.0203
Coesite	-0.2671	Ba2SiO4	-30.0617
Jadeite	-0.3332	UO2Cl2:H2O	-31.3683
Aragonite	-0.4095	Afwillite	-31.5225
Dioptase	-0.4325	UO2(NO3)2	-33.1303
Hydroxylapatite	-0.4644	KMgCl3:2H2O	-33.4141
Cristobalite(bet	-0.4762	UO2SO3	-33.6252
SiO2(am)	-0.7992	Cd	-34.1320
Siderite	-1.0107	Chloromagnesite	-34.6190
Monohydrocalcite	-1.0738	Fe	-34.7530
Ripidolite-7A	-1.1521	UF4:2.5H2O	-35.2230
Magnesite	-1.2308	UO2Cl2	-35.3992
Atacamite	-1.2610	As2O5	-36.2408
Alamosite	-1.2894	Antigorite	-37.2881
Dolomite-dis	-1.4233	BaSiF6	-39.1742
Greenalite	-1.4667	BaO	-39.6432
Anorthite	-1.5999	UF4	-39.6481
Ferrosilite	-1.6040	(UO2)2As2O7	-39.7201
Cuprite	-1.6240	Al2(SO4)3:6H2O	-39.8477
Whitlockite	-2.2541	Molysite	-39.8603
Nepheline	-2.4218	UO2(AsO3)2	-40.0993
Gypsum	-2.4266	(UO2)3(AsO4)2	-40.2199
Anhydrite	-2.7003	Ba2U2O7	-40.5477
Bixbyite	-2.7315	KMgCl3	-41.0321
CaUO4	-2.8073	Xonotlite	-41.2933
Lanarkite	-2.8743	Hatrurite	-41.9669
Alunite	-2.9179	Fe2(SO4)3	-42.0269
Rhodonite	-2.9818	U(SO4)2:8H2O	-43.3206
Clinochlore-7A	-2.9869	Arsenolite	-43.4519
Azurite	-3.2169	Claudetite	-43.5230
Chrysotile	-3.2247	C	-43.9540
Enstatite	-3.2968	U(SO4)2:4H2O	-44.5540

Fluorite	-3.3389	U(SO4)2	-44.7363
Bassanite	-3.3482	U(CO3)2	-46.9183
Anglesite	-3.4089	UOCl2	-46.9713
Sb2O3	-3.4404	U5O12Cl	-48.8040
CaSO4:0.5H2O(bet	-3.5290	UClF3	-50.6442
CdSiO3	-3.5471	As	-51.2115
Hausmannite	-3.5576	Na3UO4	-53.9264
Wustite	-3.6532	Ca4Al2Fe2O10	-54.5139
Schoepite	-3.7786	Na4SiO4	-55.9677
UO3:2H2O	-3.7798	UOF4	-56.1672
UO2(OH)2(beta)	-3.9287	Na	-56.2553
Schoepite-dehy(.	-3.9930	Al2(SO4)3	-58.1497
UO3:.9H2O(alpha)	-3.9935	Mn	-58.5025
Paralaurionite	-4.0042	Ca3Al2O6	-58.8647
Fayalite	-4.0183	(UO2)2Cl3	-59.2710
Schoepite-dehy(.	-4.0773	Na2O	-59.4133
Schoepite-dehy(1	-4.0903	K	-60.1918
Nesquehonite	-4.2892	UF3	-60.2421
Diopside	-4.3049	UOCl3	-60.2921
Cordierite_hydr	-4.3302	Pb2Cl5NH4	-60.4620
FeO	-4.3516	UF5(beta)	-63.2730
Berlinite	-4.3637	Covellite	-63.3007
Pyrolusite	-4.4612	UF5(alpha)	-63.6551
Sepiolite	-4.5390	UOCl	-63.6848
Sellaite	-4.5487	Chalcocite	-63.9112
PbCO3.PbO	-4.5760	UCl2F2	-63.9551
Fe(OH)2	-4.6612	S	-66.2158
Brucite	-4.8129	Ba3UO6	-67.0174
Litharge	-4.9052	CdS	-71.9585
Massicot	-5.0976	Galena	-72.7066
Mn(OH)2(am)	-5.1289	U2O3F6	-73.9621
Okenite	-5.2015	K2O	-77.0032
Hedenbergite	-5.2292	UCl3F	-77.0846
Schoepite-dehy(.	-5.2407	CdCl2(NH3)2	-81.1722
NaFeO2	-5.2567	Na6Si2O7	-81.2996
Wollastonite	-5.2858	U(SO3)2	-81.8409
Analcime-dehy	-5.4210	Troilite	-82.6013
UO2CO3	-5.4603	Pyrrhotite	-82.7037
Rutherfordine	-5.4782	PbSO4(NH3)2	-83.4469
Pseudowollastoni	-5.5429	Alabandite	-85.1749
Nahcolite	-5.5444	As4O6(mono)	-86.5612
Huntite	-5.6008	As4O6(cubi)	-86.7821
Niter	-5.7803	UCl4	-88.0498
Schoepite-dehy(.	-5.7810	UCl3	-90.3736
Pb2SiO4	-5.9288	UF6	-95.7164
Tephroite	-6.1398	Mg	-98.1874
Pb3SO6	-6.1561	U3O5F8	-98.8347
Grossular	-6.2186	U2F9	-99.6782
Cd(OH)2	-6.3482	BaS	-103.2237
Spinel	-6.3755	UN1.73(alpha)	-105.2680
Cu	-6.6478	UN1.59(alpha)	-108.0614
Tremolite	-6.7941	U2O2Cl5	-108.5178
Nantokite	-6.8159	UCl5	-109.8337
UO3(gamma)	-6.8358	Ca	-115.5592
Cordierite_anhyd	-6.9147	P	-117.2064
Artinite	-6.9572	Ba	-119.6947
Sanbornite	-7.1232	Al	-119.9205
Melanterite	-7.2325	UN	-121.3085
UO2HPO4:4H2O	-7.2806	Si	-124.3627
Chalcanthite	-7.3783	UCl6	-130.4253
UO3(beta)	-7.4600	Pb(N3)2(orth)	-137.9602
PbFCl	-7.6808	Pyrite	-138.0734
Ca-Al_Pyroxene	-7.7231	Pb(N3)2(mono)	-138.4109

Mirabilite	-7.7355	Chalcopyrite	-139.7899
Cd(OH)Cl	-7.7917	CdCl2(NH3)4	-157.3412
Monteponite	-7.8031	PbSO4(NH3)4	-161.2503
UO3(alpha)	-7.8064	U	-169.0862
BaUO4	-7.8532	US	-177.1208
Manganosite	-7.8881	UAs	-177.1946
Arcanite	-7.8913	U4F17	-178.0789
Sylvite	-7.9034	UC	-195.1184
Forsterite	-8.4157	UH3(beta)	-197.5607
Halite	-8.4666	US1.9	-202.5438
Phosgenite	-8.6016	US2	-207.3899
Thenardite	-9.0205	Mayenite	-217.3524
UO2FOH:2H2O	-9.1288	UAs2	-225.6913
Gyrolite	-9.1708	CdCl2(NH3)6	-233.5967
UO2.25	-9.3082	UP	-238.0663
FeF3	-9.3382	UC1.94(alpha)	-238.5260
UO2.25(beta)	-9.3743	Stibnite	-246.3138
Pb4SO7	-9.5074	Bornite	-267.2668
Nitrobarite	-9.5315	US3	-270.3336
UO2FOH:H2O	-9.5611	Orpiment	-270.5038
Monticellite	-9.6710	Pb(SCN)2	-274.1957
Saleeite	-9.8198	UP2	-350.0482
CdSO4:2.667H2O	-9.8730	U2S3	-377.3484
Natron	-10.0008	o-Phthalic_acid	-388.5448
UO2FOH	-10.0610	U2C3	-435.7527
Periclase	-10.0842	U3S5	-580.0168
CdSO4:H2O	-10.0960	U3As4	-580.6483
Mg1.25SO4(OH)0.5	-10.1124	U3P4	-826.1780
Na2CO3:7H2O	-10.4842		

Gases	fugacity	log fug.
N2(g)	0.2106	-0.676
H2O(g)	0.01398	-1.854
CO2(g)	0.0008301	-3.081
NO2(g)	3.255e-012	-11.487
HF(g)	3.155e-015	-14.501
HCl(g)	1.825e-019	-18.739
H2(g)	1.030e-028	-27.987
O2(g)	2.479e-031	-30.606
NO(g)	4.923e-032	-31.308
CO(g)	2.791e-035	-34.554
NH3(g)	6.947e-040	-39.158
SiF4(g)	1.989e-041	-40.701
SO2(g)	3.741e-043	-42.427
Cl2(g)	1.009e-044	-43.996
Cd(g)	4.657e-049	-48.332
Pb(g)	2.341e-054	-53.631
Cu(g)	1.465e-061	-60.834
UO2F2(g)	4.231e-062	-61.374
Na(g)	4.183e-071	-70.378
K(g)	4.825e-072	-71.317
UO3(g)	2.205e-073	-72.657
UO2Cl2(g)	1.332e-073	-72.875
UOF4(g)	1.375e-077	-76.862
UF5(g)	1.325e-084	-83.878
UF4(g)	4.487e-086	-85.348
H2S(g)	6.330e-089	-88.199
CH4(g)	2.573e-091	-90.590
UF6(g)	1.444e-097	-96.840
F2(g)	1.556e-101	-100.808
UO2(g)	3.084e-113	-112.511
UCl4(g)	2.036e-114	-113.691

Mg(g)	1.712e-119	-118.766
UCl5(g)	9.956e-129	-128.002
UF3(g)	2.484e-130	-129.605
UCl6(g)	1.597e-137	-136.797
UCl3(g)	1.035e-138	-137.985
U2F10(g)	3.274e-142	-141.485
Ca(g)	1.454e-142	-141.838
S2(g)	7.877e-148	-147.104
C2H4(g)	7.328e-157	-156.135
C(g)	1.322e-166	-165.879
UF2(g)	2.794e-171	-170.554
Al(g)	2.611e-173	-172.583
UCl2(g)	7.751e-181	-180.111
UO(g)	1.253e-185	-184.902
Si(g)	7.594e-199	-198.120
UF(g)	1.476e-205	-204.831
U2Cl8(g)	4.995e-217	-216.301
UCl(g)	1.751e-220	-219.757
U2Cl10(g)	3.375e-229	-228.472
U(g)	1.295e-258	-257.888

		In fluid		Sorbed		Kd
Original basis	total moles	moles	mg/kg	moles	mg/kg	L/kg
Al+++	6.54e-006	6.54e-006	0.177			
Ba++	8.36e-007	8.36e-007	0.115			
Ca++	0.000514	0.000514	20.6			
Cd++	1.10e-008	1.10e-008	0.00124			
Cl-	0.000111	0.000111	3.92			
Cu++	3.70e-007	3.70e-007	0.0235			
F-	1.03e-005	1.03e-005	0.196			
Fe++	8.78e-007	8.78e-007	0.0490			
H+	-2.10e-006	-2.10e-006	-0.00212			
H2AsO4-	2.62e-008	2.62e-008	0.00369			
H2O	55.5	55.5	1.00e+006			
HCO3-	0.00162	0.00162	99.0			
HPO4--	2.63e-006	2.63e-006	0.252			
K+	0.000702	0.000702	27.5			
Mg++	0.000202	0.000202	4.90			
Mn++	8.18e-006	8.18e-006	0.449			
NH3(aq)	0.000326	0.000326	5.56			
NO3-	0.00102	0.00102	62.9			
Na+	0.00128	0.00128	29.4			
O2(aq)	0.000244	0.000244	7.82			
Pb++	1.80e-008	1.80e-008	0.00373			
SO4--	0.000459	0.000459	44.1			
Sb(OH)3(aq)	4.03e-007	4.03e-007	0.0696			
SiO2(aq)	0.000215	0.000215	12.9			
UO2++	1.36e-008	1.36e-008	0.00367			

Elemental composition		In fluid		Sorbed	
	total moles	moles	mg/kg	moles	mg/kg
Aluminum	6.544e-006	6.544e-006	0.1765		
Antimony	4.028e-007	4.028e-007	0.04903		
Arsenic	2.619e-008	2.619e-008	0.001961		
Barium	8.357e-007	8.357e-007	0.1147		
Cadmium	1.099e-008	1.099e-008	0.001236		
Calcium	0.0005140	0.0005140	20.59		
Carbon	0.001624	0.001624	19.50		
Chlorine	0.0001107	0.0001107	3.922		
Copper	3.705e-007	3.705e-007	0.02353		
Fluorine	1.033e-005	1.033e-005	0.1961		

Hydrogen	111.0	111.0	1.119e+005
Iron	8.782e-007	8.782e-007	0.04903
Lead	1.799e-008	1.799e-008	0.003726
Magnesium	0.0002018	0.0002018	4.903
Manganese	8.178e-006	8.178e-006	0.4491
Nitrogen	0.001342	0.001342	18.79
Oxygen	55.52	55.52	8.880e+005
Phosphorus	2.629e-006	2.629e-006	0.08139
Potassium	0.0007025	0.0007025	27.46
Silicon	0.0002155	0.0002155	6.050
Sodium	0.001280	0.001280	29.42
Sulfur	0.0004595	0.0004595	14.73
Uranium	1.360e-008	1.360e-008	0.003236

```
Temperature =   9.5 C    Pressure =  1.013 bars
pH =  7.600              log fO2 =  -29.159
Eh =   0.3970 volts      pe =   7.0792
Ionic strength      =    0.004191
Charge imbalance    =   -0.000351 eq/kg (-10.64% error)
Activity of water   =    0.999996
Solvent mass        =    1.000000 kg
Solution mass       =    1.000306 kg
Solution density    =    1.024    g/cm3
Chlorinity          =    0.000110 molal
Dissolved solids    =         306 mg/kg sol'n
Hardness            =       57.57 mg/kg sol'n as CaCO3
  carbonate         =       57.57 mg/kg sol'n as CaCO3
  non-carbonate     =        0.00 mg/kg sol'n as CaCO3
Rock mass           =    0.000000 kg
Carbonate alkalinity=       74.27 mg/kg sol'n as CaCO3
Water type          =    Na-HCO3
```

Nernst redox couples	Eh (volts)	pe
e- + .25*O2(aq) + H+ = .5*H2O	0.3970	7.0792
8*e- + 9*H+ + NO3- = 3*H2O + NH3(aq)	0.5859	10.4477
14*e- + 16*H+ + 2*SO4-- = 8*H2O + S2--	-0.2531	-4.5127

No minerals in system.

Aqueous species	molality	mg/kg sol'n	act. coef.	log act.
HCO3-	0.001469	89.62	0.9340	-2.8626
Na+	0.001314	30.21	0.9340	-2.9109
NO3-	0.001228	76.12	0.9328	-2.9410
K+	0.0006736	26.33	0.9328	-3.2018
Ca++	0.0003995	16.00	0.7681	-3.5131
SO4--	0.0003201	30.74	0.7602	-3.6137
N2(aq)	0.0002217	6.209	1.0000	-3.6542
Mg++	0.0001536	3.732	0.7755	-3.9240
SiO2(aq)	0.0001378	8.279	1.0000	-3.8607
Cl-	0.0001102	3.907	0.9328	-3.9880
CO2(aq)	0.0001026	4.514	1.0000	-3.9889
F-	1.024e-005	0.1946	0.9334	-5.0195
Mn++	9.510e-006	0.5223	0.7681	-5.1364
CaSO4(aq)	8.979e-006	1.222	1.0000	-5.0468
CaHCO3+	5.239e-006	0.5295	0.9340	-5.3104
MgSO4(aq)	5.040e-006	0.6065	1.0000	-5.2975
AlO2-	3.423e-006	0.2018	0.9340	-5.4952
NaHCO3(aq)	3.265e-006	0.2742	1.0000	-5.4861
HPO4--	3.065e-006	0.2941	0.7602	-5.6326
CO3--	2.280e-006	0.1368	0.7623	-5.7600
MgHCO3+	1.971e-006	0.1681	0.9340	-5.7350
KSO4-	1.230e-006	0.1663	0.9340	-5.9396
H2PO4-	1.163e-006	0.1128	0.9340	-5.9641
Fe++	1.025e-006	0.05722	0.7681	-6.1039
CaCO3(aq)	8.372e-007	0.08377	1.0000	-6.0772
Ba++	6.900e-007	0.09472	0.7642	-6.2779
S2--	6.095e-007	0.03908	0.7602	-6.3340
HAlO2(aq)	5.322e-007	0.03191	1.0000	-6.2740
Cu++	4.306e-007	0.02735	0.7681	-6.4805
HSiO3-	3.935e-007	0.03033	0.9340	-6.4347
Sb(OH)3(aq)	3.692e-007	0.06377	1.0000	-6.4327
MnSO4(aq)	3.442e-007	0.05197	1.0000	-6.4631
MgCO3(aq)	1.701e-007	0.01434	1.0000	-6.7693
OH-	1.186e-007	0.002017	0.9334	-6.9558

NaHSiO3(aq)	2.857e-008	0.002858	1.0000	-7.5441
MgF+	2.813e-008	0.001218	0.9340	-7.5804
Al(OH)2+	2.740e-008	0.001671	0.9340	-7.5918
H+	2.673e-008	2.693e-005	0.9397	-7.6000
FeCO3+	2.497e-008	0.002892	0.9340	-7.6322
HAsO4--	2.304e-008	0.003223	0.7602	-7.7566
NaCl(aq)	1.944e-008	0.001136	1.0000	-7.7113
CaF+	1.422e-008	0.0008398	0.9340	-7.8768
Pb++	1.224e-008	0.002535	0.7623	-8.0302
NaCO3-	1.151e-008	0.0009550	0.9340	-7.9686
MgCl+	1.055e-008	0.0006300	0.9340	-8.0066
Cd++	7.736e-009	0.0008693	0.7642	-8.2283
UO2(CO3)2--	7.049e-009	0.002749	0.7602	-8.2709
CaCl+	6.883e-009	0.0005197	0.9340	-8.1919
UO2(CO3)3----	4.627e-009	0.002082	0.3337	-8.8114
H2AsO4-	3.049e-009	0.0004296	0.9340	-8.5455
KCl(aq)	1.526e-009	0.0001138	1.0000	-8.8163
MnCl+	1.145e-009	0.0001035	0.9340	-8.9708
AlOH++	1.072e-009	4.713e-005	0.7623	-9.0878
NaF(aq)	1.040e-009	4.367e-005	1.0000	-8.9828
NaAlO2(aq)	6.029e-010	4.940e-005	1.0000	-9.2198
HSO4-	4.254e-010	4.128e-005	0.9340	-9.4009
BaCO3(aq)	2.927e-010	5.775e-005	1.0000	-9.5336
HF(aq)	2.704e-010	5.408e-006	1.0000	-9.5680
UO2CO3(aq)	2.272e-010	7.495e-005	1.0000	-9.6436
FeCl+	5.938e-011	5.419e-006	0.9340	-10.2560
PO4---	5.645e-011	5.359e-006	0.5394	-10.5164
PbCl+	2.662e-011	6.459e-006	0.9340	-10.6044
NaOH(aq)	2.409e-011	9.633e-007	1.0000	-10.6181
BaCl+	1.509e-011	2.606e-006	0.9340	-10.8510
Al+++	9.562e-012	2.579e-007	0.5698	-11.2637
Cu+	9.174e-012	5.828e-007	0.9340	-11.0671
Sb(OH)4-	5.658e-012	1.073e-006	0.9340	-11.2770
H3PO4(aq)	3.474e-012	3.404e-007	1.0000	-11.4591
BaF+	3.049e-012	4.765e-007	0.9340	-11.5455
UO2OH+	2.878e-012	8.259e-007	0.9340	-11.5705
AsO4---	2.054e-012	2.853e-007	0.5394	-11.9554
Sb(OH)2F(aq)	1.994e-012	3.484e-007	1.0000	-11.7002
CdSO4(aq)	1.454e-012	3.030e-007	1.0000	-11.8375
MgP2O7--	1.141e-012	2.261e-007	0.7602	-12.0619
HNO3(aq)	1.023e-012	6.444e-008	1.0000	-11.9902
Fe+++	9.416e-013	5.257e-008	0.5698	-12.2704
CaCl2(aq)	9.269e-013	1.028e-007	1.0000	-12.0330
Sb(OH)2+	5.613e-013	8.741e-008	0.9340	-12.2804
HCl(aq)	5.505e-013	2.007e-008	1.0000	-12.2592
CdCl2(aq)	1.241e-013	2.274e-008	1.0000	-12.9063
FeF++	7.213e-014	5.397e-009	0.7623	-13.2598
HP2O7---	4.747e-014	8.302e-009	0.5394	-13.5917
UO2++	3.780e-014	1.020e-008	0.7623	-13.5404
UO2F+	3.283e-014	9.486e-009	0.9340	-13.5134
KHSO4(aq)	1.432e-014	1.950e-009	1.0000	-13.8440
H3AsO4(aq)	1.080e-014	1.533e-009	1.0000	-13.9664
PbCl2(aq)	8.907e-015	2.476e-009	1.0000	-14.0503
FeF2+	7.644e-015	7.171e-010	0.9340	-14.1463
FeSO4+	7.251e-015	1.101e-009	0.9340	-14.1693
UO2SO4(aq)	5.587e-015	2.045e-009	1.0000	-14.2529
H2P2O7--	3.772e-015	6.636e-010	0.7602	-14.5424
P2O7----	1.684e-015	2.928e-010	0.3337	-15.2504
UO2F2(aq)	9.245e-016	2.847e-010	1.0000	-15.0341
HF2-	5.622e-016	2.192e-011	0.9340	-15.2797
KP2O7---	1.219e-016	2.596e-011	0.5394	-16.1821
FeCl2(aq)	2.800e-017	3.548e-012	1.0000	-16.5528
UO2(SO4)2--	1.084e-017	5.006e-012	0.7602	-17.0842

FeCl++	5.333e-018	4.868e-013	0.7623	-17.3909
UO2Cl+	3.927e-018	1.199e-012	0.9340	-17.4356
CdCl3-	2.584e-018	5.651e-013	0.9340	-17.6173
(UO2)2(OH)2++	1.672e-018	9.598e-013	0.7623	-17.8946
UO2F3-	1.621e-018	5.300e-013	0.9340	-17.8198
PbCl3-	4.842e-019	1.518e-013	0.9340	-18.3446
(UO2)3(OH)5+	7.027e-020	6.288e-014	0.9340	-19.1829
UO2+	5.830e-020	1.574e-014	0.9340	-19.2639
(UO2)3(CO3)6(6-)	4.023e-020	4.706e-014	0.0846	-20.4682
H3P2O7-	1.735e-020	3.070e-015	0.9340	-19.7902
UO2F4--	1.180e-022	4.080e-017	0.7602	-22.0473
PbCl4--	5.730e-023	1.999e-017	0.7602	-22.3609
UO2Cl2(aq)	1.670e-023	5.691e-018	1.0000	-22.7774
U(OH)4(aq)	1.203e-023	3.682e-018	1.0000	-22.9196
HAsO2(aq)	1.013e-023	1.093e-018	1.0000	-22.9942
As(OH)3(aq)	9.004e-024	1.134e-018	1.0000	-23.0455
Mn+++	1.257e-024	6.904e-020	0.5458	-24.1636
FeCl4--	1.174e-024	2.320e-019	0.7602	-24.0494
H2AsO3-	1.265e-025	1.580e-020	0.9340	-24.9275
AsO2-	1.249e-025	1.335e-020	0.9340	-24.9330
H4P2O7(aq)	1.054e-026	1.876e-021	1.0000	-25.9770
AsO2OH--	3.194e-029	3.957e-024	0.7602	-28.6147
NO2-	8.877e-031	4.083e-026	0.9328	-30.0820
O2(aq)	1.203e-032	3.849e-028	1.0000	-31.9197
Formate	6.846e-033	3.081e-028	0.9334	-32.1945
H2(aq)	1.644e-033	3.314e-030	1.0000	-32.7840
Ca(For)+	6.336e-035	5.390e-030	0.9340	-34.2278
HNO2(aq)	5.093e-035	2.394e-030	1.0000	-34.2930
Mg(For)+	3.014e-035	2.089e-030	0.9340	-34.5504
Na(For)(aq)	9.346e-036	6.354e-031	1.0000	-35.0294
K(For)(aq)	4.128e-036	3.472e-031	1.0000	-35.3842
Mn(For)+	3.047e-036	3.045e-031	0.9340	-35.5457
ClO-	2.121e-036	1.091e-031	0.9340	-35.7031
Formic_acid(aq)	9.486e-037	4.365e-032	1.0000	-36.0229
Fe(For)+	4.867e-037	4.908e-032	0.9340	-36.3424
Cu(For)+	2.869e-037	3.114e-032	0.9340	-36.5719
SO3--	1.831e-037	1.465e-032	0.7623	-36.8553
Ba(For)+	8.176e-038	1.490e-032	0.9340	-37.1171
SiF6--	6.561e-038	9.319e-033	0.7602	-37.3021
NH4+	5.552e-038	1.001e-033	0.9321	-37.2861
HSO3-	5.291e-038	4.288e-033	0.9340	-37.3061
HO2-	1.166e-038	3.848e-034	0.9340	-37.9628
Pb(For)+	4.900e-039	1.235e-033	0.9340	-38.3394
Cd(For)+	3.461e-039	5.447e-034	0.9340	-38.4904
CO(aq)	1.522e-039	4.262e-035	1.0000	-38.8175
NH3(aq)	3.751e-040	6.386e-036	1.0000	-39.4259
Oxalate	2.223e-040	1.956e-035	0.7602	-39.7720
MnO4--	3.464e-041	4.119e-036	0.7602	-40.5795
UOH+++	6.840e-042	1.744e-036	0.5458	-41.4279
U(CO3)5(6-)	3.145e-042	1.692e-036	0.0846	-42.5752
UF3+	2.906e-042	8.571e-037	0.9340	-41.5664
UF2++	1.849e-042	5.101e-037	0.7623	-41.8511
UF4(aq)	2.768e-043	8.688e-038	1.0000	-42.5579
H-Oxalate	7.468e-044	6.646e-039	0.9340	-43.1565
SO2(aq)	6.591e-044	4.222e-039	1.0000	-43.1810
UF+++	3.380e-044	8.685e-039	0.5458	-43.7340
MnO4-	1.883e-044	2.239e-039	0.9334	-43.7551
USO4++	8.582e-046	2.866e-040	0.7623	-45.1843
U(SO4)2(aq)	6.714e-046	2.887e-040	1.0000	-45.1730
HSO5-	1.777e-046	2.008e-041	0.9340	-45.7800
U++++	2.767e-048	6.583e-043	0.3442	-48.0212
Oxalic_acid(aq)	3.179e-050	2.862e-045	1.0000	-49.4977
UCl+++	1.436e-050	3.927e-045	0.5458	-50.1056

ClO2-	7.979e-061	5.380e-056	0.9340	-60.1277
S2O6--	7.055e-062	1.129e-056	0.7602	-61.2706
S2O8--	2.501e-063	4.804e-058	0.7602	-62.7209
U+++	4.334e-066	1.031e-060	0.5458	-65.6260
Ca(For)2(aq)	3.388e-066	4.407e-061	1.0000	-65.4700
Mg(For)2(aq)	2.033e-066	2.324e-061	1.0000	-65.6918
Mn(For)2(aq)	2.939e-067	4.259e-062	1.0000	-66.5319
Fe(For)2(aq)	6.507e-068	9.489e-063	1.0000	-67.1866
Cu(For)2(aq)	5.148e-068	7.904e-063	1.0000	-67.2884
Na(For)2-	4.702e-068	5.313e-063	0.9340	-67.3573
K(For)2-	1.726e-068	2.228e-063	0.9340	-67.7927
Ba(For)2(aq)	3.263e-069	7.418e-064	1.0000	-68.4863
Cd(For)2(aq)	3.045e-069	6.162e-064	1.0000	-68.5165
Pb(For)2(aq)	5.311e-070	1.578e-064	1.0000	-69.2748
ClO3-	1.227e-070	1.023e-065	0.9334	-69.9412
Formaldehyde(aq)	6.015e-071	1.805e-066	1.0000	-70.2208
N3-	1.603e-072	6.734e-068	0.9340	-71.8247
HN3(aq)	2.715e-075	1.168e-070	1.0000	-74.5662
Cu(NH3)2++	4.576e-078	4.465e-073	0.7623	-77.4574
S2O5--	5.156e-080	7.429e-075	0.7602	-79.4067
Cd(NH3)2++	1.476e-082	2.162e-077	0.7623	-81.9488
Urea(aq)	4.857e-083	2.916e-078	1.0000	-82.3137
UO2ClO3+	1.213e-083	4.285e-078	0.9340	-82.9459
HCN(aq)	2.492e-084	6.732e-080	1.0000	-83.6035
ClO4-	7.169e-085	7.127e-080	0.9334	-84.1745
CN-	2.177e-086	5.663e-082	0.9328	-85.6923
Methanol(aq)	4.973e-088	1.593e-083	1.0000	-87.3034
Glycolate	3.608e-094	2.707e-089	0.9340	-93.4724
HS-	1.059e-094	3.502e-090	0.9334	-94.0050
H2S(aq)	4.268e-095	1.454e-090	1.0000	-94.3697
Ca(Glyc)+	5.839e-096	6.720e-091	0.9340	-95.2633
Mg(Glyc)+	1.049e-096	1.041e-091	0.9340	-96.0090
Na(Glyc)(aq)	5.048e-097	4.947e-092	1.0000	-96.2969
K(Glyc)(aq)	2.230e-097	2.544e-092	1.0000	-96.6518
Cu(Glyc)+	1.415e-097	1.960e-092	0.9340	-96.8789
Mn(Glyc)+	1.236e-097	1.606e-092	0.9340	-96.9378
Fe(Glyc)+	6.146e-098	8.042e-093	0.9340	-97.2410
Glycolic_acid(aq	6.077e-098	4.620e-093	1.0000	-97.2163
Ba(Glyc)+	2.015e-099	4.279e-094	0.9340	-98.7253
Methane(aq)	9.588e-100	1.538e-095	1.0000	-99.0183
Pb(Glyc)+	7.172e-100	2.024e-094	0.9340	-99.1740
S--	2.025e-100	6.493e-096	0.7642	-99.8103
Cd(Glyc)+	2.011e-100	3.769e-095	0.9340	-99.7262
S2O4--	6.981e-101	8.942e-096	0.7642	-100.2729
S2O3--	6.579e-101	7.375e-096	0.7602	-100.3009
Acetate	2.933e-105	1.731e-100	0.9346	-104.5620
MgCH3COO+	8.779e-108	7.315e-103	0.9340	-107.0862
CaCH3COO+	8.139e-108	8.065e-103	0.9340	-107.1191
Acetic_acid(aq)	4.015e-108	2.410e-103	1.0000	-107.3963
NaCH3COO(aq)	2.831e-108	2.321e-103	1.0000	-107.5481
KCH3COO(aq)	8.869e-109	8.701e-104	1.0000	-108.0521
MnCH3COO+	4.140e-109	4.718e-104	0.9340	-108.4126
CuCH3COO+	2.323e-109	2.847e-104	0.9340	-108.6635
FeCH3COO+	5.316e-110	6.105e-105	0.9340	-109.3041
BaCH3COO+	1.388e-110	2.724e-105	0.9340	-109.8874
PbCH3COO+	7.385e-111	1.966e-105	0.9340	-110.1613
CdCH3COO+	1.881e-111	3.224e-106	0.9340	-110.7552
Malonate	3.879e-114	3.957e-109	0.7602	-113.5304
AlCH3COO++	3.863e-114	3.322e-109	0.7623	-113.5310
Cu(NH3)3++	1.821e-114	2.087e-109	0.7623	-113.8576
CuCH3COO(aq)	5.881e-116	7.207e-111	1.0000	-115.2306
H-Malonate	3.710e-116	3.823e-111	0.9340	-115.4602
AsH3(aq)	3.432e-117	2.675e-112	1.0000	-116.4644

Malonic_acid(aq)	6.428e-121	6.687e-116	1.0000	-120.1920
Methanamine(aq)	7.700e-125	2.391e-120	1.0000	-124.1135
Glycine(aq)	1.588e-127	1.192e-122	1.0000	-126.7992
Cu(Gly)+	9.535e-128	1.312e-122	0.9340	-127.0503
Mg(Gly)+	1.756e-130	1.727e-125	0.9340	-129.7851
Mn(Gly)+	1.630e-131	2.102e-126	0.9340	-130.8175
Fe(Gly)+	8.010e-132	1.040e-126	0.9340	-131.1260
Ca(Gly)+	2.246e-132	2.562e-127	0.9340	-131.6783
Pb(Gly)+	1.262e-132	3.548e-127	0.9340	-131.9287
S3O6--	2.745e-133	5.275e-128	0.7602	-132.6804
Cd(Gly)+	1.533e-133	2.857e-128	0.9340	-132.8441
Ba(Gly)+	4.595e-135	9.711e-130	0.9340	-134.3673
Acetaldehyde(aq)	4.036e-141	1.778e-136	1.0000	-140.3940
SCN-	1.231e-141	7.146e-137	0.9334	-140.9398
NH4CH3COO(aq)	2.324e-142	1.790e-137	1.0000	-141.6339
Acetamide(aq)	1.897e-142	1.120e-137	1.0000	-141.7219
UO2SCN+	8.646e-154	2.836e-148	0.9340	-153.0928
Cd(NH3)4++	8.357e-159	1.508e-153	0.7623	-158.1958
Ethanol(aq)	7.051e-163	3.247e-158	1.0000	-162.1518
Ethyne(aq)	1.925e-163	5.012e-159	1.0000	-162.7155
Ethylene(aq)	1.080e-167	3.028e-163	1.0000	-166.9667
Lactate	5.553e-169	4.945e-164	0.9340	-168.2851
Ca(Lac)+	5.282e-171	6.820e-166	0.9340	-170.3068
Mg(Lac)+	1.615e-171	1.831e-166	0.9340	-170.8213
Na(Lac)(aq)	7.942e-172	8.897e-167	1.0000	-171.1001
K(Lac)(aq)	3.509e-172	4.496e-167	1.0000	-171.4548
Mn(Lac)+	1.345e-172	1.936e-167	0.9340	-171.9009
Cu(Lac)+	9.973e-173	1.522e-167	0.9340	-172.0308
Lactic_acid(aq)	9.798e-173	8.823e-168	1.0000	-172.0089
Fe(Lac)+	8.374e-173	1.213e-167	0.9340	-172.1067
Ba(Lac)+	1.276e-174	2.888e-169	0.9340	-173.9237
Pb(Lac)+	1.074e-174	3.180e-169	0.9340	-173.9987
Cd(Lac)+	2.094e-175	4.217e-170	0.9340	-174.7087
Ethane(aq)	5.700e-179	1.713e-174	1.0000	-178.2441
Propanoate	2.820e-182	2.060e-177	0.9340	-181.5794
Propanoic_acid(a	5.183e-185	3.838e-180	1.0000	-184.2854
Ca(Prop)+	4.362e-185	4.934e-180	0.9340	-184.3900
Na(Prop)(aq)	3.977e-185	3.820e-180	1.0000	-184.4004
Mg(Prop)+	2.285e-185	2.224e-180	0.9340	-184.6708
K(Prop)(aq)	1.757e-185	1.970e-180	1.0000	-184.7553
Mn(Prop)+	4.675e-186	5.983e-181	0.9340	-185.3598
USCN+++	3.557e-186	1.053e-180	0.5458	-185.7118
Cu(Prop)+	2.190e-186	2.991e-181	0.9340	-185.6892
Fe(Prop)+	1.214e-186	1.565e-181	0.9340	-185.9454
Pb(Prop)+	6.223e-188	1.744e-182	0.9340	-187.2356
Ca(Glyc)2(aq)	4.073e-188	7.744e-183	1.0000	-187.3900
S4O6--	3.256e-188	7.300e-183	0.7602	-187.6064
Ba(Prop)+	1.753e-188	3.688e-183	0.9340	-187.7858
Cd(Prop)+	1.663e-188	3.083e-183	0.9340	-187.8088
Mg(Glyc)2(aq)	4.510e-189	7.863e-184	1.0000	-188.3458
Cu(Glyc)2(aq)	4.015e-189	8.574e-184	1.0000	-188.3964
Succinate	1.548e-189	1.796e-184	0.7602	-188.9293
Fe(Glyc)2(aq)	1.403e-189	2.888e-184	1.0000	-188.8531
Mn(Glyc)2(aq)	3.515e-190	7.205e-185	1.0000	-189.4541
Na(Glyc)2-	2.094e-190	3.623e-185	0.9340	-189.7087
K(Glyc)2-	7.899e-191	1.494e-185	0.9340	-190.1320
Pb(Glyc)2(aq)	1.491e-191	5.325e-186	1.0000	-190.8265
H-Succinate	1.417e-191	1.659e-186	0.9340	-190.8782
Serine(aq)	8.086e-192	8.495e-187	1.0000	-191.0923
Ba(Glyc)2(aq)	3.253e-192	9.348e-187	1.0000	-191.4877
Cd(Glyc)2(aq)	2.292e-192	6.014e-187	1.0000	-191.6398
Succinic_acid(aq	5.917e-195	6.985e-190	1.0000	-194.2279
Ethanamine(aq)	1.200e-201	5.408e-197	1.0000	-200.9208

Alanine(aq)	3.325e-203	2.961e-198	1.0000	-202.4782
Cu(Ala)+	4.520e-204	6.852e-199	0.9340	-203.3745
Fe(Ala)+	2.040e-207	2.935e-202	0.9340	-206.7200
Mn(Ala)+	2.888e-208	4.129e-203	0.9340	-207.5691
Mg(Ala)+	2.456e-208	2.759e-203	0.9340	-207.6395
Ca(Ala)+	8.981e-209	1.151e-203	0.9340	-208.0763
Pb(Ala)+	2.105e-209	6.213e-204	0.9340	-208.7065
Cd(Ala)+	1.806e-209	3.619e-204	0.9340	-208.7730
Ca(CH3COO)2(aq)	4.394e-211	6.948e-206	1.0000	-210.3571
Mg(CH3COO)2(aq)	2.037e-211	2.899e-206	1.0000	-210.6911
Ba(Ala)+	6.780e-212	1.528e-206	0.9340	-211.1984
Cu(CH3COO)2(aq)	2.294e-212	4.166e-207	1.0000	-211.6393
Mn(CH3COO)2(aq)	9.922e-213	1.716e-207	1.0000	-212.0034
Na(CH3COO)2-	4.892e-213	6.900e-208	0.9340	-212.3401
Acetone(aq)	3.667e-213	2.129e-208	1.0000	-212.4357
Fe(CH3COO)2(aq)	3.398e-213	5.908e-208	1.0000	-212.4688
K(CH3COO)2-	9.991e-214	1.570e-208	0.9340	-213.0300
Aspartic_acid(aq	9.492e-214	1.263e-208	1.0000	-213.0227
Pb(CH3COO)2(aq)	1.654e-214	5.379e-209	1.0000	-213.7814
Ba(CH3COO)2(aq)	1.165e-214	2.973e-209	1.0000	-213.9339
Cd(CH3COO)2(aq)	1.136e-214	2.618e-209	1.0000	-213.9445
Al(CH3COO)2+	1.280e-216	1.856e-211	0.9340	-215.9224
Propanal(aq)	1.441e-217	8.364e-213	1.0000	-216.8415
Cu(CH3COO)2-	2.516e-220	4.569e-215	0.9340	-219.6289
1-Propyne(aq)	3.246e-236	1.300e-231	1.0000	-235.4887
S3--	4.451e-238	4.281e-233	0.7602	-237.4706
1-Propanol(aq)	7.748e-240	4.655e-235	1.0000	-239.1108
1-Propene(aq)	2.159e-242	9.083e-238	1.0000	-241.6657
2-Hydroxybutanoa	2.173e-246	2.240e-241	0.9340	-245.6926
NH4(CH3COO)2-	6.643e-247	9.040e-242	0.9340	-246.2073
Asparagine(aq)	5.308e-248	7.011e-243	1.0000	-247.2751
Cu(Gly)2(aq)	1.330e-249	2.814e-244	1.0000	-248.8762
2-Hydroxybutanoi	3.392e-250	3.531e-245	1.0000	-249.4695
Propane(aq)	2.492e-256	1.099e-251	1.0000	-255.6034
Mg(Gly)2(aq)	9.046e-257	1.559e-251	1.0000	-256.0436
Diglycine(aq)	5.573e-257	7.361e-252	1.0000	-256.2539
Mn(Gly)2(aq)	6.512e-258	1.322e-252	1.0000	-257.1863
Fe(Gly)2(aq)	6.075e-258	1.239e-252	1.0000	-257.2164
Pb(Gly)2(aq)	1.045e-258	3.712e-253	1.0000	-257.9809
Cd(Gly)2(aq)	3.868e-259	1.008e-253	1.0000	-258.4125
Diketopiperazine	2.065e-259	2.355e-254	1.0000	-258.6852
Butanoate	8.722e-260	7.594e-255	0.9340	-259.0890
Ca(Gly)2(aq)	3.883e-261	7.305e-256	1.0000	-260.4109
Butanoic_acid(aq	1.279e-262	1.127e-257	1.0000	-261.8930
Na(But)(aq)	1.185e-262	1.304e-257	1.0000	-261.9264
Ca(But)+	9.246e-263	1.176e-257	0.9340	-262.0637
K(But)(aq)	5.233e-263	6.602e-258	1.0000	-262.2812
Mg(But)+	4.616e-263	5.141e-258	0.9340	-262.3654
Mn(But)+	1.234e-263	1.752e-258	0.9340	-262.9384
Ba(Gly)2(aq)	8.744e-264	2.495e-258	1.0000	-263.0583
Cu(But)+	5.362e-264	8.075e-259	0.9340	-263.3003
Fe(But)+	3.890e-264	5.559e-259	0.9340	-263.4397
Pb(But)+	5.377e-266	1.582e-260	0.9340	-265.2991
Glutarate	4.038e-266	5.252e-261	0.7602	-265.5129
Ba(But)+	3.625e-266	8.133e-261	0.9340	-265.4703
Cd(But)+	2.172e-266	4.331e-261	0.9340	-265.6928
H-Glutarate	2.145e-268	2.812e-263	0.9340	-267.6982
Threonine(aq)	2.561e-269	3.050e-264	1.0000	-268.5916
Glutaric_acid(aq	1.131e-271	1.494e-266	1.0000	-270.9466
Ethylacetate(aq)	8.605e-272	7.580e-267	1.0000	-271.0652
S5O6--	5.017e-273	1.286e-267	0.7602	-272.4186
1-Propanamine(aq	4.451e-278	2.630e-273	1.0000	-277.3516
a-Aminobutyric_a	2.219e-280	2.288e-275	1.0000	-279.6538

Glutamic_acid(aq	2.843e-289	4.182e-284	1.0000	-288.5462
UO2(SCN)2(aq)	5.421e-295	2.093e-289	1.0000	-294.2659
Butanal(aq)	1.521e-296	1.096e-291	1.0000	-295.8179
S4--	3.691e-307	4.733e-302	0.7602	-300.0000
1-Butyne(aq)	9.427e-314	5.097e-309	1.0000	-300.0000
Cu(CH3COO)3-	2.536e-315	6.101e-310	0.9340	-300.0000
Mn(CH3COO)3-	1.090e-316	2.529e-311	0.9340	-300.0000
Pb(CH3COO)3-	5.705e-317	2.192e-311	0.9340	-300.0000
1-Butanol(aq)	4.502e-318	3.336e-313	1.0000	-300.0000
Cd(CH3COO)3-	1.047e-318	3.031e-313	0.9340	-300.0000
1-Butene(aq)	4.018e-320	2.254e-315	1.0000	-300.0000
2-Hydroxypentano	9.881e-324	1.157e-318	0.9340	-300.0000
m-Toluate	0.0000	0.0000	0.9340	-300.0000
Valine(aq)	0.0000	0.0000	1.0000	-300.0000
Undecanoic_acid(	0.0000	0.0000	1.0000	-300.0000
Undecanoate	0.0000	0.0000	0.9340	-300.0000
UO2(SCN)3-	0.0000	0.0000	0.9340	-300.0000
H-Suberate	0.0000	0.0000	0.9340	-300.0000
Alanylglycine(aq	0.0000	0.0000	1.0000	-300.0000
H-Sebacate	0.0000	0.0000	0.9340	-300.0000
H-Pimelate	0.0000	0.0000	0.9340	-300.0000
2-Hexanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexyne(aq)	0.0000	0.0000	1.0000	-300.0000
H-Azelate	0.0000	0.0000	0.9340	-300.0000
Ca(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
H-Adipate	0.0000	0.0000	0.9340	-300.0000
Tyrosine(aq)	0.0000	0.0000	1.0000	-300.0000
Tryptophan(aq)	0.0000	0.0000	1.0000	-300.0000
Toluene(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Suberic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Suberate	0.0000	0.0000	0.7602	-300.0000
Ca(Pent)+	0.0000	0.0000	0.9340	-300.0000
2-Heptanone(aq)	0.0000	0.0000	1.0000	-300.0000
Sebacic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Sb2S4--	0.0000	0.0000	0.7602	-300.0000
Glutamine(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
S5--	0.0000	0.0000	0.7602	-300.0000
2-Butanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexene(aq)	0.0000	0.0000	1.0000	-300.0000
Pimelic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Pimelate	0.0000	0.0000	0.7602	-300.0000
Phenylalanine(aq	0.0000	0.0000	1.0000	-300.0000
Pentanoic_acid(a	0.0000	0.0000	1.0000	-300.0000
Pentanal(aq)	0.0000	0.0000	1.0000	-300.0000
Fe(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Fe(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Adipic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Fe(Pent)+	0.0000	0.0000	0.9340	-300.0000
Pb(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Fe(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Pb(Pent)+	0.0000	0.0000	0.9340	-300.0000
Pb(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Adipate	0.0000	0.0000	0.7602	-300.0000
1-Hexanol(aq)	0.0000	0.0000	1.0000	-300.0000
Pb(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Pb(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Fe(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Octanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Octanoate	0.0000	0.0000	0.9340	-300.0000

Fe(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Octanal(aq)	0.0000	0.0000	1.0000	-300.0000
Nonanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Nonanoate	0.0000	0.0000	0.9340	-300.0000
Nonanal(aq)	0.0000	0.0000	1.0000	-300.0000
Ethylbenzene(aq)	0.0000	0.0000	1.0000	-300.0000
Pb(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexanamine(aq)	0.0000	0.0000	1.0000	-300.0000
Na(Prop)2-	0.0000	0.0000	0.9340	-300.0000
Na(Pent)2-	0.0000	0.0000	0.9340	-300.0000
Benzoic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Na(Pent)(aq)	0.0000	0.0000	1.0000	-300.0000
Na(Lac)2-	0.0000	0.0000	0.9340	-300.0000
Dodecanoic_acid(	0.0000	0.0000	1.0000	-300.0000
Dodecanoate	0.0000	0.0000	0.9340	-300.0000
Benzoate	0.0000	0.0000	0.9364	-300.0000
Pentanoate	0.0000	0.0000	0.9340	-300.0000
Benzene(aq)	0.0000	0.0000	1.0000	-300.0000
Phenol(aq)	0.0000	0.0000	1.0000	-300.0000
Na(But)2-	0.0000	0.0000	0.9340	-300.0000
Decanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Decanoate	0.0000	0.0000	0.9340	-300.0000
2-Pentanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Pentyne(aq)	0.0000	0.0000	1.0000	-300.0000
Decanal(aq)	0.0000	0.0000	1.0000	-300.0000
2-Octanone(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxypentano	0.0000	0.0000	1.0000	-300.0000
1-Pentene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptyne(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Pent)+	0.0000	0.0000	0.9340	-300.0000
Mn(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Pent)+	0.0000	0.0000	0.9340	-300.0000
Ba(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Pent)+	0.0000	0.0000	0.9340	-300.0000
2-Hydroxyoctanoi	0.0000	0.0000	1.0000	-300.0000
1-Pentanol(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyoctanoa	0.0000	0.0000	0.9340	-300.0000
Mg(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Sebacate	0.0000	0.0000	0.7602	-300.0000
Mg(Pent)+	0.0000	0.0000	0.9340	-300.0000
Mg(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxynonanoi	0.0000	0.0000	1.0000	-300.0000
1-Pentanamine(aq	0.0000	0.0000	1.0000	-300.0000
1-Heptene(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxynonanoa	0.0000	0.0000	0.9340	-300.0000
Methionine(aq)	0.0000	0.0000	1.0000	-300.0000
Leucylglycine(aq	0.0000	0.0000	1.0000	-300.0000
Leucine(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyhexanoi	0.0000	0.0000	1.0000	-300.0000

U(SCN)2++	0.0000	0.0000	0.7623	-300.0000
1-Octyne(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyhexanoa	0.0000	0.0000	0.9340	-300.0000
K(Prop)2-	0.0000	0.0000	0.9340	-300.0000
Cd(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
K(Pent)2-	0.0000	0.0000	0.9340	-300.0000
K(Pent)(aq)	0.0000	0.0000	1.0000	-300.0000
K(Lac)2-	0.0000	0.0000	0.9340	-300.0000
Cd(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cd(Pent)+	0.0000	0.0000	0.9340	-300.0000
Ba(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyheptano	0.0000	0.0000	1.0000	-300.0000
1-Octene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptanol(aq)	0.0000	0.0000	1.0000	-300.0000
K(But)2-	0.0000	0.0000	0.9340	-300.0000
Isoleucine(aq)	0.0000	0.0000	1.0000	-300.0000
Cd(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Hexanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Hexanoate	0.0000	0.0000	0.9340	-300.0000
Azelate	0.0000	0.0000	0.7602	-300.0000
2-Hydroxyheptano	0.0000	0.0000	0.9340	-300.0000
Hexanal(aq)	0.0000	0.0000	1.0000	-300.0000
Heptanoic_acid(a	0.0000	0.0000	1.0000	-300.0000
Heptanoate	0.0000	0.0000	0.9340	-300.0000
Heptanal(aq)	0.0000	0.0000	1.0000	-300.0000
Azelaic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
HSb2S4-	0.0000	0.0000	0.9340	-300.0000
2-Hydroxydecanoi	0.0000	0.0000	1.0000	-300.0000
1-Octanol(aq)	0.0000	0.0000	1.0000	-300.0000
p-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
2-Hydroxydecanoa	0.0000	0.0000	0.9340	-300.0000
o-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
o-Phthalate	0.0000	0.0000	0.7602	-300.0000
Cd(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
n-Pentylbenzene(	0.0000	0.0000	1.0000	-300.0000
n-Pentane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Octylbenzene(a	0.0000	0.0000	1.0000	-300.0000
n-Octane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Hexylbenzene(a	0.0000	0.0000	1.0000	-300.0000
n-Hexane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Heptylbenzene(	0.0000	0.0000	1.0000	-300.0000
Cd(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
n-Heptane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Butylbenzene(a	0.0000	0.0000	1.0000	-300.0000
n-Butane(aq)	0.0000	0.0000	1.0000	-300.0000
m-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
n-Propylbenzene(	0.0000	0.0000	1.0000	-300.0000
1-Octanamine(aq)	0.0000	0.0000	1.0000	-300.0000
o-Toluate	0.0000	0.0000	0.9340	-300.0000
1-Heptanamine(aq	0.0000	0.0000	1.0000	-300.0000
p-Toluate	0.0000	0.0000	0.9340	-300.0000
1-Butanamine(aq)	0.0000	0.0000	1.0000	-300.0000
(NH4)2Sb2S4(aq)	0.0000	0.0000	1.0000	-300.0000

Mineral saturation states

	log Q/K		log Q/K
Nontronite-Ca	24.0610s/sat	UO2SO4:H2O	-11.4745
Nontronite-Mg	24.0018s/sat	Periclase	-11.5055
Nontronite-K	23.9782s/sat	Na2U2O7	-11.5658
Nontronite-Na	23.6867s/sat	BaU2O7	-11.6171
Nontronite-H	23.1641s/sat	Gyrolite	-11.7632

Hematite	19.7244s/sat	Przhevalskite	-11.7686
Magnetite	17.6186s/sat	MgUO4	-11.9889
Ferrite-Cu	17.4432s/sat	MnSO4	-11.9908
Cronstedtite-7A	16.8508s/sat	Portlandite	-12.1114
Delafossite	13.3051s/sat	CdSO4	-12.2077
Muscovite	11.6819s/sat	Thermonatrite	-12.3064
Clinoptilolite-K	11.5219s/sat	Monticellite	-12.3126
Clinoptilolite-h	11.3112s/sat	Mg1.5SO4(OH)	-12.3271
Clinoptilolite-C	11.2223s/sat	UO2.6667	-12.4774
Clinoptilolite-h	11.1664s/sat	UO2ClOH:2H2O	-12.5632
Stilbite	9.9090s/sat	UPO5	-12.5666
Goethite	9.4029s/sat	Bassetite	-12.5815
Epidote-ord	8.9314s/sat	Na2CO3	-12.6407
Epidote	8.9302s/sat	PbF2	-12.8823
Ferrite-Ca	8.6944s/sat	FeSO4	-13.0359
Ferrite-Mg	8.6061s/sat	Pb4SO7	-13.1486
Andradite	8.4866s/sat	MgSO4	-13.2479
Clinoptilolite-N	8.0805s/sat	Autunite-H	-13.2709
Clinoptilolite-h	8.0785s/sat	Uraninite	-13.5459
Illite	8.0043s/sat	Chalcocyanite	-13.6864
Paragonite	7.7237s/sat	Coffinite	-13.8779
Beidellite-Ca	7.6983s/sat	Mordenite-dehy	-14.0939
Beidellite-Mg	7.6389s/sat	FeF2	-14.2240
Beidellite-K	7.6155s/sat	BaCl2:2H2O	-14.3087
Fluorapatite	7.5759s/sat	CdCl2:H2O	-14.5815
Beidellite-Na	7.3238s/sat	BaCl2:H2O	-15.0521
Kaolinite	7.1973s/sat	CdCl2	-15.7091
Mesolite	7.0041s/sat	Tremolite	-15.8439
Beidellite-H	6.8019s/sat	NaUO3	-15.8577
Pyrophyllite	6.4386s/sat	UO2SO4:3.5H2O	-15.9348
Montmor-Mg	6.2567s/sat	MnCl2:4H2O	-15.9710
Montmor-Ca	6.2407s/sat	UO2SO4:2.5H2O	-16.0021
Montmor-K	6.2332s/sat	UO2SO4:3H2O	-16.0786
Jarosite	5.9532s/sat	Ba(OH)2:8H2O	-16.1594
Montmor-Na	5.9366s/sat	UO2F2:3H2O	-16.3316
Scolecite	5.4960s/sat	CaAl2O4	-16.3873
Maximum_Microcli	4.5705s/sat	Ca3(AsO4)2	-16.4735
K-Feldspar	4.5684s/sat	BaCl2	-16.6139
Margarite	4.1511s/sat	Alum-K	-16.6297
Laumontite	4.0984s/sat	UO2F2	-16.6676
Fe(OH)3	4.0677s/sat	Natrosilite	-16.8718
Smectite-low-Fe-	4.0091s/sat	Ferrite-Dicalciu	-16.9597
Celadonite	3.8127s/sat	MgOHCl	-17.3554
Diaspore	3.3185s/sat	MnCl2:2H2O	-17.4369
Sanidine_high	3.2644s/sat	Na2SiO3	-17.4718
Smectite-high-Fe	3.0260s/sat	CdF2	-17.5383
Boehmite	2.8876s/sat	CaAl4O7	-17.6780
Gibbsite	2.8007s/sat	Ba2Si3O8	-17.8141
Lawsonite	2.5870s/sat	Ningyoite	-18.1233
Corundum	2.3175s/sat	Gehlenite	-18.3635
Mordenite	2.0194s/sat	CuCl2	-18.6291
Witherite	1.6268s/sat	UO2.3333(beta)	-18.6336
Albite_low	1.5496s/sat	MnCl2:H2O	-19.1330
Albite	1.5495s/sat	Hydromagnesite	-19.1736
Kyanite	1.3831s/sat	Hillebrandite	-19.2131
Chamosite-7A	1.1198s/sat	MgCl2:4H2O	-19.6637
Andalusite	1.0714s/sat	Dicalcium_silica	-19.7022
Analcime	0.9446s/sat	UO2SO4	-19.8883
Strengite	0.7263s/sat	Na2UO4(alpha)	-20.6659
Natrolite	0.7143s/sat	Akermanite	-21.0592
Dawsonite	0.6850s/sat	Larnite	-21.0869
Sillimanite	0.6766s/sat	UOFOH:.5H2O	-21.4934
Amesite-14A	0.5198s/sat	UO2(NO3)2:6H2O	-21.5385

Quartz	0.5111s/sat	UOFOH	-22.0073
Tenorite	0.4417s/sat	Scacchite	-22.5648
Barite	0.3740s/sat	Lime	-22.7566
Malachite	0.3128s/sat	UO2Cl	-22.9236
Tridymite	0.3109s/sat	Anthophyllite	-22.9670
Chalcedony	0.2250s/sat	UO2(NO3)2:3H2O	-23.2130
Kalsilite	0.1931s/sat	Lawrencite	-23.9555
Albite_high	0.1248s/sat	Hydrophilite	-24.0314
Cerussite	0.0690s/sat	(UO2)3(PO4)2	-24.0352
Hercynite	0.0040s/sat	UO2(PO3)2	-24.2117
Cristobalite(alp	-0.0756	UOF2:H2O	-24.4568
Ice	-0.0801	(UO2)2P2O7	-24.5886
Daphnite-14A	-0.1214	UO2(NO3)2:2H2O	-24.5913
Annite	-0.1563	K2UO4	-25.1056
Coesite	-0.3408	UOF2	-25.1163
Rhodochrosite	-0.3971	Pargasite	-25.5128
Alunite	-0.4092	MgCl2:2H2O	-25.5346
Cristobalite(bet	-0.5645	U(HPO4)2:4H2O	-26.2050
Jadeite	-0.5830	KAl(SO4)2	-26.3129
Wairakite	-0.8187	UP2O7	-26.5844
Calcite	-0.8567	Clinoptilolite-d	-26.5887
Prehnite	-0.8921	Pb	-26.7311
SiO2(am)	-0.9059	Clinoptilolite-d	-26.8482
Brochantite	-0.9421	Rankinite	-27.3705
Aragonite	-1.0019	UO2Cl2:3H2O	-27.5716
Dolomite-ord	-1.0227	UO2(NO3)2:H2O	-28.4507
Dolomite	-1.0228	MgCl2:H2O	-29.1366
Clinozoisite	-1.0796	Ettringite	-29.5737
Zoisite	-1.1280	Clinoptilolite-d	-30.0045
Dioptase	-1.4290	Tobermorite-14A	-30.5170
Siderite	-1.4705	UO2Cl2:H2O	-30.5511
Monohydrocalcite	-1.6548	UO2(NO3)2	-32.1551
Magnesite	-1.8935	Tobermorite-11A	-32.7957
Phlogopite	-2.0781	Ba2SiO4	-32.8349
Anorthite	-2.3337	KMgCl3:2H2O	-33.7781
Alamosite	-2.4805	Merwinite	-33.9304
Gypsum	-2.6257	Foshagite	-34.0648
Nepheline	-2.6762	UO2SO3	-34.3220
Dolomite-dis	-2.6852	UF4:2.5H2O	-34.4447
Saponite-Ca	-2.6969	UO2Cl2	-34.6812
Ferrosilite	-2.7113	As2O5	-34.7713
Hydroxylapatite	-2.7175	Chloromagnesite	-35.2559
Saponite-Mg	-2.7544	Afwillite	-35.6535
Saponite-K	-2.7797	Tobermorite-9A	-36.6671
Ripidolite-14A	-2.7966	Al2(SO4)3:6H2O	-36.9451
Minnesotaite	-2.9269	Cd	-37.0931
Anhydrite	-2.9562	BaSiF6	-37.4342
Berlinite	-2.9702	Fe	-37.5511
Saponite-Na	-3.0713	(UO2)2As2O7	-38.0505
Sb2O3	-3.2858	(UO2)3(AsO4)2	-38.4038
Fluorite	-3.3627	UO2(AsO3)2	-38.5966
Whitlockite	-3.4211	UF4	-39.0200
Saponite-H	-3.5935	Molysite	-39.1837
Bassanite	-3.6061	Fe2(SO4)3	-40.8566
Bixbyite	-3.6161	BaO	-41.4826
Anglesite	-3.6356	KMgCl3	-41.5896
Daphnite-7A	-3.6391	U(SO4)2:8H2O	-43.0272
UO3:2H2O	-3.6685	Ba2U2O7	-44.2948
Schoepite	-3.6689	U(SO4)2:4H2O	-44.3756
CaSO4:0.5H2O(bet	-3.7944	Arsenolite	-44.3856
UO2(OH)2(beta)	-3.8386	Claudetite	-44.4636
Atacamite	-3.8555	U(SO4)2	-44.6522
CaUO4	-3.8647	Hatrurite	-46.3403

Schoepite-dehy(.	-3.8987	C	-46.4605
UO3:.9H2O(alpha)	-3.9074	UOCl2	-47.5982
Talc	-3.9662	U(CO3)2	-47.7078
Schoepite-dehy(.	-3.9932	Xonotlite	-49.4047
Schoepite-dehy(1	-4.0106	UClF3	-50.2154
Rhodonite	-4.0964	U5O12Cl	-51.2334
Lanarkite	-4.1830	As	-53.9343
Pyrolusite	-4.3976	UOF4	-54.7846
Paralaurionite	-4.5288	Al2(SO4)3	-55.7908
Greenalite	-4.5881	Na3UO4	-56.6928
Wustite	-4.6295	Na	-58.3728
Enstatite	-4.6534	(UO2)2Cl3	-58.8125
Sellaite	-4.6641	Na4SiO4	-58.8631
Cuprite	-4.7682	UOCl3	-59.9838
CdSiO3	-4.8478	Ca4Al2Fe2O10	-60.5776
UO2CO3	-4.8596	UF3	-61.1693
Rutherfordine	-4.8721	Na2O	-61.4427
Nesquehonite	-5.0212	Mn	-61.7406
Azurite	-5.0803	UF5(beta)	-61.9597
Clinochlore-14A	-5.0954	Pb2Cl5NH4	-62.2028
Schoepite-dehy(.	-5.1883	UF5(alpha)	-62.3700
Hausmannite	-5.4276	K	-62.3809
FeO	-5.4556	Ca3Al2O6	-62.9272
Nahcolite	-5.4894	UCl2F2	-63.7250
Niter	-5.5785	UOCl	-65.8346
Fe(OH)2	-5.7284	Covellite	-69.0549
Schoepite-dehy(.	-5.7414	S	-69.9185
Analcime-dehy	-5.8091	Ba3UO6	-71.3863
Cordierite_hydr	-5.9918	U2O3F6	-71.6004
UO2HPO4:4H2O	-6.0036	Chalcocite	-71.8049
Brucite	-6.0971	UCl3F	-77.0497
Litharge	-6.1024	CdS	-78.0417
Fayalite	-6.1887	Galena	-78.7573
Mn(OH)2(am)	-6.1908	K2O	-79.3570
NaFeO2	-6.2404	U(SO3)2	-84.7232
Massicot	-6.3009	CdCl2(NH3)2	-85.6482
Ripidolite-7A	-6.3055	Na6Si2O7	-85.6599
PbCO3.PbO	-6.3161	PbSO4(NH3)2	-88.1848
Okenite	-6.5149	UCl4	-88.2143
Wollastonite	-6.6168	As4O6(mono)	-88.4418
UO3(gamma)	-6.8306	As4O6(cubi)	-88.6466
Pseudowollastoni	-6.8845	Troilite	-88.7415
Diopside	-6.9016	Pyrrhotite	-88.8459
Chrysotile	-7.0139	Alabandite	-91.3540
Spinel	-7.1008	UCl3	-91.7745
Melanterite	-7.2350	UF6	-93.9116
Chalcanthite	-7.4122	U3O5F8	-95.6270
UO3(beta)	-7.4677	U2F9	-97.6707
Mirabilite	-7.5725	Antigorite	-97.8227
Cd(OH)2	-7.6130	Mg	-102.4786
Hedenbergite	-7.6327	U2O2Cl5	-108.8785
PbFCl	-7.7071	UCl5	-109.2428
UO3(alpha)	-7.8241	BaS	-109.8190
Sylvite	-7.8489	UN1.73(alpha)	-110.3087
Nantokite	-7.8824	UN1.59(alpha)	-113.1774
Arcanite	-7.9461	Ca	-120.1222
FeF3	-8.1732	P	-121.1463
Huntite	-8.2235	Al	-123.6654
Tephroite	-8.3048	Ba	-124.2316
Pb2SiO4	-8.3227	UN	-126.8316
Halite	-8.4329	UCl6	-129.0533
Cd(OH)Cl	-8.4438	Si	-129.1162
Sanbornite	-8.4613	Pb(N3)2(orth)	-142.1078

Ca-Al_Pyroxene	-8.4900	Pb(N3)2(mono)	-142.5660
UO2FOH:2H2O	-8.5189	Pyrite	-147.6645
Clinochlore-7A	-8.5997	Chalcopyrite	-151.5676
Saleeite	-8.6297	CdCl2(NH3)4	-166.3220
Pb3SO6	-8.6313	PbSO4(NH3)4	-170.5482
Cordierite_anhyd	-8.6374	U4F17	-174.7960
Artinite	-8.8169	U	-175.6177
Cu	-8.8863	UAs	-185.6128
BaUO4	-8.9149	US	-186.2053
UO2FOH:H2O	-8.9823	UC	-203.8066
Manganosite	-9.0285	UH3(beta)	-206.2714
Thenardite	-9.1122	US1.9	-214.2909
Monteponite	-9.1230	US2	-219.4698
Phosgenite	-9.1512	Mayenite	-231.4603
Nitrobarite	-9.2798	UAs2	-236.7694
Grossular	-9.3527	CdCl2(NH3)6	-247.0924
AlF3	-9.3831	UP	-247.5751
UO2FOH	-9.5152	UC1.94(alpha)	-249.6152
Sepiolite	-9.7066	Stibnite	-261.4143
(UO2)3(PO4)2:4H2	-10.0708	US3	-286.0477
UO2.25	-10.1867	Orpiment	-286.4530
Torbernite	-10.1937	Pb(SCN)2	-289.7630
CdSO4:2.667H2O	-10.2062	Bornite	-294.8740
Natron	-10.2284	UP2	-363.3746
UO2.25(beta)	-10.2558	U2S3	-398.3827
Uranocircite	-10.2634	o-Phthalic_acid	-408.1520
CdSO4:H2O	-10.4703	U2C3	-455.6804
Na2CO3:7H2O	-10.8072	U3As4	-608.5652
Mg1.25SO4(OH)0.5	-10.8753	U3S5	-613.0206
Cotunnite	-10.8845	U3P4	-858.5242
Forsterite	-11.0962		

Gases	fugacity	log fug.
N2(g)	0.2577	-0.589
H2O(g)	0.009706	-2.013
CO2(g)	0.001832	-2.737
NO2(g)	2.591e-012	-11.587
HF(g)	4.813e-015	-14.318
HCl(g)	2.506e-019	-18.601
O2(g)	6.928e-030	-29.159
H2(g)	1.855e-030	-29.732
NO(g)	1.530e-031	-30.815
CO(g)	1.140e-036	-35.943
SiF4(g)	4.390e-040	-39.358
NH3(g)	2.707e-042	-41.568
Cl2(g)	2.312e-043	-42.636
SO2(g)	2.374e-044	-43.625
Cd(g)	2.006e-052	-51.698
Pb(g)	9.291e-058	-57.032
UO2F2(g)	3.398e-062	-61.469
Cu(g)	5.202e-065	-64.284
Na(g)	1.297e-073	-72.887
UO2Cl2(g)	7.440e-074	-73.128
K(g)	1.480e-074	-73.830
UO3(g)	6.799e-075	-74.168
UOF4(g)	8.824e-077	-76.054
UF5(g)	6.555e-084	-83.183
UF4(g)	1.455e-086	-85.837
H2S(g)	2.677e-094	-93.572
UF6(g)	6.135e-096	-95.212
CH4(g)	4.794e-097	-96.319
F2(g)	2.212e-101	-100.655

UCl4(g)	2.677e-115	-114.572
UO2(g)	1.285e-116	-115.891
Mg(g)	2.534e-124	-123.596
UCl5(g)	1.070e-128	-127.971
UF3(g)	7.441e-133	-132.128
UCl6(g)	1.961e-136	-135.708
U2F10(g)	4.184e-140	-139.378
UCl3(g)	2.806e-141	-140.552
Ca(g)	8.886e-148	-147.051
S2(g)	1.079e-155	-154.967
C2H4(g)	1.495e-165	-164.825
C(g)	1.109e-171	-170.955
UF2(g)	9.334e-176	-175.030
Al(g)	2.991e-178	-177.524
UCl2(g)	2.018e-185	-184.695
UO(g)	1.516e-191	-190.819
Si(g)	3.238e-205	-204.490
UF(g)	8.035e-212	-211.095
U2Cl8(g)	2.195e-218	-217.659
UCl(g)	5.286e-227	-226.277
U2Cl10(g)	2.063e-228	-227.685
U(g)	4.774e-267	-266.321

		In fluid		Sorbed		Kd
Original basis	total moles	moles	mg/kg	moles	mg/kg	L/kg
Al+++	3.98e-006	3.98e-006	0.107			
Ba++	6.90e-007	6.90e-007	0.0948			
Ca++	0.000415	0.000415	16.6			
Cd++	7.74e-009	7.74e-009	0.000870			
Cl-	0.000110	0.000110	3.91			
Cu++	4.31e-007	4.31e-007	0.0274			
F-	1.03e-005	1.03e-005	0.195			
Fe++	1.05e-006	1.05e-006	0.0586			
H+	8.45e-005	8.45e-005	0.0851			
H2AsO4-	2.61e-008	2.61e-008	0.00368			
H2O	55.5	55.5	1.00e+006			
HCO3-	0.00159	0.00159	96.7			
HPO4--	4.23e-006	4.23e-006	0.406			
K+	0.000675	0.000675	26.4			
Mg++	0.000161	0.000161	3.91			
Mn++	9.85e-006	9.85e-006	0.541			
NH3(aq)	0.000443	0.000443	7.55			
NO3-	0.00123	0.00123	76.1			
Na+	0.00132	0.00132	30.3			
O2(aq)	0.000333	0.000333	10.6			
Pb++	1.23e-008	1.23e-008	0.00254			
S2--	6.10e-007	6.10e-007	0.0391			
SO4--	0.000336	0.000336	32.2			
Sb(OH)3(aq)	3.69e-007	3.69e-007	0.0638			
SiO2(aq)	0.000138	0.000138	8.30			
UO2++	1.19e-008	1.19e-008	0.00321			

Elemental composition		In fluid		Sorbed	
	total moles	moles	mg/kg	moles	mg/kg
Aluminum	3.984e-006	3.984e-006	0.1075		
Antimony	3.692e-007	3.692e-007	0.04494		
Arsenic	2.609e-008	2.609e-008	0.001954		
Barium	6.903e-007	6.903e-007	0.09477		
Cadmium	7.737e-009	7.737e-009	0.0008695		
Calcium	0.0004145	0.0004145	16.61		
Carbon	0.001586	0.001586	19.04		

Chlorine	0.0001103	0.0001103	3.908
Copper	4.306e-007	4.306e-007	0.02736
Fluorine	1.029e-005	1.029e-005	0.1954
Hydrogen	111.0	111.0	1.119e+005
Iron	1.050e-006	1.050e-006	0.05862
Lead	1.226e-008	1.226e-008	0.002540
Magnesium	0.0001608	0.0001608	3.908
Manganese	9.855e-006	9.855e-006	0.5412
Nitrogen	0.001671	0.001671	23.40
Oxygen	55.52	55.52	8.880e+005
Phosphorus	4.228e-006	4.228e-006	0.1309
Potassium	0.0006749	0.0006749	26.38
Silicon	0.0001383	0.0001383	3.882
Sodium	0.001318	0.001318	30.29
Sulfur	0.0003369	0.0003369	10.80
Uranium	1.191e-008	1.191e-008	0.002833

```
Temperature =  25.0 C    Pressure =  1.013 bars
pH =  7.200              log fO2 =  -30.382
Eh =   0.3538 volts      pe =   5.9809
Ionic strength      =    0.002470
Charge imbalance    =    0.000089 eq/kg (5.785% error)
Activity of water   =    1.000000
Solvent mass        =    1.000000 kg
Solution mass       =    1.000136 kg
Solution density    =    1.013    g/cm3
Chlorinity          =    0.000000 molal
Dissolved solids    =         136 mg/kg sol'n
Elect. conductivity =      151.53 uS/cm (or umho/cm)
Hardness            =       81.16 mg/kg sol'n as CaCO3
  carbonate         =       60.86 mg/kg sol'n as CaCO3
  non-carbonate     =       20.30 mg/kg sol'n as CaCO3
Rock mass           =    0.000000 kg
Carbonate alkalinity=       60.86 mg/kg sol'n as CaCO3
Water type          =    Ca-HCO3
```

Nernst redox couples	Eh (volts)	pe
e- + .25*O2(aq) + H+ = .5*H2O	0.3538	5.9809
8*e- + 9*H+ + NO3- = 3*H2O + NH3(aq)	0.5662	9.5714

No minerals in system.

Aqueous species	molality	mg/kg sol'n	act. coef.	log act.
HCO3-	0.001205	73.50	0.9468	-2.9428
Ca++	0.0006018	24.11	0.8082	-3.3131
Mg++	0.0001886	4.584	0.8132	-3.8142
CO2(aq)	0.0001592	7.004	1.0000	-3.7981
SO4--	0.0001330	12.77	0.8029	-3.9716
SiO2(aq)	7.546e-005	4.533	1.0000	-4.1223
NO3-	2.742e-005	1.700	0.9460	-4.5861
CaSO4(aq)	6.706e-006	0.9128	1.0000	-5.1736
CaHCO3+	6.525e-006	0.6595	0.9468	-5.2092
MgSO4(aq)	4.226e-006	0.5086	1.0000	-5.3740
N2(aq)	2.763e-006	0.07738	1.0000	-5.5587
MgHCO3+	2.007e-006	0.1712	0.9468	-5.7213
CO3--	1.054e-006	0.06326	0.8043	-6.0716
CuCO3(aq)	9.471e-007	0.1170	1.0000	-6.0236
CaCO3(aq)	8.758e-007	0.08764	1.0000	-6.0576
OH-	1.694e-007	0.002880	0.9464	-6.7951
Cu++	1.532e-007	0.009733	0.8082	-6.9073
HSiO3-	1.409e-007	0.01086	0.9468	-6.8748
MgCO3(aq)	1.239e-007	0.01045	1.0000	-6.9069
CuOH+	1.069e-007	0.008610	0.9468	-6.9948
Mn++	1.027e-007	0.005642	0.8082	-7.0809
CaNO3+	6.678e-008	0.006816	0.9468	-7.1991
H+	6.638e-008	6.690e-005	0.9505	-7.2000
HAsO4--	5.043e-008	0.007055	0.8029	-7.3927
H2AsO4-	1.547e-008	0.002179	0.9468	-7.8344
CuSO4(aq)	3.028e-009	0.0004832	1.0000	-8.5188
MnCO3(aq)	2.331e-009	0.0002679	1.0000	-8.6325
MnSO4(aq)	1.997e-009	0.0003016	1.0000	-8.6996
Cu(CO3)2--	1.685e-009	0.0003093	0.8029	-8.8686
CaOH+	1.150e-009	6.564e-005	0.9468	-8.9631
MnHCO3+	7.615e-010	8.828e-005	0.9468	-9.1421
HSO4-	6.781e-010	6.581e-005	0.9468	-9.1925
Cu+	7.349e-011	4.669e-006	0.9468	-10.1575
MnOH+	3.572e-011	2.569e-006	0.9468	-10.4709

MnNO3+	3.604e-012	4.214e-007	0.9468	-11.4669
AsO4---	2.629e-012	3.652e-007	0.6101	-11.7948
CuCO3(OH)2--	2.519e-012	3.969e-007	0.8029	-11.6941
H2SiO4--	2.588e-013	2.435e-008	0.8029	-12.6823
H3AsO4(aq)	1.640e-013	2.328e-008	1.0000	-12.7852
HNO3(aq)	8.155e-014	5.138e-009	1.0000	-13.0886
Mn(OH)2(aq)	1.316e-015	1.170e-010	1.0000	-14.8809
H6(H2SiO4)4--	2.323e-016	8.884e-011	0.8029	-15.7292
Mn(NO3)2(aq)	2.223e-016	3.978e-011	1.0000	-15.6530
Mn2(OH)3+	3.648e-017	5.868e-012	0.9468	-16.4617
Mn2OH+++	4.894e-018	6.208e-013	0.6147	-17.5217
CuO2--	3.454e-018	3.300e-013	0.8029	-17.5570
H2SO4(aq)	4.051e-020	3.972e-015	1.0000	-19.3925
HAsO2(aq)	2.240e-020	2.417e-015	1.0000	-19.6498
Mn(OH)3-	2.066e-020	2.189e-015	0.9468	-19.7087
As(OH)3(aq)	1.887e-020	2.376e-015	1.0000	-19.7242
AsO2-	2.022e-022	2.162e-017	0.9468	-21.7179
H2AsO3-	1.971e-022	2.462e-017	0.9468	-21.7290
H4(H2SiO4)4----	5.654e-024	2.151e-018	0.4153	-23.6292
AsO2OH--	3.542e-026	4.388e-021	0.8029	-25.5461
Mg4(OH)4++++	1.467e-026	2.424e-021	0.4236	-26.2066
Mn+++	3.383e-027	1.858e-022	0.6147	-26.6821
Mn(OH)4--	3.269e-027	4.020e-022	0.8029	-26.5809
Formate	8.240e-030	3.709e-025	0.9464	-29.1080
H2(aq)	3.417e-030	6.887e-027	1.0000	-29.4664
Ca(For)+	1.078e-031	9.175e-027	0.9468	-30.9910
Mg(For)+	3.402e-032	2.358e-027	0.9468	-31.4921
NO2-	1.316e-032	6.054e-028	0.9460	-31.9048
Formic_acid(aq)	2.786e-033	1.282e-028	1.0000	-32.5550
O2(aq)	5.243e-034	1.677e-029	1.0000	-33.2804
SO3--	1.377e-034	1.102e-029	0.8043	-33.9558
HSO3-	1.184e-034	9.598e-030	0.9468	-33.9504
NH4+	1.037e-034	1.871e-030	0.9455	-34.0084
Cu(For)+	9.736e-035	1.057e-029	0.9468	-34.0354
Mn(For)+	3.425e-035	3.423e-030	0.9468	-34.4891
CO(aq)	6.269e-036	1.756e-031	1.0000	-35.2028
HNO2(aq)	1.306e-036	6.137e-032	1.0000	-35.8842
NH3(aq)	8.924e-037	1.520e-032	1.0000	-36.0494
Oxalate	2.428e-037	2.137e-032	0.8029	-36.7100
CuNO2+	1.705e-037	1.867e-032	0.9468	-36.7921
HO2-	1.913e-038	6.312e-034	0.9468	-37.7421
CuNH3++	1.506e-039	1.214e-034	0.8043	-38.9167
H2SO3(aq)	7.202e-040	5.910e-035	1.0000	-39.1426
SO2(aq)	5.127e-040	3.284e-035	1.0000	-39.2902
H-Oxalate	2.346e-040	2.088e-035	0.9468	-39.6534
MnO4--	1.316e-044	1.566e-039	0.8029	-43.9759
HSO5-	8.423e-046	9.522e-041	0.9468	-45.0983
Oxalic_acid(aq)	2.611e-046	2.351e-041	1.0000	-45.5831
NH4SO4-	5.530e-047	6.309e-042	0.9468	-46.2810
MnO4-	4.428e-048	5.266e-043	0.9464	-47.3777
S2O6--	9.386e-058	1.503e-052	0.8029	-57.1229
Ca(For)2(aq)	5.903e-060	7.680e-055	1.0000	-59.2289
Mg(For)2(aq)	1.862e-060	2.129e-055	1.0000	-59.7300
S2O8--	4.093e-062	7.862e-057	0.8029	-61.4833
Cu(For)2(aq)	1.502e-062	2.307e-057	1.0000	-61.8233
Mn(For)2(aq)	3.111e-063	4.510e-058	1.0000	-62.5071
Formaldehyde(aq)	3.674e-064	1.103e-059	1.0000	-63.4349
Cu(NO2)2(aq)	2.056e-068	3.199e-063	1.0000	-67.6869
N3-	3.038e-071	1.276e-066	0.9468	-70.5412
Cu(NH3)2++	3.465e-072	3.381e-067	0.8043	-71.5550
S2O5--	2.383e-073	3.435e-068	0.8029	-72.7181
HN3(aq)	9.096e-074	3.914e-069	1.0000	-73.0411
Urea(aq)	2.455e-076	1.474e-071	1.0000	-75.6099

HCN(aq)	4.299e-077	1.162e-072	1.0000	-76.3667
Methanol(aq)	7.468e-079	2.392e-074	1.0000	-78.1268
CN-	4.184e-079	1.088e-074	0.9460	-78.4026
HS-	1.248e-083	4.128e-079	0.9464	-82.9276
H2S(aq)	7.246e-084	2.469e-079	1.0000	-83.1399
Glycolate	4.726e-085	3.546e-080	0.9468	-84.3493
Ca(Glyc)+	1.027e-086	1.182e-081	0.9468	-86.0124
Mg(Glyc)+	1.549e-087	1.538e-082	0.9468	-86.8338
Glycolic_acid(aq	1.924e-088	1.463e-083	1.0000	-87.7157
Methane(aq)	1.892e-088	3.034e-084	1.0000	-87.7232
Cu(Glyc)+	4.544e-089	6.296e-084	0.9468	-88.3664
S--	2.699e-089	8.653e-085	0.8056	-88.6627
S2O3--	5.938e-090	6.657e-085	0.8029	-89.3217
Mn(Glyc)+	1.498e-090	1.946e-085	0.9468	-89.8484
S2O4--	1.641e-091	2.102e-086	0.8056	-90.8788
Acetate	5.616e-094	3.315e-089	0.9472	-93.2742
HS2O3-	3.281e-096	3.711e-091	0.9468	-95.5078
CaCH3COO+	2.330e-096	2.310e-091	0.9468	-95.6563
Acetic_acid(aq)	1.919e-096	1.152e-091	1.0000	-95.7170
MgCH3COO+	1.639e-096	1.366e-091	0.9468	-95.8092
CuCH3COO+	1.187e-098	1.454e-093	0.9468	-97.9494
MnCH3COO+	7.682e-100	8.755e-095	0.9468	-99.1383
Malonate	8.666e-103	8.842e-098	0.8029	-102.1575
CuCH3COO(aq)	7.908e-104	9.693e-099	1.0000	-103.1019
H-Malonate	2.300e-104	2.370e-099	0.9468	-103.6620
AsH3(aq)	2.167e-104	1.689e-099	1.0000	-103.6642
Cu(NH3)3++	2.046e-105	2.345e-100	0.8043	-104.7837
Malonic_acid(aq)	9.756e-109	1.015e-103	1.0000	-108.0107
Methanamine(aq)	1.514e-112	4.701e-108	1.0000	-111.8199
Glycine(aq)	2.594e-115	1.947e-110	1.0000	-114.5860
Cu(Gly)+	3.331e-116	4.583e-111	0.9468	-115.5012
Mg(Gly)+	3.131e-118	3.079e-113	0.9468	-117.5281
Ca(Gly)+	7.882e-120	8.995e-115	0.9468	-119.1271
S3O6--	6.865e-121	1.319e-115	0.8029	-120.2587
Mn(Gly)+	2.745e-121	3.540e-116	0.9468	-120.5852
Acetaldehyde(aq)	3.533e-126	1.556e-121	1.0000	-125.4519
SCN-	8.148e-127	4.732e-122	0.9464	-126.1129
NH4CH3COO(aq)	8.511e-128	6.559e-123	1.0000	-127.0700
Acetamide(aq)	8.477e-128	5.007e-123	1.0000	-127.0717
Ethanol(aq)	2.595e-145	1.195e-140	1.0000	-144.5858
Ethyne(aq)	3.397e-147	8.845e-143	1.0000	-146.4689
Ethylene(aq)	8.881e-150	2.491e-145	1.0000	-149.0515
Lactate	1.880e-151	1.674e-146	0.9468	-150.7497
Ca(Lac)+	2.403e-153	3.103e-148	0.9468	-152.6429
Mg(Lac)+	6.758e-154	7.661e-149	0.9468	-153.1939
Lactic_acid(aq)	8.189e-155	7.375e-150	1.0000	-154.0868
Cu(Lac)+	8.442e-156	1.288e-150	0.9468	-155.0973
Mn(Lac)+	4.201e-157	6.048e-152	0.9468	-156.4004
Ethane(aq)	4.926e-159	1.481e-154	1.0000	-158.3075
Propanoate	1.820e-162	1.329e-157	0.9468	-161.7638
Propanoic_acid(a	8.423e-165	6.239e-160	1.0000	-164.0746
Ca(Prop)+	4.167e-165	4.714e-160	0.9468	-164.4039
Mg(Prop)+	1.440e-165	1.402e-160	0.9468	-164.8654
Cu(Prop)+	3.679e-167	5.026e-162	0.9468	-166.4580
S4O6--	4.046e-168	9.072e-163	0.8029	-167.4883
Mn(Prop)+	2.829e-168	3.621e-163	0.9468	-167.5721
Succinate	9.884e-170	1.147e-164	0.8029	-169.1004
Ca(Glyc)2(aq)	7.560e-170	1.437e-164	1.0000	-169.1215
Mg(Glyc)2(aq)	6.128e-171	1.069e-165	1.0000	-170.2127
H-Succinate	2.254e-171	2.638e-166	0.9468	-170.6709
Cu(Glyc)2(aq)	1.132e-171	2.418e-166	1.0000	-170.9462
Serine(aq)	2.335e-173	2.453e-168	1.0000	-172.6317
Mn(Glyc)2(aq)	4.471e-174	9.166e-169	1.0000	-173.3496

Succinic_acid(aq	2.171e-174	2.563e-169	1.0000	-173.6634
HAsS2(aq)	1.977e-179	2.769e-174	1.0000	-178.7039
Ethanamine(aq)	7.231e-181	3.260e-176	1.0000	-180.1408
Alanine(aq)	1.413e-182	1.259e-177	1.0000	-181.8498
Cu(Ala)+	4.094e-184	6.207e-179	0.9468	-183.4116
Mg(Ala)+	1.429e-187	1.606e-182	0.9468	-186.8687
Ca(Ala)+	8.637e-188	1.107e-182	0.9468	-187.0874
Ca(CH3COO)2(aq)	1.869e-188	2.955e-183	1.0000	-187.7284
Mg(CH3COO)2(aq)	4.774e-189	6.797e-184	1.0000	-188.3211
Mn(Ala)+	1.473e-189	2.107e-184	0.9468	-188.8555
Acetone(aq)	6.884e-190	3.998e-185	1.0000	-189.1621
Cu(CH3COO)2(aq)	1.501e-190	2.726e-185	1.0000	-189.8236
Mn(CH3COO)2(aq)	2.694e-192	4.661e-187	1.0000	-191.5695
Aspartic_acid(aq	1.027e-192	1.367e-187	1.0000	-191.9885
Propanal(aq)	4.058e-194	2.357e-189	1.0000	-193.3916
Cu(CH3COO)2-	4.153e-197	7.542e-192	0.9468	-196.4054
S3--	1.673e-210	1.609e-205	0.8029	-209.8718
1-Propyne(aq)	1.183e-211	4.741e-207	1.0000	-210.9268
1-Propanol(aq)	9.463e-214	5.686e-209	1.0000	-213.0240
1-Propene(aq)	4.786e-216	2.014e-211	1.0000	-215.3200
2-Hydroxybutanoa	2.663e-220	2.745e-215	0.9468	-219.5984
NH4(CH3COO)2-	3.528e-221	4.802e-216	0.9468	-220.4762
2-Hydroxybutanoi	1.031e-223	1.073e-218	1.0000	-222.9868
Asparagine(aq)	5.844e-224	7.720e-219	1.0000	-223.2333
Cu(Gly)2(aq)	3.929e-226	8.314e-221	1.0000	-225.4058
Propane(aq)	7.684e-228	3.388e-223	1.0000	-227.1144
Butanoate	2.002e-231	1.744e-226	0.9468	-230.7222
Mg(Gly)2(aq)	2.077e-232	3.580e-227	1.0000	-231.6827
Diglycine(aq)	1.745e-232	2.305e-227	1.0000	-231.7582
Butanoic_acid(aq	7.696e-234	6.780e-229	1.0000	-233.1137
Ca(But)+	3.158e-234	4.015e-229	0.9468	-233.5244
Diketopiperazine	1.324e-234	1.510e-229	1.0000	-233.8782
Mg(But)+	1.042e-234	1.161e-229	0.9468	-234.0057
Mn(Gly)2(aq)	1.662e-235	3.374e-230	1.0000	-234.7794
Cu(But)+	3.196e-236	4.814e-231	0.9468	-235.5192
Ca(Gly)2(aq)	2.943e-236	5.537e-231	1.0000	-235.5313
Mn(But)+	2.638e-237	3.746e-232	0.9468	-236.6025
Glutarate	8.524e-238	1.109e-232	0.8029	-237.1647
H-Glutarate	1.191e-239	1.562e-234	0.9468	-238.9478
Threonine(aq)	2.701e-242	3.217e-237	1.0000	-241.5684
Glutaric_acid(aq	1.555e-242	2.054e-237	1.0000	-241.8084
Ethylacetate(aq)	1.433e-242	1.262e-237	1.0000	-241.8438
S5O6--	3.140e-244	8.049e-239	0.8029	-243.5983
1-Propanamine(aq	8.739e-249	5.165e-244	1.0000	-248.0586
a-Aminobutyric_a	3.322e-251	3.425e-246	1.0000	-250.4786
Glutamic_acid(aq	1.133e-259	1.666e-254	1.0000	-258.9459
Butanal(aq)	1.870e-264	1.348e-259	1.0000	-263.7282
S4--	2.291e-271	2.938e-266	0.8029	-270.7353
1-Butyne(aq)	1.259e-280	6.809e-276	1.0000	-279.9000
Cu(CH3COO)3-	1.537e-282	3.699e-277	0.9468	-281.8370
1-Butanol(aq)	2.130e-283	1.579e-278	1.0000	-282.6716
1-Butene(aq)	3.338e-285	1.873e-280	1.0000	-284.4765
Mn(CH3COO)3-	3.290e-285	7.635e-280	0.9468	-284.5065
2-Hydroxypentano	5.562e-289	6.514e-284	0.9468	-288.2785
2-Hydroxypentano	1.298e-292	1.533e-287	1.0000	-291.8867
Glutamine(aq)	7.359e-293	1.075e-287	1.0000	-292.1332
n-Butane(aq)	1.054e-296	6.128e-292	1.0000	-295.9770
Alanylglycine(aq	4.285e-300	6.261e-295	1.0000	-299.3681
Pentanoate	2.651e-300	2.681e-295	0.9468	-299.6003
Pentanoic_acid(a	1.109e-302	1.132e-297	1.0000	-300.0000
Ca(Lac)2(aq)	4.648e-303	1.014e-297	1.0000	-300.0000
Ca(Pent)+	2.445e-303	3.451e-298	0.9468	-300.0000
Mg(Lac)2(aq)	1.193e-303	2.415e-298	1.0000	-300.0000

Mg(Pent)+	7.896e-304	9.902e-299	0.9468	-300.0000
Cu(Lac)2(aq)	5.541e-305	1.339e-299	1.0000	-300.0000
Cu(Pent)+	4.112e-305	6.771e-300	0.9468	-300.0000
Mn(Pent)+	2.636e-306	4.113e-301	0.9468	-300.0000
Mn(Lac)2(aq)	8.317e-307	1.938e-301	1.0000	-300.0000
Adipate	3.489e-308	5.028e-303	0.8029	-300.0000
H-Adipate	4.794e-310	6.957e-305	0.9468	-300.0000
Adipic_acid(aq)	7.407e-313	1.082e-307	1.0000	-300.0000
1-Butanamine(aq)	6.095e-318	4.457e-313	1.0000	-300.0000
Valine(aq)	6.168e-320	7.225e-315	1.0000	-300.0000
Benzoic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Benzoate	0.0000	0.0000	0.9483	-300.0000
2-Hydroxyheptano	0.0000	0.0000	0.9468	-300.0000
Benzene(aq)	0.0000	0.0000	1.0000	-300.0000
Azelate	0.0000	0.0000	0.8029	-300.0000
2-Hydroxydecanoi	0.0000	0.0000	1.0000	-300.0000
1-Octyne(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Azelaic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxydecanoa	0.0000	0.0000	0.9468	-300.0000
Mn(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
1-Octene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptyne(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hexanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Octanol(aq)	0.0000	0.0000	1.0000	-300.0000
Methionine(aq)	0.0000	0.0000	1.0000	-300.0000
Leucylglycine(aq	0.0000	0.0000	1.0000	-300.0000
2-Heptanone(aq)	0.0000	0.0000	1.0000	-300.0000
Leucine(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Isoleucine(aq)	0.0000	0.0000	1.0000	-300.0000
Hexanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Hexanoate	0.0000	0.0000	0.9468	-300.0000
Cu(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Hexanal(aq)	0.0000	0.0000	1.0000	-300.0000
Heptanoic_acid(a	0.0000	0.0000	1.0000	-300.0000
2-Butanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Octanamine(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptene(aq)	0.0000	0.0000	1.0000	-300.0000
Heptanoate	0.0000	0.0000	0.9468	-300.0000
Heptanal(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(o-Phthalate)(	0.0000	0.0000	1.0000	-300.0000
1-Hexyne(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
p-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
p-Toluate	0.0000	0.0000	0.9468	-300.0000
o-Toluate	0.0000	0.0000	0.9468	-300.0000
o-Phthalate	0.0000	0.0000	0.8029	-300.0000
Ca(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
n-Pentylbenzene(	0.0000	0.0000	1.0000	-300.0000
n-Pentane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Octylbenzene(a	0.0000	0.0000	1.0000	-300.0000
2-Pentanone(aq)	0.0000	0.0000	1.0000	-300.0000
n-Hexylbenzene(a	0.0000	0.0000	1.0000	-300.0000
n-Hexane(aq)	0.0000	0.0000	1.0000	-300.0000

n-Heptylbenzene(	0.0000	0.0000	1.0000	-300.0000
n-Butylbenzene(a	0.0000	0.0000	1.0000	-300.0000
m-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
2-Octanone(aq)	0.0000	0.0000	1.0000	-300.0000
H-Suberate	0.0000	0.0000	0.9468	-300.0000
H-Sebacate	0.0000	0.0000	0.9468	-300.0000
Undecanoate	0.0000	0.0000	0.9468	-300.0000
H-Pimelate	0.0000	0.0000	0.9468	-300.0000
Tyrosine(aq)	0.0000	0.0000	1.0000	-300.0000
Tryptophan(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptanol(aq)	0.0000	0.0000	1.0000	-300.0000
Toluene(aq)	0.0000	0.0000	1.0000	-300.0000
Suberic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Suberate	0.0000	0.0000	0.8029	-300.0000
H-Azelate	0.0000	0.0000	0.9468	-300.0000
Sebacate	0.0000	0.0000	0.8029	-300.0000
H(o-Phthalate)-	0.0000	0.0000	0.9468	-300.0000
S5--	0.0000	0.0000	0.8029	-300.0000
2-Hydroxyoctanoi	0.0000	0.0000	1.0000	-300.0000
1-Pentyne(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyoctanoa	0.0000	0.0000	0.9468	-300.0000
Pimelic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Sebacic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Pimelate	0.0000	0.0000	0.8029	-300.0000
Ca(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxynonanoi	0.0000	0.0000	1.0000	-300.0000
1-Pentene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexanol(aq)	0.0000	0.0000	1.0000	-300.0000
Phenylalanine(aq	0.0000	0.0000	1.0000	-300.0000
Phenol(aq)	0.0000	0.0000	1.0000	-300.0000
Pentanal(aq)	0.0000	0.0000	1.0000	-300.0000
Ethylbenzene(aq)	0.0000	0.0000	1.0000	-300.0000
Octanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
2-Hydroxynonanoa	0.0000	0.0000	0.9468	-300.0000
Undecanoic_acid(	0.0000	0.0000	1.0000	-300.0000
Octanoate	0.0000	0.0000	0.9468	-300.0000
Octanal(aq)	0.0000	0.0000	1.0000	-300.0000
Nonanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
m-Toluate	0.0000	0.0000	0.9468	-300.0000
Nonanoate	0.0000	0.0000	0.9468	-300.0000
Nonanal(aq)	0.0000	0.0000	1.0000	-300.0000
Dodecanoic_acid(	0.0000	0.0000	1.0000	-300.0000
n-Heptane(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyhexanoi	0.0000	0.0000	1.0000	-300.0000
1-Pentanol(aq)	0.0000	0.0000	1.0000	-300.0000
Dodecanoate	0.0000	0.0000	0.9468	-300.0000
n-Octane(aq)	0.0000	0.0000	1.0000	-300.0000
Decanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyhexanoa	0.0000	0.0000	0.9468	-300.0000
Decanoate	0.0000	0.0000	0.9468	-300.0000
n-Propylbenzene(	0.0000	0.0000	1.0000	-300.0000
Decanal(aq)	0.0000	0.0000	1.0000	-300.0000
o-Phthalic_acid(	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyheptano	0.0000	0.0000	1.0000	-300.0000
o-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
1-Pentanamine(aq	0.0000	0.0000	1.0000	-300.0000
1-Hexanamine(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptanamine(aq	0.0000	0.0000	1.0000	-300.0000

Mineral saturation states

	log Q/K		log Q/K

Quartz	-0.1230	Mg1.25SO4(OH)0.5	-10.3993
Ice	-0.1387	Manganosite	-10.6049
Tenorite	-0.1633	Periclase	-10.7496
Tridymite	-0.2945	Forsterite	-10.8132
Chalcedony	-0.3942	Mn(OH)3	-11.4233
Cristobalite(alp	-0.6735	Portlandite	-11.4683
Calcite	-0.9046	Mg1.5SO4(OH)	-11.7479
Coesite	-0.9330	Monticellite	-12.0347
Aragonite	-1.0490	Tephroite	-12.5622
Malachite	-1.0972	MgSO4	-12.6638
Cristobalite(bet	-1.1170	Sepiolite	-12.8344
Dolomite	-1.1264	Hausmannite	-13.0048
Dolomite-ord	-1.1264	Gyrolite	-13.1030
SiO2(am)	-1.4087	MnSO4	-13.7086
Monohydrocalcite	-1.7383	Chalcocyanite	-13.8027
Magnesite	-1.8506	Ca3(AsO4)2	-14.6239
Rhodochrosite	-2.6309	Hydromagnesite	-18.4960
Dolomite-dis	-2.6708	Hillebrandite	-18.7674
Dioptase	-2.7069	Tremolite	-19.1121
Gypsum	-2.8024	Dicalcium_silica	-19.1209
Chrysocolla	-2.8438	Larnite	-20.4149
Anhydrite	-2.9783	Akermanite	-20.8039
Bassanite	-3.6232	Lime	-21.4892
CaSO4:0.5H2O(bet	-3.7913	Anthophyllite	-25.6741
Brochantite	-3.8369	Rankinite	-26.8916
Cuprite	-4.0120	As2O5	-32.2288
Lansfordite	-4.3979	Merwinite	-32.9120
Nesquehonite	-4.5525	Tobermorite-14A	-33.1437
Antlerite	-4.6236	Foshagite	-33.9402
Enstatite	-4.8634	Tobermorite-11A	-34.9113
Manganite	-4.9175	Afwillite	-35.0290
Brucite	-5.7122	Arsenolite	-38.0216
Epsomite	-5.8234	Claudetite	-38.0934
Talc	-5.8700	Tobermorite-9A	-38.3790
Hexahydrite	-6.0589	C	-41.0359
Pentahydrite	-6.3985	Todorokite	-43.0443
Rhodonite	-6.5333	Hatrurite	-44.2671
Starkeyite	-6.7858	As	-46.6766
Wollastonite	-6.7959	Xonotlite	-50.0389
Azurite	-6.9681	Birnessite	-52.9858
Pseudowollastoni	-7.0351	Mn	-58.9911
Cu	-7.3788	Covellite	-59.8039
Kieserite	-7.5187	Chalcocite	-61.3085
Diopside	-7.5361	S	-61.6698
Okenite	-7.5393	As4O6(mono)	-75.6787
Chrysotile	-7.6125	As4O6(cubi)	-75.9526
Pyrolusite	-7.8845	Alabandite	-82.4141
Mn(OH)2(am)	-7.9911	Mg	-95.3104
Huntite	-8.0279	Realgar	-96.0268
Chalcanthite	-8.2573	Antigorite	-109.2324
Artinite	-8.6271	Ca	-112.1193
Lammerite	-9.1447	Si	-119.7478
Bixbyite	-9.1987	Orpiment	-248.8250
MnO2(gamma)	-9.4023	o-Phthalic_acid	-364.5975

Gases	fugacity	log fug.
H2O(g)	0.02598	-1.585
CO2(g)	0.004686	-2.329
N2(g)	0.004244	-2.372
NO2(g)	1.468e-012	-11.833
H2(g)	4.351e-027	-26.361

O2(g)	4.148e-031	-30.382
NO(g)	2.883e-032	-31.540
CO(g)	6.368e-033	-32.196
NH3(g)	1.425e-038	-37.846
SO2(g)	3.466e-040	-39.460
Cu(g)	2.959e-060	-59.529
H2S(g)	7.052e-083	-82.152
CH4(g)	1.340e-085	-84.873
Mg(g)	9.477e-116	-115.023
S2(g)	5.857e-138	-137.232
Ca(g)	4.460e-138	-137.351
C2H4(g)	1.871e-147	-146.728
C(g)	2.319e-159	-158.635
Si(g)	1.612e-191	-190.793

		In fluid		Sorbed		Kd
Original basis	total moles	moles	mg/kg	moles	mg/kg	L/kg
Ca++	0.000616	0.000616	24.7			
Cu++	1.21e-006	1.21e-006	0.0770			
H+	0.000155	0.000155	0.156			
H2AsO4-	6.59e-008	6.59e-008	0.00929			
H2O	55.5	55.5	1.00e+006			
HCO3-	0.00138	0.00138	83.9			
Mg++	0.000195	0.000195	4.74			
Mn++	1.08e-007	1.08e-007	0.00592			
NH3(aq)	5.53e-006	5.53e-006	0.0941			
NO3-	2.75e-005	2.75e-005	1.70			
O2(aq)	3.88e-006	3.88e-006	0.124			
SO4--	0.000144	0.000144	13.8			
SiO2(aq)	7.56e-005	7.56e-005	4.54			

Elemental composition		In fluid		Sorbed	
	total moles	moles	mg/kg	moles	mg/kg
Arsenic	6.590e-008	6.590e-008	0.004936		
Calcium	0.0006159	0.0006159	24.68		
Carbon	0.001376	0.001376	16.52		
Copper	1.212e-006	1.212e-006	0.07701		
Hydrogen	111.0	111.0	1.119e+005		
Magnesium	0.0001950	0.0001950	4.739		
Manganese	1.078e-007	1.078e-007	0.005924		
Nitrogen	3.301e-005	3.301e-005	0.4623		
Oxygen	55.51	55.51	8.881e+005		
Silicon	7.560e-005	7.560e-005	2.123		
Sulfur	0.0001439	0.0001439	4.614		

```
Temperature =   5.3 C    Pressure =  1.013 bars
pH =  7.800              log fO2 =  -28.736
Eh =   0.4050 volts      pe =   7.3321
Ionic strength      =    0.001989
Charge imbalance    =   -0.000109 eq/kg (-8.459% error)
Activity of water   =    1.000000
Solvent mass        =    1.000000 kg
Solution mass       =    1.000122 kg
Solution density    =    1.026    g/cm3
Chlorinity          =    0.000000 molal
Dissolved solids    =         122 mg/kg sol'n
Hardness            =       53.40 mg/kg sol'n as CaCO3
  carbonate         =       39.68 mg/kg sol'n as CaCO3
  non-carbonate     =       13.73 mg/kg sol'n as CaCO3
Rock mass           =    0.000000 kg
Carbonate alkalinity=       39.68 mg/kg sol'n as CaCO3
Water type          =    Ca-HCO3
```

Nernst redox couples	Eh (volts)	pe
e- + .25*O2(aq) + H+ = .5*H2O	0.4050	7.3321
8*e- + 9*H+ + NO3- = 3*H2O + NH3(aq)	0.5819	10.5353

No minerals in system.

Aqueous species	molality	mg/kg sol'n	act. coef.	log act.
HCO3-	0.0007850	47.89	0.9531	-3.1260
Ca++	0.0004042	16.20	0.8290	-3.4749
NO3-	0.0002239	13.88	0.9524	-3.6710
SO4--	0.0001648	15.83	0.8247	-3.8667
SiO2(aq)	0.0001535	9.221	1.0000	-3.8139
Na+	0.0001270	2.919	0.9531	-3.9172
Mg++	0.0001172	2.849	0.8330	-4.0103
N2(aq)	5.858e-005	1.641	1.0000	-4.2323
K+	4.980e-005	1.947	0.9524	-4.3240
CO2(aq)	3.893e-005	1.713	1.0000	-4.4097
Mn++	5.420e-006	0.2977	0.8290	-5.3475
CaSO4(aq)	5.402e-006	0.7354	1.0000	-5.2674
CaHCO3+	3.123e-006	0.3157	0.9531	-5.5263
MgSO4(aq)	2.074e-006	0.2497	1.0000	-5.6831
AlO2-	1.909e-006	0.1126	0.9531	-5.7400
CO3--	1.612e-006	0.09670	0.8258	-5.8759
Cu++	1.288e-006	0.08184	0.8290	-5.9715
HPO4--	1.266e-006	0.1215	0.8247	-5.9813
MgHCO3+	8.793e-007	0.07502	0.9531	-6.0767
CaCO3(aq)	6.468e-007	0.06473	1.0000	-6.1892
HSiO3-	5.797e-007	0.04469	0.9531	-6.2577
Ba++	4.611e-007	0.06331	0.8268	-6.4188
H2PO4-	3.385e-007	0.03282	0.9531	-6.4913
HAlO2(aq)	2.465e-007	0.01479	1.0000	-6.6081
NaHCO3(aq)	1.913e-007	0.01607	1.0000	-6.7183
OH-	1.258e-007	0.002139	0.9528	-6.9214
MnSO4(aq)	1.139e-007	0.01720	1.0000	-6.9435
MgCO3(aq)	1.030e-007	0.008683	1.0000	-6.9872
Sb(OH)3(aq)	6.403e-008	0.01106	1.0000	-7.1936
KSO4-	5.099e-008	0.006892	0.9531	-7.3133
Pb++	3.762e-008	0.007795	0.8258	-7.5077
HAsO4--	2.381e-008	0.003331	0.8247	-7.7070
H+	1.658e-008	1.671e-005	0.9560	-7.8000
Al(OH)2+	1.057e-008	0.0006444	0.9531	-7.9969
Cd++	7.541e-009	0.0008476	0.8268	-8.2051

NaHSiO3(aq)	4.701e-009	0.0004705	1.0000	-8.3278
H2AsO4-	2.205e-009	0.0003107	0.9531	-8.6775
NaCO3-	9.531e-010	7.910e-005	0.9531	-9.0417
UO2(CO3)2--	3.752e-010	0.0001463	0.8247	-9.5094
AlOH++	3.354e-010	1.475e-005	0.8258	-9.5576
UO2(CO3)3----	2.204e-010	9.918e-005	0.4623	-9.9919
BaCO3(aq)	1.488e-010	2.935e-005	1.0000	-9.8275
HSO4-	1.326e-010	1.287e-005	0.9531	-9.8984
NaAlO2(aq)	3.242e-011	2.657e-006	1.0000	-10.4892
PO4---	2.973e-011	2.824e-006	0.6480	-10.7152
UO2CO3(aq)	1.811e-011	5.977e-006	1.0000	-10.7420
Cu+	1.388e-011	8.818e-007	0.9531	-10.8785
NaOH(aq)	2.675e-012	1.070e-007	1.0000	-11.5726
AsO4---	2.663e-012	3.700e-007	0.6480	-11.7630
Al+++	2.381e-012	6.423e-008	0.6663	-11.7996
Sb(OH)4-	1.067e-012	2.025e-007	0.9531	-11.9927
CdSO4(aq)	8.574e-013	1.787e-007	1.0000	-12.0668
H3PO4(aq)	6.268e-013	6.141e-008	1.0000	-12.2029
UO2OH+	3.491e-013	1.002e-007	0.9531	-12.4779
MgP2O7--	1.384e-013	2.744e-008	0.8247	-12.9425
HNO3(aq)	1.096e-013	6.908e-009	1.0000	-12.9601
Sb(OH)2+	7.168e-014	1.116e-008	0.9531	-13.1655
H3AsO4(aq)	4.823e-015	6.846e-010	1.0000	-14.3166
HP2O7---	4.637e-015	8.111e-010	0.6480	-14.5222
UO2++	3.612e-015	9.752e-010	0.8258	-14.5254
KHSO4(aq)	3.282e-016	4.468e-011	1.0000	-15.4839
UO2SO4(aq)	2.912e-016	1.066e-010	1.0000	-15.5359
H2P2O7--	2.558e-016	4.500e-011	0.8247	-15.6758
P2O7----	2.136e-016	3.714e-011	0.4623	-16.0055
KP2O7---	1.308e-018	2.786e-013	0.6480	-18.0719
UO2(SO4)2--	2.709e-019	1.252e-013	0.8247	-18.6509
(UO2)2(OH)2++	3.200e-020	1.837e-014	0.8258	-19.5780
UO2+	3.056e-021	8.252e-016	0.9531	-20.5357
H3P2O7-	7.986e-022	1.413e-016	0.9531	-21.1185
(UO2)3(OH)5+	3.929e-022	3.517e-016	0.9531	-21.4266
(UO2)3(CO3)6(6-)	8.271e-024	9.677e-018	0.1762	-23.8365
HAsO2(aq)	9.906e-025	1.069e-019	1.0000	-24.0041
As(OH)3(aq)	8.966e-025	1.129e-019	1.0000	-24.0474
Mn+++	8.163e-025	4.484e-020	0.6518	-24.2741
U(OH)4(aq)	4.860e-025	1.487e-019	1.0000	-24.3133
H2AsO3-	1.608e-026	2.008e-021	0.9531	-25.8146
AsO2-	1.558e-026	1.666e-021	0.9531	-25.8282
H4P2O7(aq)	2.953e-028	5.254e-023	1.0000	-27.5298
AsO2OH--	5.035e-030	6.239e-025	0.8247	-29.3817
NO2-	1.082e-030	4.976e-026	0.9524	-29.9870
O2(aq)	3.519e-032	1.126e-027	1.0000	-31.4536
Formate	4.088e-034	1.840e-029	0.9528	-33.4095
H2(aq)	1.665e-034	3.357e-031	1.0000	-33.7785
HNO2(aq)	4.361e-035	2.050e-030	1.0000	-34.3604
Ca(For)+	4.296e-036	3.655e-031	0.9531	-35.3878
Mg(For)+	1.625e-036	1.127e-031	0.9531	-35.8099
Mn(For)+	1.191e-037	1.191e-032	0.9531	-36.9448
Cu(For)+	6.032e-038	6.548e-033	0.9531	-37.2404
Na(For)(aq)	5.723e-038	3.891e-033	1.0000	-37.2424
Formic_acid(aq)	3.718e-038	1.711e-033	1.0000	-37.4297
K(For)(aq)	1.880e-038	1.581e-033	1.0000	-37.7259
HO2-	1.286e-038	4.244e-034	0.9531	-37.9116
SO3--	9.905e-039	7.930e-034	0.8258	-38.0873
Ba(For)+	3.491e-039	6.365e-034	0.9531	-38.4779
HSO3-	1.865e-039	1.512e-034	0.9531	-38.7502
NH4+	1.209e-039	2.181e-035	0.9521	-38.9388
Pb(For)+	9.763e-040	2.462e-034	0.9531	-39.0313
Cd(For)+	2.332e-040	3.670e-035	0.9531	-39.6532

MnO4--	1.294e-040	1.539e-035	0.8247	-39.9718
CO(aq)	5.443e-041	1.524e-036	1.0000	-40.2642
NH3(aq)	9.492e-042	1.616e-037	1.0000	-41.0226
Oxalate	6.528e-042	5.746e-037	0.8247	-41.2689
MnO4-	7.522e-044	8.945e-039	0.9528	-43.1447
UOH+++	6.804e-044	1.735e-038	0.6518	-43.3531
U(CO3)5(6-)	5.444e-045	2.929e-039	0.1762	-45.0181
H-Oxalate	1.443e-045	1.285e-040	0.9531	-44.8616
SO2(aq)	1.381e-045	8.848e-041	1.0000	-44.8597
HSO5-	4.381e-047	4.953e-042	0.9531	-46.3793
USO4++	4.451e-048	1.487e-042	0.8258	-47.4347
U(SO4)2(aq)	1.839e-048	7.910e-043	1.0000	-47.7354
U++++	2.073e-050	4.933e-045	0.4696	-50.0118
Oxalic_acid(aq)	3.956e-052	3.562e-047	1.0000	-51.4027
S2O6--	5.023e-064	8.042e-059	0.8247	-63.3828
S2O8--	1.456e-064	2.798e-059	0.8247	-63.9204
Ca(For)2(aq)	1.516e-068	1.972e-063	1.0000	-67.8194
U+++	9.487e-069	2.258e-063	0.6518	-68.2088
Mg(For)2(aq)	7.741e-069	8.850e-064	1.0000	-68.1112
Mn(For)2(aq)	7.773e-070	1.127e-064	1.0000	-69.1094
Cu(For)2(aq)	7.514e-070	1.154e-064	1.0000	-69.1241
Na(For)2-	1.900e-071	2.147e-066	0.9531	-70.7422
Cd(For)2(aq)	1.434e-071	2.904e-066	1.0000	-70.8433
Ba(For)2(aq)	8.666e-072	1.970e-066	1.0000	-71.0622
Pb(For)2(aq)	6.639e-072	1.973e-066	1.0000	-71.1779
K(For)2-	4.972e-072	6.420e-067	0.9531	-71.3243
Formaldehyde(aq)	2.379e-073	7.141e-069	1.0000	-72.6237
N3-	1.548e-074	6.502e-070	0.9531	-73.8312
HN3(aq)	1.838e-077	7.909e-073	1.0000	-76.7356
Cu(NH3)2++	1.138e-080	1.111e-075	0.8258	-80.0270
S2O5--	6.224e-083	8.970e-078	0.8247	-82.2896
Cd(NH3)2++	1.071e-085	1.569e-080	0.8258	-85.0532
Urea(aq)	1.376e-086	8.261e-082	1.0000	-85.8615
HCN(aq)	1.907e-087	5.152e-083	1.0000	-86.7197
CN-	1.893e-089	4.925e-085	0.9524	-88.7440
Methanol(aq)	3.687e-091	1.181e-086	1.0000	-90.4333
Glycolate	1.401e-097	1.051e-092	0.9531	-96.8745
HS-	1.700e-098	5.623e-094	0.9528	-97.7905
H2S(aq)	5.257e-099	1.792e-094	1.0000	-98.2792
Ca(Glyc)+	2.622e-099	3.018e-094	0.9531	-98.6022
Mg(Glyc)+	3.496e-100	3.473e-095	0.9531	-99.4773
Cu(Glyc)+	2.021e-100	2.800e-095	0.9531	-99.7154
Mn(Glyc)+	3.160e-101	4.107e-096	0.9531	-100.5211
Na(Glyc)(aq)	2.031e-101	1.990e-096	1.0000	-100.6924
Glycolic_acid(aq	1.554e-101	1.182e-096	1.0000	-100.8084
K(Glyc)(aq)	6.670e-102	7.612e-097	1.0000	-101.1759
Pb(Glyc)+	9.532e-103	2.690e-097	0.9531	-102.0417
Ba(Glyc)+	5.805e-103	1.233e-097	0.9531	-102.2570
Methane(aq)	1.600e-103	2.566e-099	1.0000	-102.7959
Cd(Glyc)+	8.912e-104	1.670e-098	0.9531	-103.0709
S--	3.577e-104	1.147e-099	0.8268	-103.5290
S2O4--	1.284e-104	1.645e-099	0.8268	-103.9740
S2O3--	3.872e-105	4.341e-100	0.8247	-104.4958
Acetate	2.483e-109	1.466e-104	0.9534	-108.6257
CaCH3COO+	7.722e-112	7.653e-107	0.9531	-111.1331
MgCH3COO+	6.656e-112	5.547e-107	0.9531	-111.1976
Acetic_acid(aq)	2.216e-112	1.331e-107	1.0000	-111.6544
CuCH3COO+	7.060e-113	8.653e-108	0.9531	-112.1721
NaCH3COO(aq)	2.469e-113	2.025e-108	1.0000	-112.6075
MnCH3COO+	2.278e-113	2.596e-108	0.9531	-112.6633
KCH3COO(aq)	5.719e-114	5.613e-109	1.0000	-113.2426
PbCH3COO+	2.147e-114	5.717e-109	0.9531	-113.6890
BaCH3COO+	8.361e-115	1.642e-109	0.9531	-114.0986

CdCH3COO+	1.821e-115	3.121e-110	0.9531	-114.7607
Malonate	1.493e-118	1.523e-113	0.8247	-117.9097
Cu(NH3)3++	1.304e-118	1.495e-113	0.8258	-117.9677
AlCH3COO++	1.057e-118	9.088e-114	0.8258	-118.0592
CuCH3COO(aq)	8.265e-120	1.013e-114	1.0000	-119.0828
H-Malonate	9.538e-121	9.829e-116	0.9531	-120.0414
AsH3(aq)	4.705e-121	3.667e-116	1.0000	-120.3274
Malonic_acid(aq)	1.085e-125	1.129e-120	1.0000	-124.9644
Methanamine(aq)	1.716e-129	5.328e-125	1.0000	-128.7655
Cu(Gly)+	4.310e-132	5.930e-127	0.9531	-131.3864
Glycine(aq)	1.590e-132	1.194e-127	1.0000	-131.7985
Mg(Gly)+	1.797e-135	1.768e-130	0.9531	-134.7662
Mn(Gly)+	1.229e-136	1.585e-131	0.9531	-135.9314
Pb(Gly)+	5.056e-137	1.422e-131	0.9531	-136.3171
Ca(Gly)+	2.677e-137	3.055e-132	0.9531	-136.5933
Cd(Gly)+	2.029e-138	3.783e-133	0.9531	-137.7136
S3O6--	1.867e-138	3.587e-133	0.8247	-137.8127
Ba(Gly)+	3.474e-140	7.342e-135	0.9531	-139.4801
Acetaldehyde(aq)	2.334e-146	1.028e-141	1.0000	-145.6320
SCN-	1.676e-147	9.732e-143	0.9528	-146.7968
NH4CH3COO(aq)	4.500e-148	3.469e-143	1.0000	-147.3468
Acetamide(aq)	3.471e-148	2.050e-143	1.0000	-147.4596
UO2SCN+	1.212e-160	3.975e-155	0.9531	-159.9375
Cd(NH3)4++	4.340e-165	7.835e-160	0.8258	-164.4456
Ethanol(aq)	6.548e-169	3.016e-164	1.0000	-168.1839
Ethyne(aq)	4.677e-169	1.218e-164	1.0000	-168.3301
Ethylene(aq)	7.943e-174	2.228e-169	1.0000	-173.1000
Lactate	2.659e-175	2.368e-170	0.9531	-174.5961
Ca(Lac)+	2.926e-177	3.778e-172	0.9531	-176.5547
Mg(Lac)+	6.471e-178	7.336e-173	0.9531	-177.2099
Cu(Lac)+	1.747e-178	2.666e-173	0.9531	-177.7785
Mn(Lac)+	4.248e-179	6.117e-174	0.9531	-178.3927
Na(Lac)(aq)	3.967e-179	4.445e-174	1.0000	-178.4015
Lactic_acid(aq)	3.070e-179	2.765e-174	1.0000	-178.5128
K(Lac)(aq)	1.303e-179	1.670e-174	1.0000	-178.8849
Pb(Lac)+	1.771e-180	5.246e-175	0.9531	-179.7727
Ba(Lac)+	4.458e-181	1.009e-175	0.9531	-180.3717
Cd(Lac)+	1.145e-181	2.306e-176	0.9531	-180.9622
Ethane(aq)	1.005e-185	3.023e-181	1.0000	-184.9976
Propanoate	2.728e-189	1.994e-184	0.9531	-188.5849
Ca(Prop)+	4.745e-192	5.369e-187	0.9531	-191.3446
Propanoic_acid(a	3.260e-192	2.414e-187	1.0000	-191.4868
Mg(Prop)+	1.980e-192	1.927e-187	0.9531	-191.7243
Cu(Prop)+	7.662e-193	1.047e-187	0.9531	-192.1366
Na(Prop)(aq)	4.017e-193	3.858e-188	1.0000	-192.3961
Mn(Prop)+	2.969e-193	3.800e-188	0.9531	-192.5482
K(Prop)(aq)	1.319e-193	1.480e-188	1.0000	-192.8796
USCN+++	5.122e-194	1.516e-188	0.6518	-193.4765
Pb(Prop)+	2.079e-194	5.827e-189	0.9531	-193.7029
Ca(Glyc)2(aq)	8.016e-195	1.524e-189	1.0000	-194.0960
Cu(Glyc)2(aq)	2.652e-195	5.664e-190	1.0000	-194.5765
Cd(Prop)+	1.851e-195	3.433e-190	0.9531	-194.7535
Ba(Prop)+	1.180e-195	2.483e-190	0.9531	-194.9489
Mg(Glyc)2(aq)	6.861e-196	1.196e-190	1.0000	-195.1636
S4O6--	3.116e-196	6.987e-191	0.8247	-195.5901
Succinate	7.129e-197	8.274e-192	0.8247	-196.2307
Mn(Glyc)2(aq)	3.950e-197	8.097e-192	1.0000	-196.4034
Pb(Glyc)2(aq)	8.301e-198	2.965e-192	1.0000	-197.0809
Na(Glyc)2-	3.645e-198	6.308e-193	0.9531	-197.4592
K(Glyc)2-	9.887e-199	1.870e-193	0.9531	-198.0258
Serine(aq)	4.580e-199	4.812e-194	1.0000	-198.3392
Cd(Glyc)2(aq)	4.555e-199	1.196e-193	1.0000	-198.3415
H-Succinate	4.498e-199	5.266e-194	0.9531	-198.3678

Ba(Glyc)2(aq)	3.849e-199	1.106e-193	1.0000	-198.4147
Succinic_acid(aq	1.255e-202	1.481e-197	1.0000	-201.9015
Ethanamine(aq)	3.138e-209	1.414e-204	1.0000	-208.5034
Alanine(aq)	4.100e-211	3.653e-206	1.0000	-210.3872
Cu(Ala)+	2.521e-211	3.821e-206	0.9531	-210.6194
Mg(Ala)+	2.901e-216	3.260e-211	0.9531	-215.5583
Mn(Ala)+	2.567e-216	3.672e-211	0.9531	-215.6114
Ca(Ala)+	1.299e-216	1.665e-211	0.9531	-215.9071
Pb(Ala)+	1.010e-216	2.983e-211	0.9531	-216.0164
Cd(Ala)+	2.939e-217	5.892e-212	0.9531	-216.5527
Ca(CH3COO)2(aq)	4.027e-219	6.368e-214	1.0000	-218.3950
Mg(CH3COO)2(aq)	1.567e-219	2.231e-214	1.0000	-218.8050
Cu(CH3COO)2(aq)	7.033e-220	1.277e-214	1.0000	-219.1529
Ba(Ala)+	6.129e-220	1.381e-214	0.9531	-219.2335
Mn(CH3COO)2(aq)	5.299e-221	9.168e-216	1.0000	-220.2758
Acetone(aq)	2.760e-221	1.603e-216	1.0000	-220.5592
Pb(CH3COO)2(aq)	4.103e-222	1.335e-216	1.0000	-221.3869
Na(CH3COO)2-	4.026e-222	5.678e-217	0.9531	-221.4160
Aspartic_acid(aq	3.818e-222	5.082e-217	1.0000	-221.4181
Cd(CH3COO)2(aq)	1.082e-222	2.495e-217	1.0000	-221.9656
Ba(CH3COO)2(aq)	6.250e-223	1.596e-217	1.0000	-222.2041
K(CH3COO)2-	5.857e-223	9.205e-218	0.9531	-222.2532
Al(CH3COO)2+	4.002e-225	5.805e-220	0.9531	-224.4186
Propanal(aq)	9.631e-226	5.593e-221	1.0000	-225.0163
Cu(CH3COO)2-	3.434e-228	6.237e-223	0.9531	-227.4850
1-Propyne(aq)	1.036e-244	4.151e-240	1.0000	-243.9846
S3--	7.536e-248	7.249e-243	0.8247	-247.2066
1-Propanol(aq)	8.255e-249	4.960e-244	1.0000	-248.0833
1-Propene(aq)	1.933e-251	8.134e-247	1.0000	-250.7137
2-Hydroxybutanoa	1.164e-255	1.200e-250	0.9531	-254.9549
NH4(CH3COO)2-	1.192e-256	1.622e-251	0.9531	-255.9447
Asparagine(aq)	6.907e-258	9.124e-253	1.0000	-257.1607
Cu(Gly)2(aq)	9.102e-259	1.926e-253	1.0000	-258.0409
2-Hydroxybutanoi	1.187e-259	1.235e-254	1.0000	-258.9257
Propane(aq)	4.932e-266	2.175e-261	1.0000	-265.3070
Mg(Gly)2(aq)	1.241e-266	2.140e-261	1.0000	-265.9061
Diglycine(aq)	5.363e-267	7.085e-262	1.0000	-266.2706
Mn(Gly)2(aq)	6.280e-268	1.275e-262	1.0000	-267.2020
Pb(Gly)2(aq)	4.987e-268	1.772e-262	1.0000	-267.3022
Cd(Gly)2(aq)	6.819e-269	1.776e-263	1.0000	-268.1663
Diketopiperazine	1.614e-269	1.842e-264	1.0000	-268.7920
Butanoate	9.473e-270	8.250e-265	0.9531	-269.0444
Ca(Gly)2(aq)	5.338e-271	1.004e-265	1.0000	-270.2726
Ca(But)+	1.128e-272	1.435e-267	0.9531	-271.9684
Butanoic_acid(aq	8.927e-273	7.865e-268	1.0000	-272.0493
Mg(But)+	4.483e-273	4.993e-268	0.9531	-272.3693
Cu(But)+	2.109e-273	3.176e-268	0.9531	-272.6968
Na(But)(aq)	1.349e-273	1.485e-268	1.0000	-272.8701
Mn(But)+	8.817e-274	1.252e-268	0.9531	-273.0755
Ba(Gly)2(aq)	7.228e-274	2.063e-268	1.0000	-273.1410
K(But)(aq)	4.431e-274	5.591e-269	1.0000	-273.3535
Pb(But)+	1.988e-275	5.850e-270	0.9531	-274.7224
Ba(But)+	2.736e-276	6.140e-271	0.9531	-275.5837
Cd(But)+	2.692e-276	5.370e-271	0.9531	-275.5908
Glutarate	2.132e-276	2.773e-271	0.8247	-275.7550
H-Glutarate	7.684e-279	1.007e-273	0.9531	-278.1353
Threonine(aq)	1.618e-279	1.927e-274	1.0000	-278.7910
Ethylacetate(aq)	4.480e-282	3.946e-277	1.0000	-281.3488
Glutaric_acid(aq	2.649e-282	3.499e-277	1.0000	-281.5769
S5O6--	3.438e-284	8.811e-279	0.8247	-283.5474
1-Propanamine(aq	1.342e-288	7.930e-284	1.0000	-287.8723
a-Aminobutyric_a	3.084e-291	3.180e-286	1.0000	-290.5109
Glutamic_acid(aq	1.271e-300	1.870e-295	1.0000	-299.8957

Butanal(aq)	1.077e-307	7.764e-303	1.0000	-300.0000
UO2(SCN)2(aq)	1.038e-307	4.008e-302	1.0000	-300.0000
S4--	6.199e-320	7.950e-315	0.8247	-300.0000
Cd(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
K(Prop)2-	0.0000	0.0000	0.9531	-300.0000
K(Pent)2-	0.0000	0.0000	0.9531	-300.0000
K(Pent)(aq)	0.0000	0.0000	1.0000	-300.0000
Cd(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
K(Lac)2-	0.0000	0.0000	0.9531	-300.0000
Alanylglycine(aq	0.0000	0.0000	1.0000	-300.0000
K(But)2-	0.0000	0.0000	0.9531	-300.0000
2-Hexanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexyne(aq)	0.0000	0.0000	1.0000	-300.0000
Isoleucine(aq)	0.0000	0.0000	1.0000	-300.0000
Hexanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Hexanoate	0.0000	0.0000	0.9531	-300.0000
Hexanal(aq)	0.0000	0.0000	1.0000	-300.0000
Heptanoic_acid(a	0.0000	0.0000	1.0000	-300.0000
Ca(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Heptanoate	0.0000	0.0000	0.9531	-300.0000
Heptanal(aq)	0.0000	0.0000	1.0000	-300.0000
2-Heptanone(aq)	0.0000	0.0000	1.0000	-300.0000
HSb2S4-	0.0000	0.0000	0.9531	-300.0000
Ca(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
p-Toluate	0.0000	0.0000	0.9531	-300.0000
o-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
o-Toluate	0.0000	0.0000	0.9531	-300.0000
Ca(Pent)+	0.0000	0.0000	0.9531	-300.0000
n-Propylbenzene(	0.0000	0.0000	1.0000	-300.0000
n-Pentane(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
n-Octane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Hexylbenzene(a	0.0000	0.0000	1.0000	-300.0000
n-Hexane(aq)	0.0000	0.0000	1.0000	-300.0000
2-Butanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Butyne(aq)	0.0000	0.0000	1.0000	-300.0000
n-Heptane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Butylbenzene(a	0.0000	0.0000	1.0000	-300.0000
n-Butane(aq)	0.0000	0.0000	1.0000	-300.0000
m-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
m-Toluate	0.0000	0.0000	0.9531	-300.0000
Valine(aq)	0.0000	0.0000	1.0000	-300.0000
Undecanoic_acid(	0.0000	0.0000	1.0000	-300.0000
Undecanoate	0.0000	0.0000	0.9531	-300.0000
UO2(SCN)3-	0.0000	0.0000	0.9531	-300.0000
Adipic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
U(SCN)2++	0.0000	0.0000	0.8258	-300.0000
Tyrosine(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Adipate	0.0000	0.0000	0.8247	-300.0000
1-Hexanol(aq)	0.0000	0.0000	1.0000	-300.0000
Tryptophan(aq)	0.0000	0.0000	1.0000	-300.0000
Toluene(aq)	0.0000	0.0000	1.0000	-300.0000
Suberic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Suberate	0.0000	0.0000	0.8247	-300.0000
Ca(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
H-Suberate	0.0000	0.0000	0.9531	-300.0000
Sebacate	0.0000	0.0000	0.8247	-300.0000
Sb2S4--	0.0000	0.0000	0.8247	-300.0000
H-Sebacate	0.0000	0.0000	0.9531	-300.0000
H-Pimelate	0.0000	0.0000	0.9531	-300.0000
S5--	0.0000	0.0000	0.8247	-300.0000

H-Azelate	0.0000	0.0000	0.9531	-300.0000
H-Adipate	0.0000	0.0000	0.9531	-300.0000
1-Hexanamine(aq)	0.0000	0.0000	1.0000	-300.0000
1-Butene(aq)	0.0000	0.0000	1.0000	-300.0000
Pimelic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Glutamine(aq)	0.0000	0.0000	1.0000	-300.0000
Phenol(aq)	0.0000	0.0000	1.0000	-300.0000
Pentanoic_acid(a	0.0000	0.0000	1.0000	-300.0000
Pentanal(aq)	0.0000	0.0000	1.0000	-300.0000
Benzoic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Pb(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Pb(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Pb(Pent)+	0.0000	0.0000	0.9531	-300.0000
Benzoate	0.0000	0.0000	0.9543	-300.0000
2-Pentanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Pentyne(aq)	0.0000	0.0000	1.0000	-300.0000
Pb(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ethylbenzene(aq)	0.0000	0.0000	1.0000	-300.0000
Benzene(aq)	0.0000	0.0000	1.0000	-300.0000
2-Octanone(aq)	0.0000	0.0000	1.0000	-300.0000
Pb(CH3COO)3-	0.0000	0.0000	0.9531	-300.0000
Pb(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Pb(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Dodecanoic_acid(	0.0000	0.0000	1.0000	-300.0000
Pentanoate	0.0000	0.0000	0.9531	-300.0000
Dodecanoate	0.0000	0.0000	0.9531	-300.0000
2-Hydroxypentano	0.0000	0.0000	1.0000	-300.0000
Phenylalanine(aq	0.0000	0.0000	1.0000	-300.0000
Pimelate	0.0000	0.0000	0.8247	-300.0000
1-Pentene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptyne(aq)	0.0000	0.0000	1.0000	-300.0000
Octanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Octanoate	0.0000	0.0000	0.9531	-300.0000
Ba(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Octanal(aq)	0.0000	0.0000	1.0000	-300.0000
Decanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Nonanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Decanoate	0.0000	0.0000	0.9531	-300.0000
2-Hydroxypentano	0.0000	0.0000	0.9531	-300.0000
Nonanoate	0.0000	0.0000	0.9531	-300.0000
Nonanal(aq)	0.0000	0.0000	1.0000	-300.0000
Decanal(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Pent)+	0.0000	0.0000	0.9531	-300.0000
2-Hydroxyoctanoi	0.0000	0.0000	1.0000	-300.0000
1-Pentanol(aq)	0.0000	0.0000	1.0000	-300.0000
Na(Prop)2-	0.0000	0.0000	0.9531	-300.0000
Na(Pent)2-	0.0000	0.0000	0.9531	-300.0000
Cu(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Na(Pent)(aq)	0.0000	0.0000	1.0000	-300.0000
Na(Lac)2-	0.0000	0.0000	0.9531	-300.0000
Cu(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyoctanoa	0.0000	0.0000	0.9531	-300.0000
Cu(Pent)+	0.0000	0.0000	0.9531	-300.0000
Sebacic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Na(But)2-	0.0000	0.0000	0.9531	-300.0000
Cu(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxynonanoi	0.0000	0.0000	1.0000	-300.0000
1-Pentanamine(aq	0.0000	0.0000	1.0000	-300.0000
1-Heptene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Butanol(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxynonanoa	0.0000	0.0000	0.9531	-300.0000

Mn(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Pent)+	0.0000	0.0000	0.9531	-300.0000
Cu(CH3COO)3-	0.0000	0.0000	0.9531	-300.0000
2-Hydroxyhexanoi	0.0000	0.0000	1.0000	-300.0000
1-Octyne(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyhexanoa	0.0000	0.0000	0.9531	-300.0000
Mn(CH3COO)3-	0.0000	0.0000	0.9531	-300.0000
Cu(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyheptano	0.0000	0.0000	1.0000	-300.0000
1-Octene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptanol(aq)	0.0000	0.0000	1.0000	-300.0000
Cd(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Pent)+	0.0000	0.0000	0.9531	-300.0000
Cd(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Azelate	0.0000	0.0000	0.8247	-300.0000
2-Hydroxyheptano	0.0000	0.0000	0.9531	-300.0000
Mg(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cd(Pent)+	0.0000	0.0000	0.9531	-300.0000
Azelaic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Cd(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxydecanoi	0.0000	0.0000	1.0000	-300.0000
1-Octanol(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
n-Heptylbenzene(	0.0000	0.0000	1.0000	-300.0000
Methionine(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxydecanoa	0.0000	0.0000	0.9531	-300.0000
Leucylglycine(aq	0.0000	0.0000	1.0000	-300.0000
n-Octylbenzene(a	0.0000	0.0000	1.0000	-300.0000
Leucine(aq)	0.0000	0.0000	1.0000	-300.0000
n-Pentylbenzene(	0.0000	0.0000	1.0000	-300.0000
Cd(CH3COO)3-	0.0000	0.0000	0.9531	-300.0000
o-Phthalate	0.0000	0.0000	0.8247	-300.0000
1-Octanamine(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptanamine(aq	0.0000	0.0000	1.0000	-300.0000
1-Butanamine(aq)	0.0000	0.0000	1.0000	-300.0000
p-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
(NH4)2Sb2S4(aq)	0.0000	0.0000	1.0000	-300.0000

Mineral saturation states

	log Q/K		log Q/K
Stilbite	10.5604s/sat	Saleeite	-11.2705
Muscovite	10.4610s/sat	Thenardite	-11.3703
Beidellite-Ca	7.6939s/sat	Mg1.25SO4(OH)0.5	-11.3920
Beidellite-Mg	7.6053s/sat	UO2.25	-11.4240
Illite	7.4140s/sat	UO2.25(beta)	-11.4955
Beidellite-K	7.2668s/sat	Periclase	-11.6121
Kaolinite	7.0250s/sat	Portlandite	-12.0343
Beidellite-Na	6.9988s/sat	Monticellite	-12.0471
Beidellite-H	6.7466s/sat	Natron	-12.1750
Mesolite	6.5548s/sat	Torbernite	-12.2021
Pyrophyllite	6.5291s/sat	CdSO4	-12.5691
Paragonite	6.5271s/sat	MnSO4	-12.6189

Montmor-Ca	6.4899s/sat	UO2SO4:H2O	-12.8062
Montmor-Mg	6.4784s/sat	MgUO4	-12.8179
Montmor-K	6.1398s/sat	Na2CO3:7H2O	-12.8327
Montmor-Na	5.8662s/sat	Mg1.5SO4(OH)	-12.8454
Scolecite	5.6727s/sat	Uranocircite	-12.8490
Laumontite	4.3936s/sat	BaU2O7	-13.0904
Maximum_Microcli	3.8311s/sat	(UO2)3(PO4)2:4H2	-13.4441
K-Feldspar	3.8283s/sat	Chalcocyanite	-13.6196
Margarite	3.5161s/sat	Przhevalskite	-13.6870
Celadonite	3.3019s/sat	MgSO4	-13.8233
Diaspore	3.0755s/sat	Tremolite	-14.0514
Boehmite	2.6370s/sat	Mordenite-dehy	-14.1277
Lawsonite	2.5935s/sat	UPO5	-14.2789
Gibbsite	2.5820s/sat	UO2.6667	-14.4214
Sanidine_high	2.4941s/sat	Thermonatrite	-14.4581
Mordenite	2.2695s/sat	Na2CO3	-14.8252
Corundum	1.7463s/sat	Na2U2O7	-14.8342
Brochantite	1.5763s/sat	Uraninite	-14.9571
Witherite	1.4749s/sat	Coffinite	-15.1458
Malachite	1.4574s/sat	Autunite-H	-16.0046
Tenorite	1.1693s/sat	Ba(OH)2:8H2O	-16.0911
Kyanite	0.9317s/sat	Ca3(AsO4)2	-16.2386
Albite_low	0.8464s/sat	CaAl2O4	-17.0363
Albite	0.8464s/sat	UO2SO4:3.5H2O	-17.2504
Quartz	0.6643s/sat	UO2SO4:2.5H2O	-17.3385
Andalusite	0.6080s/sat	Ba2Si3O8	-17.3769
Cerussite	0.5749s/sat	UO2SO4:3H2O	-17.4124
Tridymite	0.4656s/sat	NaUO3	-17.8966
Chalcedony	0.3739s/sat	Natrosilite	-18.5105
Sillimanite	0.2041s/sat	Gehlenite	-18.6620
Analcime	0.1438s/sat	Alum-K	-18.7361
Barite	0.0717s/sat	Hillebrandite	-18.8456
Cristobalite(alp	0.0672s/sat	CaAl4O7	-19.0023
Ice	-0.0649	Na2SiO3	-19.2581
Amesite-14A	-0.0745	Dicalcium_silica	-19.3731
Coesite	-0.1996	Hydromagnesite	-20.2824
Cristobalite(bet	-0.4351	Ningyoite	-20.4534
Dioptase	-0.5313	Akermanite	-20.5537
Prehnite	-0.5722	Larnite	-20.7840
Albite_high	-0.6091	UO2.3333(beta)	-20.9962
Wairakite	-0.6696	UO2SO4	-21.3416
Rhodochrosite	-0.7249	Anthophyllite	-21.6402
Dawsonite	-0.7358	Lime	-22.8599
SiO2(am)	-0.7915	Na2UO4(alpha)	-23.3525
Kalsilite	-0.9049	UO2(NO3)2:6H2O	-23.9223
Calcite	-0.9467	UO2(NO3)2:3H2O	-25.6758
Aragonite	-1.0922	Pargasite	-26.0882
Clinozoisite	-1.1006	UO2(PO3)2	-26.4209
Natrolite	-1.1119	Rankinite	-26.7782
Zoisite	-1.1500	Pb	-26.8153
Dolomite-ord	-1.3521	UO2(NO3)2:2H2O	-27.0968
Dolomite	-1.3522	(UO2)2P2O7	-27.5095
Jadeite	-1.4384	(UO2)3(PO4)2	-27.6703
Alamosite	-1.5385	K2UO4	-28.0348
Monohydrocalcite	-1.7382	Tobermorite-14A	-28.6287
Saponite-Ca	-2.0227	U(HPO4)2:4H2O	-28.8182
Saponite-Mg	-2.1088	KAl(SO4)2	-28.8290
Magnesite	-2.1615	UP2O7	-29.3424
Saponite-K	-2.4498	Ettringite	-29.9290
Anorthite	-2.4871	UO2(NO3)2:H2O	-31.0468
Phlogopite	-2.6811	Tobermorite-11A	-31.0494
Saponite-Na	-2.7176	Ba2SiO4	-32.9161
Gypsum	-2.8304	Foshagite	-33.1374

Saponite-H	-2.9701	Merwinite	-33.3820
Lanarkite	-3.0361	UO2(NO3)2	-34.8239
Dolomite-dis	-3.0488	Tobermorite-9A	-35.0360
Alunite	-3.0543	Afwillite	-35.1053
Bixbyite	-3.1781	As2O5	-35.5210
Talc	-3.1999	UO2SO3	-36.5064
Anhydrite	-3.2046	Cd	-37.8931
Hydroxylapatite	-3.2546	Al2(SO4)3:6H2O	-39.3105
Anglesite	-3.3152	UO2(AsO3)2	-40.1357
Azurite	-3.6128	(UO2)2As2O7	-40.2743
Nepheline	-3.7339	(UO2)3(AsO4)2	-41.3282
Bassanite	-3.8562	BaO	-41.9772
Whitlockite	-3.8930	U(SO4)2:8H2O	-45.6205
Berlinite	-3.9040	Hatrurite	-46.1794
Cuprite	-3.9173	Arsenolite	-46.3077
Pyrolusite	-3.9599	Claudetite	-46.3910
Rhodonite	-4.0279	Ba2U2O7	-46.6185
CaSO4:0.5H2O(bet	-4.0503	U(SO4)2:4H2O	-47.0553
CaUO4	-4.3792	U(SO4)2	-47.4018
UO3:2H2O	-4.3974	Xonotlite	-47.7879
Schoepite	-4.3991	C	-48.4694
CdSiO3	-4.5027	U(CO3)2	-50.2997
Enstatite	-4.5106	As	-56.1301
UO2(OH)2(beta)	-4.5836	Al2(SO4)3	-58.5785
Sb2O3	-4.6275	Na	-60.3584
Schoepite-dehy(.	-4.6403	Na3UO4	-61.0112
UO3:.9H2O(alpha)	-4.6578	Na4SiO4	-62.9503
Schoepite-dehy(.	-4.7451	Mn	-63.1790
Schoepite-dehy(1	-4.7661	Ca3Al2O6	-63.8337
Clinochlore-14A	-4.9311	Na2O	-64.0412
Hausmannite	-5.0187	K	-64.5151
PbCO3.PbO	-5.0860	Covellite	-71.8399
Nesquehonite	-5.3600	Ba3UO6	-72.7915
Litharge	-5.3660	S	-72.9308
Massicot	-5.5692	Chalcocite	-74.4310
UO2CO3	-5.9617	CdS	-81.3983
Schoepite-dehy(.	-5.9651	Galena	-81.5789
Rutherfordine	-5.9682	K2O	-82.3937
Okenite	-6.0198	U(SO3)2	-89.0858
Brucite	-6.0968	Antigorite	-90.1764
Mn(OH)2(am)	-6.2818	PbSO4(NH3)2	-91.0205
Wollastonite	-6.3313	Na6Si2O7	-91.7047
Diopside	-6.4024	As4O6(mono)	-92.2962
Cordierite_hydr	-6.4972	As4O6(cubi)	-92.4887
Schoepite-dehy(.	-6.5279	Alabandite	-95.2083
Chrysotile	-6.5655	Mg	-104.4778
Pseudowollastoni	-6.6073	BaS	-113.7961
Pb2SiO4	-6.6488	UN1.73(alpha)	-114.6016
Nahcolite	-6.7063	UN1.59(alpha)	-117.4815
Analcime-dehy	-6.7225	Ca	-122.2118
Pb3SO6	-6.7238	P	-124.8173
Chalcanthite	-7.1416	Ba	-126.4839
UO2HPO4:4H2O	-7.2971	Al	-126.6184
Niter	-7.3246	UN	-131.2706
Cd(OH)2	-7.4413	Si	-131.9304
UO3(gamma)	-7.6418	Pb(N3)2(orth)	-145.3842
Spinel	-7.7675	Pb(N3)2(mono)	-145.8484
Sanbornite	-8.1659	PbSO4(NH3)4	-176.5780
UO3(beta)	-8.2892	U	-180.4839
Tephroite	-8.3168	UAs	-192.0199
Clinochlore-7A	-8.4738	US	-193.1836
Sepiolite	-8.5381	UC	-210.4076
UO3(alpha)	-8.6534	UH3(beta)	-212.3172

Cu	-8.8053	US1.9	-223.4556
Ca-Al_Pyroxene	-8.8680	US2	-228.9066
Grossular	-8.9291	Mayenite	-236.7296
Monteponite	-8.9936	UAs2	-245.3229
Artinite	-9.0171	UP	-255.3584
Huntite	-9.1507	UC1.94(alpha)	-258.1395
Manganosite	-9.1789	Stibnite	-273.9683
Cordierite_anhyd	-9.1902	US3	-298.4432
BaUO4	-9.6159	Orpiment	-299.4082
Mirabilite	-9.6413	Pb(SCN)2	-300.9248
Arcanite	-10.3597	UP2	-374.7331
Pb4SO7	-10.4802	U2S3	-414.6957
CdSO4:2.667H2O	-10.4830	o-Phthalic_acid	-424.2301
Nitrobarite	-10.7513	U2C3	-470.9262
CdSO4:H2O	-10.7779	U3As4	-629.9350
Gyrolite	-10.9404	U3S5	-638.6823
Forsterite	-10.9839	U3P4	-885.4510

Gases	fugacity	log fug.
N2(g)	0.06239	-1.205
H2O(g)	0.007285	-2.138
CO2(g)	0.0005978	-3.223
NO2(g)	1.736e-013	-12.761
O2(g)	1.836e-029	-28.736
H2(g)	1.805e-031	-30.743
NO(g)	7.712e-032	-31.113
CO(g)	3.704e-038	-37.431
NH3(g)	5.428e-044	-43.265
SO2(g)	4.124e-046	-45.385
Cd(g)	1.526e-053	-52.816
Pb(g)	2.150e-058	-57.668
Cu(g)	7.024e-066	-65.153
Na(g)	6.588e-076	-75.181
UO3(g)	6.820e-077	-76.166
K(g)	6.030e-077	-76.220
H2S(g)	2.889e-098	-97.539
CH4(g)	7.177e-101	-100.144
UO2(g)	1.002e-119	-118.999
Mg(g)	9.521e-127	-126.021
Ca(g)	2.212e-150	-149.655
S2(g)	4.463e-162	-161.350
C2H4(g)	9.668e-172	-171.015
C(g)	1.047e-175	-174.980
Al(g)	3.807e-182	-181.419
UO(g)	2.760e-196	-195.559
Si(g)	2.672e-209	-208.573
U(g)	2.106e-273	-272.677

		In fluid		Sorbed		Kd
Original basis	total moles	moles	mg/kg	moles	mg/kg	L/kg
Al+++	2.17e-006	2.17e-006	0.0585			
Ba++	4.61e-007	4.61e-007	0.0633			
Ca++	0.000413	0.000413	16.6			
Cd++	7.54e-009	7.54e-009	0.000848			
Cu++	1.29e-006	1.29e-006	0.0818			
H+	2.77e-005	2.77e-005	0.0280			
H2AsO4-	2.60e-008	2.60e-008	0.00367			
H2O	55.5	55.5	1.00e+006			
HCO3-	0.000830	0.000830	50.7			
HPO4--	1.60e-006	1.60e-006	0.154			
K+	4.98e-005	4.98e-005	1.95			

Mg++	0.000120	0.000120	2.92
Mn++	5.53e-006	5.53e-006	0.304
NH3(aq)	0.000117	0.000117	2.00
NO3-	0.000224	0.000224	13.9
Na+	0.000127	0.000127	2.92
O2(aq)	8.79e-005	8.79e-005	2.81
Pb++	3.76e-008	3.76e-008	0.00779
SO4--	0.000172	0.000172	16.6
Sb(OH)3(aq)	6.40e-008	6.40e-008	0.0111
SiO2(aq)	0.000154	0.000154	9.26
UO2++	6.14e-010	6.14e-010	0.000166

Elemental composition		In fluid		Sorbed	
	total moles	moles	mg/kg	moles	mg/kg
Aluminum	2.167e-006	2.167e-006	0.05846		
Antimony	6.403e-008	6.403e-008	0.007795		
Arsenic	2.601e-008	2.601e-008	0.001949		
Barium	4.612e-007	4.612e-007	0.06333		
Cadmium	7.542e-009	7.542e-009	0.0008477		
Calcium	0.0004133	0.0004133	16.56		
Carbon	0.0008305	0.0008305	9.973		
Copper	1.288e-006	1.288e-006	0.08184		
Hydrogen	111.0	111.0	1.119e+005		
Lead	3.762e-008	3.762e-008	0.007795		
Magnesium	0.0001203	0.0001203	2.923		
Manganese	5.534e-006	5.534e-006	0.3040		
Nitrogen	0.0003411	0.0003411	4.777		
Oxygen	55.51	55.51	8.881e+005		
Phosphorus	1.605e-006	1.605e-006	0.04969		
Potassium	4.985e-005	4.985e-005	1.949		
Silicon	0.0001541	0.0001541	4.327		
Sodium	0.0001272	0.0001272	2.923		
Sulfur	0.0001724	0.0001724	5.529		
Uranium	6.141e-010	6.141e-010	0.0001462		

```
Temperature =   6.0 C    Pressure =  1.013 bars
pH =  7.800              log fO2 =  -29.280
Eh =   0.3950 volts      pe =   7.1308
Ionic strength      =    0.003519
Charge imbalance    =   -0.000033 eq/kg (-1.414% error)
Activity of water   =    1.000000
Solvent mass        =    1.000000 kg
Solution mass       =    1.000204 kg
Solution density    =    1.026    g/cm3
Chlorinity          =    0.000000 molal
Dissolved solids    =         204 mg/kg sol'n
Hardness            =      106.00 mg/kg sol'n as CaCO3
  carbonate         =       73.41 mg/kg sol'n as CaCO3
  non-carbonate     =       32.59 mg/kg sol'n as CaCO3
Rock mass           =    0.000000 kg
Carbonate alkalinity=       73.41 mg/kg sol'n as CaCO3
Water type          =    Ca-HCO3
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Nernst redox couples	Eh (volts)	pe
e- + .25*O2(aq) + H+ = .5*H2O	0.3950	7.1308
8*e- + 9*H+ + NO3- = 3*H2O + NH3(aq)	0.5795	10.4608

No minerals in system.

Aqueous species	molality	mg/kg sol'n	act. coef.	log act.
HCO3-	0.001445	88.14	0.9392	-2.8675
Ca++	0.0007574	30.35	0.7841	-3.2263
NO3-	0.0005562	34.48	0.9381	-3.2825
Mg++	0.0002726	6.623	0.7906	-3.6666
Na+	0.0001692	3.889	0.9392	-3.7989
SO4--	0.0001594	15.31	0.7773	-3.9068
SiO2(aq)	0.0001245	7.476	1.0000	-3.9050
N2(aq)	8.590e-005	2.406	1.0000	-4.0660
CO2(aq)	6.927e-005	3.048	1.0000	-4.1594
K+	4.983e-005	1.948	0.9381	-4.3303
CaHCO3+	1.014e-005	1.025	0.9392	-5.0211
CaSO4(aq)	8.752e-006	1.191	1.0000	-5.0579
MgSO4(aq)	4.257e-006	0.5123	1.0000	-5.3709
MgHCO3+	3.557e-006	0.3034	0.9392	-5.4762
CO3--	3.171e-006	0.1902	0.7791	-5.6073
AlO2-	2.887e-006	0.1703	0.9392	-5.5668
Mn++	2.841e-006	0.1560	0.7841	-5.6521
HPO4--	2.411e-006	0.2314	0.7773	-5.7272
CaCO3(aq)	2.159e-006	0.2161	1.0000	-5.6657
Fe++	8.303e-007	0.04636	0.7841	-6.1864
Cu++	6.291e-007	0.03997	0.7841	-6.3069
H2PO4-	6.107e-007	0.05922	0.9392	-6.2414
Ba++	4.967e-007	0.06820	0.7808	-6.4114
HSiO3-	4.916e-007	0.03789	0.9392	-6.3356
NaHCO3(aq)	4.483e-007	0.03765	1.0000	-6.3485
MgCO3(aq)	4.246e-007	0.03579	1.0000	-6.3721
HAlO2(aq)	3.501e-007	0.02100	1.0000	-6.4559
OH-	1.372e-007	0.002333	0.9386	-6.8901
Sb(OH)3(aq)	1.201e-007	0.02075	1.0000	-6.9204
MnSO4(aq)	5.184e-008	0.007826	1.0000	-7.2853
KSO4-	4.646e-008	0.006279	0.9392	-7.3601
FeCO3+	4.259e-008	0.004933	0.9392	-7.3980
HAsO4--	2.392e-008	0.003347	0.7773	-7.7306
Cd++	1.908e-008	0.002144	0.7808	-7.8269
H+	1.679e-008	1.692e-005	0.9441	-7.8000

Al(OH)2+	1.440e-008	0.0008781	0.9392	-7.8689
Pb++	9.411e-009	0.001950	0.7791	-8.1348
NaHSiO3(aq)	5.057e-009	0.0005060	1.0000	-8.2961
UO2(CO3)3----	2.881e-009	0.001296	0.3647	-8.9785
UO2(CO3)2--	2.386e-009	0.0009303	0.7773	-8.7318
NaCO3-	2.309e-009	0.0001916	0.9392	-8.6638
H2AsO4-	2.102e-009	0.0002961	0.9392	-8.7047
AlOH++	4.502e-010	1.980e-005	0.7791	-9.4550
BaCO3(aq)	2.853e-010	5.630e-005	1.0000	-9.5446
HSO4-	1.250e-010	1.213e-005	0.9392	-9.9303
NaAlO2(aq)	6.392e-011	5.238e-006	1.0000	-10.1944
PO4---	6.235e-011	5.920e-006	0.5671	-10.4515
UO2CO3(aq)	5.790e-011	1.910e-005	1.0000	-10.2373
Cu+	1.065e-011	6.765e-007	0.9392	-11.0000
NaOH(aq)	3.745e-012	1.498e-007	1.0000	-11.4265
Al+++	3.191e-012	8.608e-008	0.5942	-11.7221
AsO4---	2.956e-012	4.105e-007	0.5671	-11.7757
Sb(OH)4-	2.173e-012	4.124e-007	0.9392	-11.6901
CdSO4(aq)	1.867e-012	3.892e-007	1.0000	-11.7288
H3PO4(aq)	1.122e-012	1.099e-007	1.0000	-11.9500
MgP2O7--	1.089e-012	2.158e-007	0.7773	-12.0725
Fe+++	7.381e-013	4.121e-008	0.5942	-12.3579
UO2OH+	6.444e-013	1.849e-007	0.9392	-12.2181
HNO3(aq)	2.728e-013	1.718e-008	1.0000	-12.5642
Sb(OH)2+	1.321e-013	2.057e-008	0.9392	-12.9065
HP2O7---	1.730e-014	3.026e-009	0.5671	-14.0083
UO2++	6.605e-015	1.783e-009	0.7791	-14.2886
H3AsO4(aq)	4.566e-015	6.480e-010	1.0000	-14.3404
FeSO4+	2.713e-015	4.121e-010	0.9392	-14.5938
P2O7----	8.939e-016	1.555e-010	0.3647	-15.4868
H2P2O7--	8.876e-016	1.561e-010	0.7773	-15.1612
UO2SO4(aq)	4.668e-016	1.709e-010	1.0000	-15.3308
KHSO4(aq)	3.031e-016	4.126e-011	1.0000	-15.5184
KP2O7---	4.888e-018	1.041e-012	0.5671	-17.5572
UO2(SO4)2--	4.256e-019	1.967e-013	0.7773	-18.4804
(UO2)2(OH)2++	1.061e-019	6.088e-014	0.7791	-19.0828
UO2+	8.630e-021	2.330e-015	0.9392	-20.0913
H3P2O7-	2.644e-021	4.678e-016	0.9392	-20.6050
(UO2)3(CO3)6(6-)	2.610e-021	3.053e-015	0.1033	-21.5692
(UO2)3(OH)5+	2.321e-021	2.077e-015	0.9392	-20.6615
HAsO2(aq)	2.130e-024	2.298e-019	1.0000	-23.6717
U(OH)4(aq)	2.030e-024	6.210e-019	1.0000	-23.6926
As(OH)3(aq)	1.920e-024	2.418e-019	1.0000	-23.7166
Mn+++	3.094e-025	1.700e-020	0.5728	-24.7514
H2AsO3-	3.627e-026	4.531e-021	0.9392	-25.4677
AsO2-	3.530e-026	3.773e-021	0.9392	-25.4795
H4P2O7(aq)	9.736e-028	1.732e-022	1.0000	-27.0116
AsO2OH--	1.230e-029	1.524e-024	0.7773	-29.0196
NO2-	5.510e-031	2.534e-026	0.9381	-30.2866
O2(aq)	9.867e-033	3.157e-028	1.0000	-32.0058
Formate	1.940e-033	8.729e-029	0.9386	-32.7398
H2(aq)	4.371e-034	8.809e-031	1.0000	-33.3594
Ca(For)+	3.584e-035	3.049e-030	0.9392	-34.4729
HNO2(aq)	2.153e-035	1.012e-030	1.0000	-34.6670
Mg(For)+	1.670e-035	1.157e-030	0.9392	-34.8046
Na(For)(aq)	3.499e-037	2.379e-032	1.0000	-36.4561
Mn(For)+	2.768e-037	2.766e-032	0.9392	-36.5851
Formic_acid(aq)	1.731e-037	7.966e-033	1.0000	-36.7617
Cu(For)+	1.300e-037	1.411e-032	0.9392	-36.9133
Fe(For)+	1.227e-037	1.237e-032	0.9392	-36.9384
K(For)(aq)	8.674e-038	7.295e-033	1.0000	-37.0618
SO3--	2.497e-038	1.998e-033	0.7791	-37.7111
Ba(For)+	1.687e-038	3.076e-033	0.9392	-37.8001

HO2-	8.157e-039	2.692e-034	0.9392	-38.1157
NH4+	5.489e-039	9.899e-035	0.9375	-38.2885
HSO3-	4.521e-039	3.665e-034	0.9392	-38.3720
Cd(For)+	2.608e-039	4.105e-034	0.9392	-38.6109
Pb(For)+	1.092e-039	2.754e-034	0.9392	-38.9890
CO(aq)	2.577e-040	7.217e-036	1.0000	-39.5889
Oxalate	5.919e-041	5.209e-036	0.7773	-40.3371
NH3(aq)	4.516e-041	7.689e-037	1.0000	-40.3453
MnO4--	2.318e-041	2.757e-036	0.7773	-40.7442
U(CO3)5(6-)	7.387e-043	3.974e-037	0.1033	-43.1173
UOH+++	3.141e-043	8.009e-038	0.5728	-42.7449
H-Oxalate	1.255e-044	1.117e-039	0.9392	-43.9284
MnO4-	9.037e-045	1.075e-039	0.9386	-44.0715
SO2(aq)	3.348e-045	2.145e-040	1.0000	-44.4752
HSO5-	2.528e-047	2.858e-042	0.9392	-46.6244
USO4++	1.650e-047	5.512e-042	0.7791	-46.8909
U(SO4)2(aq)	6.014e-048	2.587e-042	1.0000	-47.2208
U++++	9.945e-050	2.367e-044	0.3745	-49.4289
Oxalic_acid(aq)	3.391e-051	3.052e-046	1.0000	-50.4697
S2O6--	1.274e-063	2.039e-058	0.7773	-63.0043
S2O8--	8.538e-065	1.640e-059	0.7773	-64.1780
Ca(For)2(aq)	5.758e-067	7.491e-062	1.0000	-66.2397
Mg(For)2(aq)	3.575e-067	4.087e-062	1.0000	-66.4467
U+++	7.605e-068	1.810e-062	0.5728	-67.3609
Mn(For)2(aq)	8.183e-069	1.186e-063	1.0000	-68.0871
Cu(For)2(aq)	7.302e-069	1.121e-063	1.0000	-68.1365
Fe(For)2(aq)	5.140e-069	7.497e-064	1.0000	-68.2890
Cd(For)2(aq)	7.225e-070	1.462e-064	1.0000	-69.1412
Na(For)2-	5.405e-070	6.108e-065	0.9392	-69.2944
Ba(For)2(aq)	1.929e-070	4.384e-065	1.0000	-69.7148
K(For)2-	1.076e-070	1.390e-065	0.9392	-69.9953
Pb(For)2(aq)	3.413e-071	1.014e-065	1.0000	-70.4668
Formaldehyde(aq)	2.909e-072	8.733e-068	1.0000	-71.5362
N3-	6.511e-074	2.735e-069	0.9392	-73.2136
HN3(aq)	7.502e-077	3.227e-072	1.0000	-76.1248
Cu(NH3)2++	1.200e-079	1.171e-074	0.7791	-79.0291
S2O5--	3.761e-082	5.420e-077	0.7773	-81.5341
Cd(NH3)2++	5.970e-084	8.742e-079	0.7791	-83.3325
Urea(aq)	5.385e-085	3.234e-080	1.0000	-84.2688
HCN(aq)	4.433e-086	1.198e-081	1.0000	-85.3533
CN-	4.741e-088	1.233e-083	0.9381	-87.3519
Methanol(aq)	1.054e-089	3.378e-085	1.0000	-88.9770
Glycolate	7.400e-096	5.552e-091	0.9392	-95.1580
HS-	5.650e-097	1.868e-092	0.9386	-96.2755
Ca(Glyc)+	2.428e-097	2.794e-092	0.9392	-96.6420
H2S(aq)	1.665e-097	5.672e-093	1.0000	-96.7787
Mg(Glyc)+	4.038e-098	4.011e-093	0.9392	-97.4211
Cu(Glyc)+	4.810e-099	6.664e-094	0.9392	-98.3451
Na(Glyc)(aq)	1.380e-099	1.352e-094	1.0000	-98.8602
Fe(Glyc)+	1.143e-099	1.496e-094	0.9392	-98.9691
Mn(Glyc)+	8.168e-100	1.061e-094	0.9392	-99.1152
Glycolic_acid(aq	8.055e-100	6.125e-095	1.0000	-99.0939
K(Glyc)(aq)	3.421e-100	3.904e-095	1.0000	-99.4659
Ba(Glyc)+	3.103e-101	6.589e-096	0.9392	-100.5355
Pb(Glyc)+	1.182e-101	3.335e-096	0.9392	-100.9547
Cd(Glyc)+	1.108e-101	2.076e-096	0.9392	-100.9828
Methane(aq)	1.033e-101	1.657e-097	1.0000	-100.9857
S--	1.314e-102	4.211e-098	0.7808	-101.9890
S2O4--	1.884e-103	2.413e-098	0.7808	-102.8325
S2O3--	1.203e-103	1.349e-098	0.7773	-103.0292
Acetate	2.981e-107	1.760e-102	0.9397	-106.5526
MgCH3COO+	1.734e-109	1.445e-104	0.9392	-108.7883
CaCH3COO+	1.635e-109	1.620e-104	0.9392	-108.8138

Acetic_acid(aq)	2.615e-110	1.570e-105	1.0000	-109.5825
CuCH3COO+	3.837e-111	4.702e-106	0.9392	-110.4433
NaCH3COO(aq)	3.817e-111	3.131e-106	1.0000	-110.4183
MnCH3COO+	1.341e-111	1.529e-106	0.9392	-110.8997
KCH3COO(aq)	6.681e-112	6.556e-107	1.0000	-111.1751
FeCH3COO+	4.674e-112	5.370e-107	0.9392	-111.3575
BaCH3COO+	1.024e-112	2.010e-107	0.9392	-112.0171
PbCH3COO+	6.047e-113	1.610e-107	0.9392	-112.2457
CdCH3COO+	5.141e-113	8.813e-108	0.9392	-112.3162
Malonate	3.478e-116	3.548e-111	0.7773	-115.5681
AlCH3COO++	1.535e-116	1.320e-111	0.7791	-115.9223
Cu(NH3)3++	6.390e-117	7.324e-112	0.7791	-116.3030
CuCH3COO(aq)	7.317e-118	8.968e-113	1.0000	-117.1357
H-Malonate	2.126e-118	2.191e-113	0.9392	-117.6996
AsH3(aq)	1.731e-119	1.349e-114	1.0000	-118.7618
Malonic_acid(aq)	2.374e-123	2.470e-118	1.0000	-122.6244
Methanamine(aq)	2.260e-127	7.018e-123	1.0000	-126.6459
Cu(Gly)+	4.680e-130	6.439e-125	0.9392	-129.3570
Glycine(aq)	3.613e-130	2.712e-125	1.0000	-129.4422
Mg(Gly)+	9.526e-133	9.368e-128	0.9392	-132.0483
Fe(Gly)+	1.957e-134	2.542e-129	0.9392	-133.7356
Mn(Gly)+	1.468e-134	1.894e-129	0.9392	-133.8604
Ca(Gly)+	1.169e-134	1.334e-129	0.9392	-133.9595
Pb(Gly)+	2.886e-135	8.115e-130	0.9392	-134.5670
Cd(Gly)+	1.163e-135	2.168e-130	0.9392	-134.9616
S3O6--	5.976e-137	1.148e-131	0.7773	-136.3330
Ba(Gly)+	8.775e-138	1.855e-132	0.9392	-137.0840
Acetaldehyde(aq)	7.184e-144	3.164e-139	1.0000	-143.1436
SCN-	4.827e-145	2.803e-140	0.9386	-144.3439
NH4CH3COO(aq)	2.376e-145	1.831e-140	1.0000	-144.6242
Acetamide(aq)	1.852e-145	1.094e-140	1.0000	-144.7323
UO2SCN+	6.024e-158	1.976e-152	0.9392	-157.2474
Cd(NH3)4++	5.363e-162	9.680e-157	0.7791	-161.3790
Ethanol(aq)	4.852e-166	2.235e-161	1.0000	-165.3141
Ethyne(aq)	1.694e-166	4.410e-162	1.0000	-165.7711
Ethylene(aq)	6.148e-171	1.724e-166	1.0000	-170.2113
Lactate	3.651e-172	3.251e-167	0.9392	-171.4648
Ca(Lac)+	7.039e-174	9.089e-169	0.9392	-173.1797
Mg(Lac)+	1.952e-174	2.212e-169	0.9392	-173.7368
Cu(Lac)+	1.082e-175	1.651e-170	0.9392	-174.9931
Na(Lac)(aq)	6.996e-176	7.839e-171	1.0000	-175.1551
Fe(Lac)+	5.010e-176	7.259e-171	0.9392	-175.3274
Lactic_acid(aq)	4.140e-176	3.728e-171	1.0000	-175.3830
Mn(Lac)+	2.852e-176	4.107e-171	0.9392	-175.5721
K(Lac)(aq)	1.735e-176	2.223e-171	1.0000	-175.7607
Ba(Lac)+	6.212e-178	1.406e-172	0.9392	-177.2340
Pb(Lac)+	5.698e-178	1.688e-172	0.9392	-177.2715
Cd(Lac)+	3.697e-178	7.447e-173	0.9392	-177.4594
Ethane(aq)	1.737e-182	5.223e-178	1.0000	-181.7601
Propanoate	8.636e-186	6.309e-181	0.9392	-185.0909
Ca(Prop)+	2.646e-188	2.994e-183	0.9392	-187.6046
Mg(Prop)+	1.359e-188	1.323e-183	0.9392	-187.8940
Propanoic_acid(a	1.015e-188	7.515e-184	1.0000	-187.9937
Na(Prop)(aq)	1.633e-189	1.568e-184	1.0000	-188.7870
Cu(Prop)+	1.096e-189	1.497e-184	0.9392	-188.9875
Mn(Prop)+	4.600e-190	5.887e-185	0.9392	-189.3645
K(Prop)(aq)	4.048e-190	4.540e-185	1.0000	-189.3927
Fe(Prop)+	3.335e-190	4.298e-185	0.9392	-189.5042
USCN+++	6.104e-191	1.807e-185	0.5728	-190.4564
Ca(Glyc)2(aq)	3.748e-191	7.126e-186	1.0000	-190.4262
Pb(Prop)+	1.542e-191	4.320e-186	0.9392	-190.8392
Cd(Prop)+	1.376e-191	2.552e-186	0.9392	-190.8886
Mg(Glyc)2(aq)	3.972e-192	6.925e-187	1.0000	-191.4010

Ba(Prop)+	3.826e-192	8.047e-187	0.9392	-191.4446
Cu(Glyc)2(aq)	3.155e-192	6.739e-187	1.0000	-191.5010
Fe(Glyc)2(aq)	6.043e-193	1.244e-187	1.0000	-192.2188
Succinate	4.341e-193	5.038e-188	0.7773	-192.4718
S4O6--	1.171e-193	2.625e-188	0.7773	-193.0410
Mn(Glyc)2(aq)	5.152e-194	1.056e-188	1.0000	-193.2880
Na(Glyc)2-	1.281e-194	2.218e-189	0.9392	-193.9195
Pb(Glyc)2(aq)	5.241e-195	1.872e-189	1.0000	-194.2806
Cd(Glyc)2(aq)	2.846e-195	7.470e-190	1.0000	-194.5457
K(Glyc)2-	2.641e-195	4.994e-190	0.9392	-194.6056
H-Succinate	2.605e-195	3.050e-190	0.9392	-194.6114
Serine(aq)	1.190e-195	1.250e-190	1.0000	-194.9246
Ba(Glyc)2(aq)	1.052e-195	3.022e-190	1.0000	-194.9781
Succinic_acid(aq	7.109e-199	8.393e-194	1.0000	-198.1482
Ethanamine(aq)	1.084e-205	4.886e-201	1.0000	-204.9650
Alanine(aq)	2.421e-207	2.157e-202	1.0000	-206.6159
Cu(Ala)+	7.111e-208	1.078e-202	0.9392	-207.1753
Fe(Ala)+	1.651e-211	2.375e-206	0.9392	-210.8096
Mg(Ala)+	4.045e-212	4.545e-207	0.9392	-211.4203
Ca(Ala)+	1.479e-212	1.895e-207	0.9392	-211.8574
Mn(Ala)+	8.039e-213	1.149e-207	0.9392	-212.1221
Cd(Ala)+	4.380e-213	8.781e-208	0.9392	-212.3857
Pb(Ala)+	1.507e-213	4.448e-208	0.9392	-212.8492
Ca(CH3COO)2(aq)	9.764e-215	1.544e-209	1.0000	-214.0104
Mg(CH3COO)2(aq)	4.630e-215	6.592e-210	1.0000	-214.3344
Cu(CH3COO)2(aq)	4.342e-216	7.885e-211	1.0000	-215.3623
Ba(Ala)+	4.046e-216	9.119e-211	0.9392	-215.4202
Mn(CH3COO)2(aq)	3.570e-217	6.177e-212	1.0000	-216.4473
Fe(CH3COO)2(aq)	3.452e-217	6.004e-212	1.0000	-216.4619
Acetone(aq)	2.185e-217	1.269e-212	1.0000	-216.6605
Na(CH3COO)2-	7.318e-218	1.032e-212	0.9392	-217.1628
Aspartic_acid(aq	4.130e-218	5.496e-213	1.0000	-217.3840
Cd(CH3COO)2(aq)	3.488e-218	8.039e-213	1.0000	-217.4574
Pb(CH3COO)2(aq)	1.355e-218	4.406e-213	1.0000	-217.8682
Ba(CH3COO)2(aq)	8.899e-219	2.273e-213	1.0000	-218.0506
K(CH3COO)2-	8.102e-219	1.273e-213	0.9392	-218.1187
Al(CH3COO)2+	6.315e-221	9.160e-216	0.9392	-220.2269
Propanal(aq)	7.798e-222	4.528e-217	1.0000	-221.1080
Cu(CH3COO)2-	3.556e-224	6.457e-219	0.9392	-223.4763
1-Propyne(aq)	9.638e-241	3.861e-236	1.0000	-240.0160
S3--	4.377e-244	4.210e-239	0.7773	-243.4682
1-Propanol(aq)	1.611e-244	9.681e-240	1.0000	-243.7928
1-Propene(aq)	3.898e-247	1.640e-242	1.0000	-246.4091
2-Hydroxybutanoa	4.230e-251	4.360e-246	0.9392	-250.4009
NH4(CH3COO)2-	7.423e-252	1.010e-246	0.9392	-251.1567
Asparagine(aq)	3.394e-253	4.483e-248	1.0000	-252.4693
Cu(Gly)2(aq)	2.240e-254	4.740e-249	1.0000	-253.6498
2-Hydroxybutanoi	4.237e-255	4.410e-250	1.0000	-254.3729
Propane(aq)	2.255e-261	9.940e-257	1.0000	-260.6469
Mg(Gly)2(aq)	1.525e-261	2.630e-256	1.0000	-260.8166
Diglycine(aq)	2.789e-262	3.684e-257	1.0000	-261.5546
Fe(Gly)2(aq)	4.508e-263	9.193e-258	1.0000	-262.3460
Mn(Gly)2(aq)	1.755e-263	3.564e-258	1.0000	-262.7556
Cd(Gly)2(aq)	9.075e-264	2.364e-258	1.0000	-263.0422
Pb(Gly)2(aq)	6.749e-264	2.397e-258	1.0000	-263.1708
Diketopiperazine	8.729e-265	9.958e-260	1.0000	-264.0590
Butanoate	7.932e-265	6.907e-260	0.9392	-264.1279
Ca(Gly)2(aq)	5.559e-266	1.046e-260	1.0000	-265.2550
Ca(But)+	1.664e-267	2.116e-262	0.9392	-266.8060
Mg(But)+	8.142e-268	9.069e-263	0.9392	-267.1165
Butanoic_acid(aq	7.367e-268	6.489e-263	1.0000	-267.1327
Na(But)(aq)	1.449e-268	1.595e-263	1.0000	-267.8389
Cu(But)+	7.977e-269	1.201e-263	0.9392	-268.1254

Ba(Gly)2(aq)	4.399e-269	1.255e-263	1.0000	-268.3566
Mn(But)+	3.611e-269	5.129e-264	0.9392	-268.4696
K(But)(aq)	3.593e-269	4.534e-264	1.0000	-268.4445
Fe(But)+	3.186e-269	4.554e-264	0.9392	-268.5240
Cd(But)+	5.301e-271	1.057e-265	0.9392	-270.3029
Pb(But)+	3.909e-271	1.150e-265	0.9392	-270.4351
Glutarate	3.420e-271	4.449e-266	0.7773	-270.5753
Ba(But)+	2.346e-271	5.264e-266	0.9392	-270.6569
H-Glutarate	1.176e-273	1.542e-268	0.9392	-272.9568
Threonine(aq)	1.113e-274	1.326e-269	1.0000	-273.9534
Glutaric_acid(aq	3.983e-277	5.261e-272	1.0000	-276.3998
Ethylacetate(aq)	3.905e-277	3.440e-272	1.0000	-276.4083
S5O6--	1.721e-280	4.412e-275	0.7773	-279.8735
1-Propanamine(aq	1.220e-283	7.211e-279	1.0000	-282.9136
a-Aminobutyric_a	4.814e-286	4.963e-281	1.0000	-285.3175
Glutamic_acid(aq	3.644e-295	5.361e-290	1.0000	-294.4384
Butanal(aq)	2.332e-302	1.681e-297	1.0000	-300.0000
UO2(SCN)2(aq)	1.453e-302	5.611e-297	1.0000	-300.0000
S4--	4.512e-315	5.787e-310	0.7773	-300.0000
1-Butyne(aq)	8.257e-320	4.465e-315	1.0000	-300.0000
Cu(CH3COO)3-	5.830e-321	1.403e-315	0.9392	-300.0000
Pb(CH3COO)3-	5.435e-323	2.088e-317	0.9392	-300.0000
Mn(CH3COO)3-	4.941e-323	1.146e-317	0.9392	-300.0000
1-Butanol(aq)	4.941e-324	3.661e-319	1.0000	-300.0000
Cd(CH3COO)3-	4.941e-324	1.430e-318	0.9392	-300.0000
Heptanoate	0.0000	0.0000	0.9392	-300.0000
Heptanal(aq)	0.0000	0.0000	1.0000	-300.0000
HSb2S4-	0.0000	0.0000	0.9392	-300.0000
Cd(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cd(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Alanylglycine(aq	0.0000	0.0000	1.0000	-300.0000
p-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
p-Toluate	0.0000	0.0000	0.9392	-300.0000
2-Hexanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexyne(aq)	0.0000	0.0000	1.0000	-300.0000
o-Toluate	0.0000	0.0000	0.9392	-300.0000
o-Phthalate	0.0000	0.0000	0.7773	-300.0000
n-Propylbenzene(	0.0000	0.0000	1.0000	-300.0000
n-Pentane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Octylbenzene(a	0.0000	0.0000	1.0000	-300.0000
n-Octane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Hexane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Heptane(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
n-Butane(aq)	0.0000	0.0000	1.0000	-300.0000
m-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
m-Toluate	0.0000	0.0000	0.9392	-300.0000
2-Heptanone(aq)	0.0000	0.0000	1.0000	-300.0000
Valine(aq)	0.0000	0.0000	1.0000	-300.0000
Undecanoic_acid(	0.0000	0.0000	1.0000	-300.0000
Ca(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Undecanoate	0.0000	0.0000	0.9392	-300.0000
Ca(Pent)+	0.0000	0.0000	0.9392	-300.0000
Ca(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
H-Suberate	0.0000	0.0000	0.9392	-300.0000
UO2(SCN)3-	0.0000	0.0000	0.9392	-300.0000
H-Sebacate	0.0000	0.0000	0.9392	-300.0000
2-Butanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexene(aq)	0.0000	0.0000	1.0000	-300.0000
H-Pimelate	0.0000	0.0000	0.9392	-300.0000
U(SCN)2++	0.0000	0.0000	0.7791	-300.0000
H-Azelate	0.0000	0.0000	0.9392	-300.0000
Tryptophan(aq)	0.0000	0.0000	1.0000	-300.0000

Toluene(aq)	0.0000	0.0000	1.0000	-300.0000
H-Adipate	0.0000	0.0000	0.9392	-300.0000
Suberic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Suberate	0.0000	0.0000	0.7773	-300.0000
Sebacic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Sebacate	0.0000	0.0000	0.7773	-300.0000
Sb2S4--	0.0000	0.0000	0.7773	-300.0000
Adipic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Glutamine(aq)	0.0000	0.0000	1.0000	-300.0000
S5--	0.0000	0.0000	0.7773	-300.0000
Ca(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Adipate	0.0000	0.0000	0.7773	-300.0000
1-Hexanol(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Pimelic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Fe(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Pimelate	0.0000	0.0000	0.7773	-300.0000
Phenylalanine(aq	0.0000	0.0000	1.0000	-300.0000
Fe(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Pentanal(aq)	0.0000	0.0000	1.0000	-300.0000
Fe(Pent)+	0.0000	0.0000	0.9392	-300.0000
Fe(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Pb(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Pb(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Pb(Pent)+	0.0000	0.0000	0.9392	-300.0000
Pb(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexanamine(aq)	0.0000	0.0000	1.0000	-300.0000
1-Butene(aq)	0.0000	0.0000	1.0000	-300.0000
Pb(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Pb(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Fe(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Fe(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Benzoic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Octanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Octanoate	0.0000	0.0000	0.9392	-300.0000
Octanal(aq)	0.0000	0.0000	1.0000	-300.0000
Benzoate	0.0000	0.0000	0.9412	-300.0000
2-Pentanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Pentyne(aq)	0.0000	0.0000	1.0000	-300.0000
Nonanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Nonanoate	0.0000	0.0000	0.9392	-300.0000
Nonanal(aq)	0.0000	0.0000	1.0000	-300.0000
Ethylbenzene(aq)	0.0000	0.0000	1.0000	-300.0000
Benzene(aq)	0.0000	0.0000	1.0000	-300.0000
2-Octanone(aq)	0.0000	0.0000	1.0000	-300.0000
Na(Prop)2-	0.0000	0.0000	0.9392	-300.0000
Pentanoate	0.0000	0.0000	0.9392	-300.0000
Pentanoic_acid(a	0.0000	0.0000	1.0000	-300.0000
Phenol(aq)	0.0000	0.0000	1.0000	-300.0000
Na(Pent)2-	0.0000	0.0000	0.9392	-300.0000
Dodecanoic_acid(	0.0000	0.0000	1.0000	-300.0000
Na(Pent)(aq)	0.0000	0.0000	1.0000	-300.0000
Na(Lac)2-	0.0000	0.0000	0.9392	-300.0000
Dodecanoate	0.0000	0.0000	0.9392	-300.0000
2-Hydroxypentano	0.0000	0.0000	1.0000	-300.0000
1-Pentene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptyne(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Decanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Na(But)2-	0.0000	0.0000	0.9392	-300.0000
Decanoate	0.0000	0.0000	0.9392	-300.0000
2-Hydroxypentano	0.0000	0.0000	0.9392	-300.0000
Decanal(aq)	0.0000	0.0000	1.0000	-300.0000

Ba(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Pent)+	0.0000	0.0000	0.9392	-300.0000
2-Hydroxyoctanoi	0.0000	0.0000	1.0000	-300.0000
1-Pentanol(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyoctanoa	0.0000	0.0000	0.9392	-300.0000
Mn(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Pent)+	0.0000	0.0000	0.9392	-300.0000
Cu(Pent)+	0.0000	0.0000	0.9392	-300.0000
Mn(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxynonanoi	0.0000	0.0000	1.0000	-300.0000
1-Pentanamine(aq	0.0000	0.0000	1.0000	-300.0000
1-Heptene(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxynonanoa	0.0000	0.0000	0.9392	-300.0000
Mg(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyhexanoi	0.0000	0.0000	1.0000	-300.0000
1-Octyne(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Tyrosine(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Pent)+	0.0000	0.0000	0.9392	-300.0000
Mg(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyhexanoa	0.0000	0.0000	0.9392	-300.0000
Cu(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Methionine(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyheptano	0.0000	0.0000	1.0000	-300.0000
1-Octene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptanol(aq)	0.0000	0.0000	1.0000	-300.0000
Cd(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Leucylglycine(aq	0.0000	0.0000	1.0000	-300.0000
Leucine(aq)	0.0000	0.0000	1.0000	-300.0000
Cd(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Azelate	0.0000	0.0000	0.7773	-300.0000
2-Hydroxyheptano	0.0000	0.0000	0.9392	-300.0000
Cd(Pent)+	0.0000	0.0000	0.9392	-300.0000
Azelaic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
K(Prop)2-	0.0000	0.0000	0.9392	-300.0000
Cd(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxydecanoi	0.0000	0.0000	1.0000	-300.0000
1-Octanol(aq)	0.0000	0.0000	1.0000	-300.0000
K(Pent)2-	0.0000	0.0000	0.9392	-300.0000
K(Pent)(aq)	0.0000	0.0000	1.0000	-300.0000
K(Lac)2-	0.0000	0.0000	0.9392	-300.0000
n-Butylbenzene(a	0.0000	0.0000	1.0000	-300.0000
2-Hydroxydecanoa	0.0000	0.0000	0.9392	-300.0000
n-Heptylbenzene(	0.0000	0.0000	1.0000	-300.0000
K(But)2-	0.0000	0.0000	0.9392	-300.0000
n-Hexylbenzene(a	0.0000	0.0000	1.0000	-300.0000
Isoleucine(aq)	0.0000	0.0000	1.0000	-300.0000
Hexanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Hexanoate	0.0000	0.0000	0.9392	-300.0000
n-Pentylbenzene(	0.0000	0.0000	1.0000	-300.0000
Hexanal(aq)	0.0000	0.0000	1.0000	-300.0000

Heptanoic_acid(a	0.0000	0.0000	1.0000	-300.0000
1-Octanamine(aq)	0.0000	0.0000	1.0000	-300.0000
o-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
1-Heptanamine(aq	0.0000	0.0000	1.0000	-300.0000
1-Butanamine(aq)	0.0000	0.0000	1.0000	-300.0000
(NH4)2Sb2S4(aq)	0.0000	0.0000	1.0000	-300.0000

Mineral saturation states

	log Q/K		log Q/K
Nontronite-Ca	25.0427s/sat	UO3(alpha)	-8.3706
Nontronite-Mg	24.9716s/sat	Monteponite	-8.5601
Nontronite-K	24.5663s/sat	Pb3SO6	-8.6065
Nontronite-Na	24.3425s/sat	Cu	-8.7528
Nontronite-H	24.0497s/sat	Tephroite	-8.9353
Hematite	20.4604s/sat	BaUO4	-9.3011
Ferrite-Cu	18.5653s/sat	Manganosite	-9.4198
Magnetite	18.4744s/sat	Mirabilite	-9.4813
Cronstedtite-7A	17.9267s/sat	Saleeite	-9.8912
Delafossite	14.0424s/sat	Nitrobarite	-9.9915
Clinoptilolite-h	12.3715s/sat	CdSO4:2.667H2O	-10.1361
Clinoptilolite-C	12.2620s/sat	Forsterite	-10.2820
Andradite	10.7947s/sat	CdSO4:H2O	-10.4253
Muscovite	10.5320s/sat	Arcanite	-10.4284
Stilbite	10.4023s/sat	Gyrolite	-10.6804
Epidote-ord	10.1308s/sat	UO2.25	-10.8904
Epidote	10.1295s/sat	Mg1.25SO4(OH)0.5	-10.9546
Ferrite-Ca	9.8103s/sat	UO2.25(beta)	-10.9614
Goethite	9.7727s/sat	Thenardite	-11.1754
Ferrite-Mg	9.6584s/sat	Periclase	-11.1893
Clinoptilolite-K	8.4743s/sat	Monticellite	-11.4458
Clinoptilolite-h	8.0349s/sat	Torbernite	-11.5090
Beidellite-Ca	7.6552s/sat	Natron	-11.7039
Beidellite-Mg	7.5839s/sat	Portlandite	-11.7178
Illite	7.4350s/sat	Uranocircite	-11.8268
Beidellite-K	7.1789s/sat	MgUO4	-12.1325
Kaolinite	7.0715s/sat	(UO2)3(PO4)2:4H2	-12.2027
Beidellite-Na	6.9548s/sat	CdSO4	-12.2064
Mesolite	6.7642s/sat	Mg1.5SO4(OH)	-12.3070
Paragonite	6.7399s/sat	Na2CO3:7H2O	-12.3466
Beidellite-H	6.6629s/sat	Tremolite	-12.3726
Montmor-Mg	6.4556s/sat	BaU2O7	-12.5034
Montmor-Ca	6.4501s/sat	UO2SO4:H2O	-12.5921
Pyrophyllite	6.3612s/sat	MnSO4	-12.9331
Montmor-K	6.0505s/sat	Pb4SO7	-12.9596
Scolecite	5.9021s/sat	Przhevalskite	-13.3000
Montmor-Na	5.8209s/sat	MgSO4	-13.4756
Clinoptilolite-N	5.7142s/sat	FeSO4	-13.5631
Clinoptilolite-h	5.7111s/sat	UPO5	-13.6010
Jarosite	4.7575s/sat	UO2.6667	-13.6474
Laumontite	4.5183s/sat	Thermonatrite	-13.9487
Fe(OH)3	4.3894s/sat	Chalcocyanite	-13.9597
Smectite-low-Fe-	4.2255s/sat	Na2U2O7	-14.0325
Margarite	4.1596s/sat	Bassetite	-14.1918
Maximum_Microcli	3.6325s/sat	Na2CO3	-14.3097
K-Feldspar	3.6299s/sat	Uraninite	-14.3327
Smectite-high-Fe	3.4151s/sat	Mordenite-dehy	-14.3708
Celadonite	3.3806s/sat	Coffinite	-14.6309
Diaspore	3.2107s/sat	Autunite-H	-15.0106
Lawsonite	2.9374s/sat	Ca3(AsO4)2	-15.4689
Boehmite	2.7736s/sat	Ferrite-Dicalciu	-15.6348
Gibbsite	2.7126s/sat	Ba(OH)2:8H2O	-16.0472
Sanidine_high	2.3013s/sat	CaAl2O4	-16.4043

Corundum	2.0324s/sat	UO2SO4:3.5H2O	-17.0391
Mordenite	1.9731s/sat	UO2SO4:2.5H2O	-17.1233
Amesite-14A	1.8412s/sat	UO2SO4:3H2O	-17.1976
Witherite	1.7309s/sat	NaUO3	-17.3036
Chamosite-7A	1.1799s/sat	Hydromagnesite	-17.3749
Kyanite	1.1130s/sat	Ba2Si3O8	-17.5943
Malachite	1.0846s/sat	Gehlenite	-17.8474
Tenorite	0.8681s/sat	CaAl4O7	-18.0639
Andalusite	0.7917s/sat	Hillebrandite	-18.3351
Albite_low	0.7874s/sat	Natrosilite	-18.4339
Albite	0.7874s/sat	Alum-K	-18.7561
Strengite	0.6743s/sat	Dicalcium_silica	-18.8555
Quartz	0.5530s/sat	Na2SiO3	-19.0713
Daphnite-14A	0.4760s/sat	Ningyoite	-19.0990
Sillimanite	0.3895s/sat	Anthophyllite	-19.7305
Tridymite	0.3539s/sat	Akermanite	-19.7490
Brochantite	0.2821s/sat	UO2.3333(beta)	-19.9887
Chalcedony	0.2634s/sat	Larnite	-20.2614
Cerussite	0.1974s/sat	UO2SO4	-21.1047
Analcime	0.1801s/sat	Lime	-22.5094
Barite	0.0216s/sat	Na2UO4(alpha)	-22.7871
Prehnite	-0.0387	UO2(NO3)2:6H2O	-22.9201
Cristobalite(alp	-0.0421	Pargasite	-23.9668
Ice	-0.0677	UO2(NO3)2:3H2O	-24.6588
Hercynite	-0.1768	UO2(PO3)2	-25.6526
Dolomite-ord	-0.2138	Rankinite	-26.0615
Dolomite	-0.2139	UO2(NO3)2:2H2O	-26.0718
Dawsonite	-0.2410	Clinoptilolite-d	-26.3793
Coesite	-0.3087	(UO2)3(PO4)2	-26.3802
Clinozoisite	-0.4135	(UO2)2P2O7	-26.4805
Calcite	-0.4275	Pb	-27.0209
Zoisite	-0.4628	K2UO4	-27.7164
Wairakite	-0.5176	U(HPO4)2:4H2O	-27.7417
Cristobalite(bet	-0.5419	Tobermorite-14A	-27.8232
Aragonite	-0.5729	Ettringite	-28.1840
Albite_high	-0.6624	UP2O7	-28.2387
Annite	-0.6779	KAl(SO4)2	-28.7724
Rhodochrosite	-0.7611	UO2(NO3)2:H2O	-30.0046
Kalsilite	-0.8712	Clinoptilolite-d	-30.2167
SiO2(am)	-0.8955	Tobermorite-11A	-30.2174
Natrolite	-0.9034	Foshagite	-32.2352
Dioptase	-0.9471	Merwinite	-32.2543
Hydroxylapatite	-1.1593	Ba2SiO4	-32.8711
Saponite-Ca	-1.1598	Clinoptilolite-d	-32.9452
Monohydrocalcite	-1.2201	UO2(NO3)2	-33.7681
Saponite-Mg	-1.2287	Tobermorite-9A	-34.1824
Ripidolite-14A	-1.3066	Afwillite	-34.3803
Jadeite	-1.3863	As2O5	-35.5596
Siderite	-1.4259	UO2SO3	-35.8998
Magnesite	-1.5371	Cd	-37.0527
Saponite-K	-1.6361	Fe	-38.0312
Phlogopite	-1.6971	Al2(SO4)3:6H2O	-39.1760
Saponite-Na	-1.8601	(UO2)2As2O7	-39.7819
Dolomite-dis	-1.9041	UO2(AsO3)2	-39.8990
Anorthite	-2.1132	(UO2)3(AsO4)2	-40.5773
Saponite-H	-2.1523	BaO	-41.8282
Alamosite	-2.2519	Fe2(SO4)3	-42.4304
Minnesotaite	-2.3453	U(SO4)2:8H2O	-45.0996
Talc	-2.4657	Hatrurite	-45.2991
Ferrosilite	-2.5575	Ba2U2O7	-45.5832
Whitlockite	-2.5851	Arsenolite	-45.6614
Gypsum	-2.6240	Claudetite	-45.7437
Alunite	-2.7944	U(SO4)2:4H2O	-46.5184

Anhydrite	-2.9900	Xonotlite	-46.6010
Clinochlore-14A	-3.0168	U(SO4)2	-46.8520
Daphnite-7A	-3.0758	C	-47.4561
Berlinite	-3.5259	U(CO3)2	-49.1106
Nepheline	-3.5613	As	-55.2266
Bassanite	-3.6413	Al2(SO4)3	-58.3649
CaUO4	-3.8246	Ca4Al2Fe2O10	-59.1310
CaSO4:0.5H2O(bet	-3.8343	Na	-59.9023
Anglesite	-3.9922	Na3UO4	-60.0562
Bixbyite	-4.0310	Na4SiO4	-62.3974
Azurite	-4.0395	Ca3Al2O6	-62.4908
Greenalite	-4.0787	Mn	-62.9456
Sb2O3	-4.1148	Na2O	-63.6192
UO3:2H2O	-4.1335	K	-64.1775
Schoepite	-4.1349	Covellite	-70.7152
Cuprite	-4.1741	S	-71.8310
CdSiO3	-4.1923	Ba3UO6	-72.2318
Enstatite	-4.2172	Chalcocite	-73.2684
UO2(OH)2(beta)	-4.3167	Antigorite	-75.0871
Lanarkite	-4.3221	CdS	-79.5439
Schoepite-dehy(.	-4.3740	Galena	-80.7365
UO3:.9H2O(alpha)	-4.3897	K2O	-82.1822
Rhodonite	-4.3925	U(SO3)2	-87.7685
Schoepite-dehy(.	-4.4768	PbSO4(NH3)2	-90.3497
Schoepite-dehy(1	-4.4971	Troilite	-90.9049
Wustite	-4.5400	Na6Si2O7	-90.9328
Pyrolusite	-4.5436	As4O6(mono)	-91.0017
Nesquehonite	-4.7212	Pyrrhotite	-91.0106
Ripidolite-7A	-4.8476	As4O6(cubi)	-91.1965
FeO	-5.3785	Alabandite	-93.9872
UO2CO3	-5.4563	Mg	-103.4671
Rutherfordine	-5.4640	BaS	-112.2267
Chrysotile	-5.6066	UN1.73(alpha)	-112.9211
Fe(OH)2	-5.6283	UN1.59(alpha)	-115.8029
Cordierite_hydr	-5.6512	Ca	-121.2558
Schoepite-dehy(.	-5.6921	P	-123.4337
Brucite	-5.6942	Al	-125.6256
Diopside	-5.9275	Ba	-125.7723
Fayalite	-5.9319	UN	-129.5825
Okenite	-5.9466	Si	-131.0195
Litharge	-5.9581	Pb(N3)2(orth)	-144.8163
PbCO3.PbO	-6.0532	Pb(N3)2(mono)	-145.2794
Hausmannite	-6.1352	Pyrite	-151.5805
Wollastonite	-6.1365	Chalcopyrite	-155.3169
Massicot	-6.1604	PbSO4(NH3)4	-174.5523
Schoepite-dehy(.	-6.2531	U	-178.7457
Nahcolite	-6.3395	UAs	-189.5013
Pseudowollastoni	-6.4109	US	-190.5149
Mn(OH)2(am)	-6.5337	UC	-207.7075
Clinochlore-7A	-6.5523	UH3(beta)	-210.0086
Analcime-dehy	-6.6650	US1.9	-219.8957
Huntite	-6.7519	US2	-225.2422
NaFeO2	-6.7917	Mayenite	-230.5117
UO2HPO4:4H2O	-6.8136	UAs2	-241.9100
Niter	-6.9625	UP	-252.3783
Hedenbergite	-6.9766	UC1.94(alpha)	-254.4803
Cd(OH)2	-7.0157	Stibnite	-269.0514
Spinel	-7.0605	US3	-293.6891
UO3(gamma)	-7.3624	Orpiment	-294.3908
Chalcanthite	-7.5197	Pb(SCN)2	-296.6520
Melanterite	-7.5785	Bornite	-301.5776
Sepiolite	-7.6417	UP2	-370.3874
Pb2SiO4	-7.9534	U2S3	-408.3817

Artinite	-8.0026	o-Phthalic_acid	-416.3540
UO3(beta)	-8.0079	U2C3	-464.5062
Grossular	-8.0841	U3As4	-621.4843
Sanbornite	-8.3303	U3S5	-628.7206
Cordierite_anhyd	-8.3353	U3P4	-875.1448
Ca-Al_Pyroxene	-8.3694		

Gases	fugacity	log fug.
N2(g)	0.09304	-1.031
H2O(g)	0.007689	-2.114
CO2(g)	0.001095	-2.961
NO2(g)	6.132e-013	-12.212
O2(g)	5.246e-030	-29.280
H2(g)	4.775e-031	-30.321
NO(g)	5.481e-032	-31.261
CO(g)	1.786e-037	-36.748
NH3(g)	2.698e-043	-42.569
SO2(g)	1.036e-045	-44.985
Cd(g)	1.213e-052	-51.916
Pb(g)	1.700e-058	-57.769
Cu(g)	1.196e-065	-64.922
Na(g)	2.153e-075	-74.667
UO3(g)	2.169e-076	-75.664
K(g)	1.466e-076	-75.834
H2S(g)	9.378e-097	-96.028
CH4(g)	4.733e-099	-98.325
UO2(g)	8.792e-119	-118.056
Mg(g)	1.174e-125	-124.930
Ca(g)	2.499e-149	-148.602
S2(g)	8.252e-160	-159.083
C2H4(g)	7.670e-169	-168.115
C(g)	2.584e-174	-173.588
Al(g)	5.635e-181	-180.249
UO(g)	8.375e-195	-194.077
Si(g)	3.771e-208	-207.424
U(g)	2.195e-271	-270.659

		In fluid		Sorbed		Kd
Original basis	total moles	moles	mg/kg	moles	mg/kg	L/kg
Al+++	3.25e-006	3.25e-006	0.0877			
Ba++	4.97e-007	4.97e-007	0.0682			
Ca++	0.000778	0.000778	31.2			
Cd++	1.91e-008	1.91e-008	0.00214			
Cu++	6.29e-007	6.29e-007	0.0400			
Fe++	8.73e-007	8.73e-007	0.0487			
H+	5.08e-005	5.08e-005	0.0512			
H2AsO4-	2.60e-008	2.60e-008	0.00367			
H2O	55.5	55.5	1.00e+006			
HCO3-	0.00153	0.00153	93.6			
HPO4--	3.02e-006	3.02e-006	0.290			
K+	4.99e-005	4.99e-005	1.95			
Mg++	0.000281	0.000281	6.82			
Mn++	2.89e-006	2.89e-006	0.159			
NH3(aq)	0.000172	0.000172	2.93			
NO3-	0.000556	0.000556	34.5			
Na+	0.000170	0.000170	3.90			
O2(aq)	0.000129	0.000129	4.12			
Pb++	9.41e-009	9.41e-009	0.00195			
SO4--	0.000173	0.000173	16.6			
Sb(OH)3(aq)	1.20e-007	1.20e-007	0.0207			
SiO2(aq)	0.000125	0.000125	7.51			

UO2++	5.33e-009	5.33e-009	0.00144

Elemental composition		In fluid		Sorbed	
	total moles	moles	mg/kg	moles	mg/kg
Aluminum	3.252e-006	3.252e-006	0.08773		
Antimony	1.201e-007	1.201e-007	0.01462		
Arsenic	2.603e-008	2.603e-008	0.001950		
Barium	4.970e-007	4.970e-007	0.06824		
Cadmium	1.908e-008	1.908e-008	0.002145		
Calcium	0.0007785	0.0007785	31.19		
Carbon	0.001534	0.001534	18.42		
Copper	6.291e-007	6.291e-007	0.03997		
Hydrogen	111.0	111.0	1.119e+005		
Iron	8.729e-007	8.729e-007	0.04874		
Lead	9.411e-009	9.411e-009	0.001950		
Magnesium	0.0002808	0.0002808	6.824		
Manganese	2.893e-006	2.893e-006	0.1589		
Nitrogen	0.0007280	0.0007280	10.19		
Oxygen	55.52	55.52	8.880e+005		
Phosphorus	3.022e-006	3.022e-006	0.09358		
Potassium	4.987e-005	4.987e-005	1.950		
Silicon	0.0001250	0.0001250	3.509		
Sodium	0.0001696	0.0001696	3.899		
Sulfur	0.0001725	0.0001725	5.532		
Uranium	5.325e-009	5.325e-009	0.001267		

```
Temperature =  25.0 C    Pressure =  1.013 bars
pH =  7.300              log fO2 =  -30.442
Eh =   0.3470 volts      pe =   5.8659
Ionic strength      =    0.002847
Charge imbalance    =    0.000124 eq/kg (6.787% error)
Activity of water   =    1.000000
Solvent mass        =    1.000000 kg
Solution mass       =    1.000163 kg
Solution density    =    1.013    g/cm3
Chlorinity          =    0.000000 molal
Dissolved solids    =         163 mg/kg sol'n
Elect. conductivity =      172.28 uS/cm (or umho/cm)
Hardness            =       96.28 mg/kg sol'n as CaCO3
  carbonate         =       80.74 mg/kg sol'n as CaCO3
  non-carbonate     =       15.54 mg/kg sol'n as CaCO3
Rock mass           =    0.000000 kg
Carbonate alkalinity=       80.74 mg/kg sol'n as CaCO3
Water type          =    Ca-HCO3
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Nernst redox couples	Eh (volts)	pe
e- + .25*O2(aq) + H+ = .5*H2O	0.3470	5.8659
8*e- + 9*H+ + NO3- = 3*H2O + NH3(aq)	0.5596	9.4597

No minerals in system.

Aqueous species	molality	mg/kg sol'n	act. coef.	log act.
HCO3-	0.001596	97.35	0.9432	-2.8224
Ca++	0.0006747	27.04	0.7968	-3.2695
Mg++	0.0002651	6.443	0.8024	-3.6721
CO2(aq)	0.0001668	7.341	1.0000	-3.7777
SiO2(aq)	0.0001295	7.781	1.0000	-3.8876
SO4--	7.112e-005	6.830	0.7909	-4.2499
NO3-	2.883e-005	1.787	0.9423	-4.5660
CaHCO3+	9.553e-006	0.9656	0.9432	-5.0452
CaSO4(aq)	3.905e-006	0.5316	1.0000	-5.4083
MgHCO3+	3.686e-006	0.3144	0.9432	-5.4588
MgSO4(aq)	3.088e-006	0.3716	1.0000	-5.5103
N2(aq)	2.390e-006	0.06693	1.0000	-5.6217
CO3--	1.778e-006	0.1067	0.7924	-5.8512
CaCO3(aq)	1.608e-006	0.1609	1.0000	-5.7936
Mn++	8.329e-007	0.04575	0.7968	-6.1781
CuCO3(aq)	5.360e-007	0.06621	1.0000	-6.2709
HSiO3-	3.057e-007	0.02356	0.9432	-6.5401
MgCO3(aq)	2.855e-007	0.02407	1.0000	-6.5444
OH-	2.140e-007	0.003640	0.9428	-6.6951
Zn++	2.114e-007	0.01382	0.7968	-6.7735
CaNO3+	7.760e-008	0.007920	0.9432	-7.1355
Cu++	5.293e-008	0.003363	0.7968	-7.3750
H+	5.290e-008	5.331e-005	0.9474	-7.3000
CuOH+	4.602e-008	0.003706	0.9432	-7.3625
MnCO3(aq)	3.096e-008	0.003558	1.0000	-7.5093
MnSO4(aq)	8.413e-009	0.001270	1.0000	-8.0751
MnHCO3+	8.063e-009	0.0009349	0.9432	-8.1189
ZnHCO3+	7.071e-009	0.0008937	0.9432	-8.1759
ZnOH+	3.907e-009	0.0003219	0.9432	-8.4335
ZnSO4(aq)	1.918e-009	0.0003096	1.0000	-8.7172
ZnCO3(aq)	1.885e-009	0.0002363	1.0000	-8.7247
Cu(CO3)2--	1.608e-009	0.0002952	0.7909	-8.8955
CaOH+	1.606e-009	9.169e-005	0.9432	-8.8195
CuSO4(aq)	5.434e-010	8.672e-005	1.0000	-9.2649

MnOH+	3.609e-010	2.596e-005	0.9432	-9.4681
Zn(OH)2(aq)	3.150e-010	3.131e-005	1.0000	-9.5017
HSO4-	2.848e-010	2.764e-005	0.9432	-9.5708
Cu+	3.274e-011	2.080e-006	0.9432	-10.5103
MnNO3+	3.029e-011	3.542e-006	0.9432	-10.5441
CuCO3(OH)2--	2.294e-012	3.613e-007	0.7909	-11.7414
H2SiO4--	7.149e-013	6.726e-008	0.7909	-12.2476
HNO3(aq)	6.784e-014	4.274e-009	1.0000	-13.1685
Zn(OH)3-	2.065e-014	2.404e-009	0.9432	-13.7104
Mn(OH)2(aq)	1.667e-014	1.483e-009	1.0000	-13.7781
Mn2(OH)3+	4.670e-015	7.512e-010	0.9432	-14.3561
H6(H2SiO4)4--	3.245e-015	1.241e-009	0.7909	-14.5906
Mn(NO3)2(aq)	1.949e-015	3.488e-010	1.0000	-14.7101
Mn2OH+++	4.070e-016	5.163e-011	0.5948	-15.6161
CuO2--	3.001e-018	2.866e-013	0.7909	-17.6247
Mn(OH)3-	3.308e-019	3.504e-014	0.9432	-18.5059
Zn(OH)4--	8.379e-020	1.118e-014	0.7909	-19.1787
H2SO4(aq)	1.346e-020	1.320e-015	1.0000	-19.8708
H4(H2SiO4)4----	1.310e-022	4.982e-017	0.3910	-22.2906
Mg4(OH)4++++	1.444e-025	2.386e-020	0.3999	-25.2385
Mn(OH)4--	6.665e-026	8.195e-021	0.7909	-25.2781
Mn+++	2.145e-026	1.178e-021	0.5948	-25.8942
Formate	1.169e-029	5.263e-025	0.9428	-28.9577
H2(aq)	3.660e-030	7.378e-027	1.0000	-29.4365
Ca(For)+	1.692e-031	1.439e-026	0.9432	-30.7971
Mg(For)+	6.694e-032	4.640e-027	0.9432	-31.1997
NO2-	1.395e-032	6.417e-028	0.9423	-31.8812
Formic_acid(aq)	3.128e-033	1.440e-028	1.0000	-32.5047
O2(aq)	4.568e-034	1.462e-029	1.0000	-33.3402
Mn(For)+	3.886e-034	3.883e-029	0.9432	-33.4359
Zn(For)+	1.160e-034	1.280e-029	0.9432	-33.9610
NH4+	8.529e-035	1.538e-030	0.9418	-34.0951
SO3--	7.886e-035	6.313e-030	0.7924	-34.2042
HSO3-	5.328e-035	4.319e-030	0.9432	-34.2988
Cu(For)+	4.706e-035	5.108e-030	0.9432	-34.3527
CO(aq)	7.039e-036	1.971e-031	1.0000	-35.1525
HNO2(aq)	1.095e-036	5.147e-032	1.0000	-35.9606
NH3(aq)	9.202e-037	1.567e-032	1.0000	-36.0361
Oxalate	4.598e-037	4.047e-032	0.7909	-36.4393
CuNO2+	6.155e-038	6.742e-033	0.9432	-37.2361
HO2-	2.256e-038	7.445e-034	0.9432	-37.6720
CuNH3++	5.370e-040	4.326e-035	0.7924	-39.3711
H-Oxalate	3.489e-040	3.106e-035	0.9432	-39.4827
H2SO3(aq)	2.565e-040	2.105e-035	1.0000	-39.5910
SO2(aq)	1.826e-040	1.169e-035	1.0000	-39.7386
Zn(NH3)++	2.209e-041	1.820e-036	0.7924	-40.7569
MnO4--	2.339e-043	2.781e-038	0.7909	-42.7329
HSO5-	3.303e-046	3.734e-041	0.9432	-45.5065
Oxalic_acid(aq)	3.073e-046	2.767e-041	1.0000	-45.5124
MnO4-	5.969e-047	7.099e-042	0.9428	-46.2497
NH4SO4-	2.395e-047	2.733e-042	0.9432	-46.6460
S2O6--	1.788e-058	2.862e-053	0.7909	-57.8496
Ca(For)2(aq)	1.304e-059	1.697e-054	1.0000	-58.8847
Mg(For)2(aq)	5.161e-060	5.900e-055	1.0000	-59.2873
Mn(For)2(aq)	4.970e-062	7.204e-057	1.0000	-61.3036
Zn(For)2(aq)	1.704e-062	2.648e-057	1.0000	-61.7686
Cu(For)2(aq)	1.023e-062	1.570e-057	1.0000	-61.9903
S2O8--	6.793e-063	1.305e-057	0.7909	-62.2698
Formaldehyde(aq)	4.419e-064	1.327e-059	1.0000	-63.3547
Cu(NO2)2(aq)	7.810e-069	1.215e-063	1.0000	-68.1073
N3-	3.196e-071	1.343e-066	0.9432	-70.5208
Cu(NH3)2++	1.274e-072	1.243e-067	0.7924	-71.9960
HN3(aq)	7.573e-074	3.258e-069	1.0000	-73.1207

S2O5--	4.863e-074	7.008e-069	0.7909	-73.4150
Zn(NH3)2++	3.268e-075	3.250e-070	0.7924	-74.5867
Urea(aq)	2.736e-076	1.643e-071	1.0000	-75.5628
HCN(aq)	4.977e-077	1.345e-072	1.0000	-76.3030
ZnN3+	1.490e-077	1.600e-072	0.9432	-76.8523
Methanol(aq)	9.623e-079	3.083e-074	1.0000	-78.0167
CN-	6.122e-079	1.593e-074	0.9423	-78.2389
HS-	6.907e-084	2.284e-079	0.9428	-83.1863
H2S(aq)	3.172e-084	1.081e-079	1.0000	-83.4986
Glycolate	8.066e-085	6.052e-080	0.9432	-84.1187
Ca(Glyc)+	1.937e-086	2.230e-081	0.9432	-85.7383
Mg(Glyc)+	3.666e-087	3.642e-082	0.9432	-86.4612
Methane(aq)	2.612e-088	4.189e-084	1.0000	-87.5831
Glycolic_acid(aq	2.599e-088	1.977e-083	1.0000	-87.5851
Zn(Glyc)+	3.259e-089	4.577e-084	0.9432	-88.5122
Cu(Glyc)+	2.642e-089	3.661e-084	0.9432	-88.6035
Mn(Glyc)+	2.044e-089	2.656e-084	0.9432	-88.7150
S--	1.900e-089	6.092e-085	0.7939	-88.8214
S2O3--	1.390e-090	1.559e-085	0.7909	-89.9587
S2O4--	3.585e-092	4.593e-087	0.7939	-91.5457
Acetate	1.027e-093	6.061e-089	0.9437	-93.0137
Zn(For)3-	7.366e-094	1.476e-088	0.9432	-93.1581
CaCH3COO+	4.710e-096	4.668e-091	0.9432	-95.3523
MgCH3COO+	4.156e-096	3.463e-091	0.9432	-95.4067
Acetic_acid(aq)	2.776e-096	1.667e-091	1.0000	-95.5565
HS2O3-	6.033e-097	6.825e-092	0.9432	-96.2448
MnCH3COO+	1.123e-098	1.280e-093	0.9432	-97.9750
CuCH3COO+	7.391e-099	9.059e-094	0.9432	-98.1567
ZnCH3COO+	6.974e-099	8.676e-094	0.9432	-98.1819
Malonate	2.115e-102	2.158e-097	0.7909	-101.7766
CuCH3COO(aq)	6.394e-104	7.837e-099	1.0000	-103.1942
H-Malonate	4.408e-104	4.542e-099	0.9432	-103.3811
Cu(NH3)3++	7.756e-106	8.890e-101	0.7924	-105.2114
Malonic_acid(aq)	1.480e-108	1.540e-103	1.0000	-107.8298
Zn(NH3)3++	4.836e-109	5.632e-104	0.7924	-108.4165
Methanamine(aq)	2.012e-112	6.247e-108	1.0000	-111.6964
Glycine(aq)	3.614e-115	2.712e-110	1.0000	-114.4421
Cu(Gly)+	1.997e-116	2.747e-111	0.9432	-115.7250
Mg(Gly)+	7.642e-118	7.516e-113	0.9432	-117.1422
Zn(Gly)+	5.150e-119	7.181e-114	0.9432	-118.3136
Ca(Gly)+	1.534e-119	1.750e-114	0.9432	-118.8397
Mn(Gly)+	3.863e-120	4.982e-115	0.9432	-119.4385
S3O6--	5.344e-122	1.027e-116	0.7909	-121.3740
Zn(For)4--	1.718e-122	4.217e-117	0.7909	-121.8668
Acetaldehyde(aq)	5.477e-126	2.412e-121	1.0000	-125.2615
SCN-	4.873e-127	2.830e-122	0.9428	-126.3378
NH4CH3COO(aq)	1.270e-127	9.787e-123	1.0000	-126.8962
Acetamide(aq)	1.265e-127	7.471e-123	1.0000	-126.8979
Zn(NH3)4++	3.605e-143	4.812e-138	0.7924	-142.5441
Ethanol(aq)	4.310e-145	1.985e-140	1.0000	-144.3656
Ethyne(aq)	5.266e-147	1.371e-142	1.0000	-146.2785
Zn(N3)2(aq)	2.400e-147	3.586e-142	1.0000	-146.6198
Ethylene(aq)	1.475e-149	4.137e-145	1.0000	-148.8313
Lactate	4.134e-151	3.682e-146	0.9432	-150.4090
Ca(Lac)+	5.844e-153	7.546e-148	0.9432	-152.2587
Mg(Lac)+	2.062e-153	2.337e-148	0.9432	-152.7112
Lactic_acid(aq)	1.425e-154	1.284e-149	1.0000	-153.8461
Zn(Lac)+	1.103e-155	1.704e-150	0.9432	-154.9828
Mn(Lac)+	7.387e-156	1.064e-150	0.9432	-155.1569
Cu(Lac)+	6.325e-156	9.651e-151	0.9432	-155.2243
Ethane(aq)	8.763e-159	2.635e-154	1.0000	-158.0573
Propanoate	4.288e-162	3.133e-157	0.9432	-161.3931
Propanoic_acid(a	1.571e-164	1.163e-159	1.0000	-163.8039

Ca(Prop)+	1.085e-164	1.228e-159	0.9432	-163.9898
Mg(Prop)+	4.706e-165	4.581e-160	0.9432	-164.3528
Mn(Prop)+	5.329e-167	6.821e-162	0.9432	-166.2987
Cu(Prop)+	2.953e-167	4.034e-162	0.9432	-166.5551
Zn(Prop)+	1.262e-167	1.748e-162	0.9432	-166.9242
Succinate	3.108e-169	3.607e-164	0.7909	-168.6094
Ca(Glyc)2(aq)	2.417e-169	4.595e-164	1.0000	-168.6168
S4O6--	1.287e-169	2.886e-164	0.7909	-168.9923
Mg(Glyc)2(aq)	2.458e-170	4.285e-165	1.0000	-169.6095
H-Succinate	5.566e-171	6.515e-166	0.9432	-170.2799
Zn(Glyc)2(aq)	1.656e-171	3.568e-166	1.0000	-170.7809
Cu(Glyc)2(aq)	1.115e-171	2.382e-166	1.0000	-170.9527
Mn(Glyc)2(aq)	1.034e-172	2.119e-167	1.0000	-171.9856
Serine(aq)	3.912e-173	4.111e-168	1.0000	-172.4076
Succinic_acid(aq	4.243e-174	5.009e-169	1.0000	-173.3724
Ethanamine(aq)	1.238e-180	5.582e-176	1.0000	-179.9072
Alanine(aq)	2.536e-182	2.259e-177	1.0000	-181.5958
Cu(Ala)+	3.163e-184	4.796e-179	0.9432	-183.5252
Mg(Ala)+	4.495e-187	5.052e-182	0.9432	-186.3726
Zn(Ala)+	3.479e-187	5.338e-182	0.9432	-186.4840
Ca(Ala)+	2.166e-187	2.775e-182	0.9432	-186.6898
Ca(CH3COO)2(aq)	6.856e-188	1.084e-182	1.0000	-187.1639
Mn(Ala)+	2.671e-188	3.820e-183	0.9432	-187.5986
Mg(CH3COO)2(aq)	2.197e-188	3.128e-183	1.0000	-187.6582
Acetone(aq)	1.375e-189	7.986e-185	1.0000	-188.8616
Zn(CH3COO)2(aq)	4.482e-190	8.222e-185	1.0000	-189.3485
Cu(CH3COO)2(aq)	1.697e-190	3.081e-185	1.0000	-189.7704
Mn(CH3COO)2(aq)	7.149e-191	1.237e-185	1.0000	-190.1458
Aspartic_acid(aq	1.932e-192	2.571e-187	1.0000	-191.7140
Propanal(aq)	8.107e-194	4.708e-189	1.0000	-193.0911
Cu(CH3COO)2-	6.140e-197	1.115e-191	0.9432	-196.2372
1-Propyne(aq)	2.364e-211	9.470e-207	1.0000	-210.6263
S3--	1.969e-211	1.894e-206	0.7909	-210.8077
1-Propanol(aq)	2.025e-213	1.217e-208	1.0000	-212.6936
1-Propene(aq)	1.024e-215	4.309e-211	1.0000	-214.9896
2-Hydroxybutanoa	7.549e-220	7.781e-215	0.9432	-219.1475
NH4(CH3COO)2-	9.626e-221	1.310e-215	0.9432	-220.0419
2-Hydroxybutanoi	2.313e-223	2.407e-218	1.0000	-222.6359
Asparagine(aq)	1.134e-223	1.498e-218	1.0000	-222.9455
Cu(Gly)2(aq)	4.115e-226	8.708e-221	1.0000	-225.3857
Propane(aq)	1.762e-227	7.767e-223	1.0000	-226.7541
Butanoate	6.080e-231	5.295e-226	0.9432	-230.2415
Zn(Gly)2(aq)	1.569e-231	3.349e-226	1.0000	-230.8044
Mg(Gly)2(aq)	8.855e-232	1.527e-226	1.0000	-231.0528
Diglycine(aq)	3.385e-232	4.472e-227	1.0000	-231.4704
Butanoic_acid(aq	1.849e-233	1.629e-228	1.0000	-232.7330
Ca(But)+	1.060e-233	1.348e-228	0.9432	-233.0001
Mg(But)+	4.390e-234	4.890e-229	0.9432	-233.3829
Mn(Gly)2(aq)	4.086e-234	8.295e-229	1.0000	-233.3888
Diketopiperazine	2.568e-234	2.930e-229	1.0000	-233.5904
Ca(Gly)2(aq)	1.000e-235	1.882e-230	1.0000	-234.9999
Mn(But)+	6.404e-236	9.094e-231	0.9432	-235.2189
Cu(But)+	3.306e-236	4.979e-231	0.9432	-235.5061
Zn(But)+	2.823e-236	4.304e-231	0.9432	-235.5747
Glutarate	3.454e-237	4.494e-232	0.7909	-236.5635
H-Glutarate	3.791e-239	4.970e-234	0.9432	-238.4466
Threonine(aq)	5.833e-242	6.947e-237	1.0000	-241.2341
Glutaric_acid(aq	3.916e-242	5.172e-237	1.0000	-241.4072
Ethylacetate(aq)	3.443e-242	3.033e-237	1.0000	-241.4631
S5O6--	4.083e-246	1.046e-240	0.7909	-245.4909
1-Propanamine(aq	1.928e-248	1.140e-243	1.0000	-247.7148
a-Aminobutyric_a	7.684e-251	7.922e-246	1.0000	-250.1144
Glutamic_acid(aq	2.746e-259	4.039e-254	1.0000	-258.5613

Zn(SCN)2(aq)	2.697e-259	4.895e-254	1.0000	-258.5692
Butanal(aq)	4.813e-264	3.470e-259	1.0000	-263.3176
S4--	1.102e-272	1.413e-267	0.7909	-272.0598
1-Butyne(aq)	3.241e-280	1.753e-275	1.0000	-279.4894
Cu(CH3COO)3-	3.177e-282	7.646e-277	0.9432	-281.5233
Zn(CH3COO)3-	2.575e-282	6.245e-277	0.9432	-281.6145
1-Butanol(aq)	5.874e-283	4.354e-278	1.0000	-282.2310
Mn(CH3COO)3-	1.596e-283	3.704e-278	0.9432	-282.8223
1-Butene(aq)	9.206e-285	5.164e-280	1.0000	-284.0359
2-Hydroxypentano	2.032e-288	2.379e-283	0.9432	-287.7175
2-Hydroxypentano	3.752e-292	4.432e-287	1.0000	-291.4257
Glutamine(aq)	1.840e-292	2.688e-287	1.0000	-291.7352
n-Butane(aq)	3.115e-296	1.810e-291	1.0000	-295.5065
Alanylglycine(aq	1.071e-299	1.565e-294	1.0000	-298.9701
Pentanoate	1.037e-299	1.049e-294	0.9432	-299.0094
Pentanoic_acid(a	3.434e-302	3.507e-297	1.0000	-300.0000
Ca(Lac)2(aq)	2.467e-302	5.383e-297	1.0000	-300.0000
Ca(Pent)+	1.057e-302	1.493e-297	0.9432	-300.0000
Mg(Lac)2(aq)	7.946e-303	1.608e-297	1.0000	-300.0000
Mg(Pent)+	4.285e-303	5.374e-298	0.9432	-300.0000
Zn(CN)4--	1.193e-303	2.022e-298	0.7909	-300.0000
Zn(Lac)2(aq)	1.441e-304	3.508e-299	1.0000	-300.0000
Cu(Lac)2(aq)	9.063e-305	2.190e-299	1.0000	-300.0000
Mn(Pent)+	8.245e-305	1.287e-299	0.9432	-300.0000
Cu(Pent)+	5.482e-305	9.025e-300	0.9432	-300.0000
Zn(Pent)+	3.988e-305	6.640e-300	0.9432	-300.0000
Mn(Lac)2(aq)	3.193e-305	7.441e-300	1.0000	-300.0000
Adipate	1.822e-307	2.626e-302	0.7909	-300.0000
H-Adipate	1.966e-309	2.853e-304	0.9432	-300.0000
Adipic_acid(aq)	2.404e-312	3.513e-307	1.0000	-300.0000
1-Butanamine(aq)	1.733e-317	1.267e-312	1.0000	-300.0000
Valine(aq)	1.838e-319	2.153e-314	1.0000	-300.0000
Decanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Decanoate	0.0000	0.0000	0.9432	-300.0000
Decanal(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyheptano	0.0000	0.0000	0.9432	-300.0000
Mn(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxydecanoi	0.0000	0.0000	1.0000	-300.0000
1-Octyne(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Benzoic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxydecanoa	0.0000	0.0000	0.9432	-300.0000
Benzoate	0.0000	0.0000	0.9450	-300.0000
Cu(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Benzene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Octene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptyne(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Azelate	0.0000	0.0000	0.7909	-300.0000
Azelaic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hexanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Octanol(aq)	0.0000	0.0000	1.0000	-300.0000
2-Heptanone(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Methionine(aq)	0.0000	0.0000	1.0000	-300.0000
2-Butanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Octanamine(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptene(aq)	0.0000	0.0000	1.0000	-300.0000

Leucylglycine(aq	0.0000	0.0000	1.0000	-300.0000
Leucine(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
p-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Isoleucine(aq)	0.0000	0.0000	1.0000	-300.0000
o-Toluate	0.0000	0.0000	0.9432	-300.0000
o-Phthalic_acid(	0.0000	0.0000	1.0000	-300.0000
Hexanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Cu(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Hexanoate	0.0000	0.0000	0.9432	-300.0000
n-Pentane(aq)	0.0000	0.0000	1.0000	-300.0000
Hexanal(aq)	0.0000	0.0000	1.0000	-300.0000
Heptanoic_acid(a	0.0000	0.0000	1.0000	-300.0000
n-Hexylbenzene(a	0.0000	0.0000	1.0000	-300.0000
n-Hexane(aq)	0.0000	0.0000	1.0000	-300.0000
Heptanoate	0.0000	0.0000	0.9432	-300.0000
Heptanal(aq)	0.0000	0.0000	1.0000	-300.0000
n-Butylbenzene(a	0.0000	0.0000	1.0000	-300.0000
m-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
m-Toluate	0.0000	0.0000	0.9432	-300.0000
1-Hexyne(aq)	0.0000	0.0000	1.0000	-300.0000
Zn(SCN)4--	0.0000	0.0000	0.7909	-300.0000
Zn(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Zn(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Pentanone(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(o-Phthalate)(	0.0000	0.0000	1.0000	-300.0000
Ca(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Octanone(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptanol(aq)	0.0000	0.0000	1.0000	-300.0000
Zn(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Zn(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
H-Suberate	0.0000	0.0000	0.9432	-300.0000
H-Sebacate	0.0000	0.0000	0.9432	-300.0000
Undecanoic_acid(	0.0000	0.0000	1.0000	-300.0000
H-Pimelate	0.0000	0.0000	0.9432	-300.0000
Undecanoate	0.0000	0.0000	0.9432	-300.0000
Tyrosine(aq)	0.0000	0.0000	1.0000	-300.0000
Tryptophan(aq)	0.0000	0.0000	1.0000	-300.0000
Toluene(aq)	0.0000	0.0000	1.0000	-300.0000
Suberic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
H-Azelate	0.0000	0.0000	0.9432	-300.0000
2-Hydroxyoctanoi	0.0000	0.0000	1.0000	-300.0000
1-Pentyne(aq)	0.0000	0.0000	1.0000	-300.0000
Suberate	0.0000	0.0000	0.7909	-300.0000
Sebacic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Sebacate	0.0000	0.0000	0.7909	-300.0000
H(o-Phthalate)-	0.0000	0.0000	0.9432	-300.0000
2-Hydroxyoctanoa	0.0000	0.0000	0.9432	-300.0000
S5--	0.0000	0.0000	0.7909	-300.0000
2-Hydroxynonanoi	0.0000	0.0000	1.0000	-300.0000
1-Pentene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexanol(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxynonanoa	0.0000	0.0000	0.9432	-300.0000
Pimelic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Pimelate	0.0000	0.0000	0.7909	-300.0000
Phenylalanine(aq	0.0000	0.0000	1.0000	-300.0000
Ca(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Phenol(aq)	0.0000	0.0000	1.0000	-300.0000
Pentanal(aq)	0.0000	0.0000	1.0000	-300.0000
Ethylbenzene(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyhexanoi	0.0000	0.0000	1.0000	-300.0000

1-Pentanol(aq)	0.0000	0.0000	1.0000	-300.0000
Octanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Octanoate	0.0000	0.0000	0.9432	-300.0000
Ca(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Octanal(aq)	0.0000	0.0000	1.0000	-300.0000
Nonanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyhexanoa	0.0000	0.0000	0.9432	-300.0000
Nonanoate	0.0000	0.0000	0.9432	-300.0000
n-Heptane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Heptylbenzene(	0.0000	0.0000	1.0000	-300.0000
Nonanal(aq)	0.0000	0.0000	1.0000	-300.0000
Dodecanoic_acid(	0.0000	0.0000	1.0000	-300.0000
n-Octane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Octylbenzene(a	0.0000	0.0000	1.0000	-300.0000
Dodecanoate	0.0000	0.0000	0.9432	-300.0000
n-Pentylbenzene(	0.0000	0.0000	1.0000	-300.0000
n-Propylbenzene(	0.0000	0.0000	1.0000	-300.0000
o-Phthalate	0.0000	0.0000	0.7909	-300.0000
2-Hydroxyheptano	0.0000	0.0000	1.0000	-300.0000
1-Pentanamine(aq	0.0000	0.0000	1.0000	-300.0000
o-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
p-Toluate	0.0000	0.0000	0.9432	-300.0000
1-Hexanamine(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptanamine(aq	0.0000	0.0000	1.0000	-300.0000

Mineral saturation states

	log Q/K		log Q/K
Quartz	0.1117s/sat	Chalcanthite	-9.0034
Tridymite	-0.0598	ZnSO4:7H2O	-9.1551
Ice	-0.1387	ZnSO4:6H2O	-9.3388
Chalcedony	-0.1595	Manganosite	-9.5021
Tenorite	-0.4310	Hausmannite	-9.7263
Cristobalite(alp	-0.4388	Forsterite	-9.8945
Dolomite	-0.5000	Sepiolite	-10.0583
Dolomite-ord	-0.5000	Tephroite	-10.1219
Calcite	-0.6406	Mn(OH)3	-10.3354
Coesite	-0.6983	Periclase	-10.4075
Aragonite	-0.7850	Mg1.25SO4(OH)0.5	-10.4501
Cristobalite(bet	-0.8823	ZnSO4:H2O	-10.4851
SiO2(am)	-1.1740	Zn2SO4(OH)2	-10.7785
Monohydrocalcite	-1.4743	Monticellite	-11.2145
Magnesite	-1.4881	Portlandite	-11.2247
Rhodochrosite	-1.5077	Hydrozincite	-11.4199
Malachite	-1.6122	Mg1.5SO4(OH)	-11.7132
Dolomite-dis	-2.0444	Gyrolite	-11.9119
Zn2SiO4	-2.1042	MgSO4	-12.8001
ZnCO3:H2O	-2.4357	MnSO4	-13.0841
Dioptase	-2.7399	Chalcocyanite	-14.5488
Smithsonite	-2.7592	ZnSO4	-14.5686
Chrysocolla	-2.8768	Tremolite	-15.0375
Gypsum	-3.0371	Hydromagnesite	-16.7041
Anhydrite	-3.2130	Hillebrandite	-18.0457
Zincite	-3.3822	Dicalcium_silica	-18.3992
Manganite	-3.8296	Zn(NO3)2:6H2O	-19.3157
Zn(OH)2(epsilon)	-3.8360	Akermanite	-19.5055
Bassanite	-3.8579	Larnite	-19.6932
Talc	-3.9053	Lime	-21.2456
CaSO4:0.5H2O(bet	-4.0260	Anthophyllite	-21.4025
Lansfordite	-4.0354	Rankinite	-25.6917
Zn(OH)2(gamma)	-4.0567	Zn5(NO3)2(OH)8	-27.2669
Zn(OH)2(beta)	-4.1076	Tobermorite-14A	-30.5180
Nesquehonite	-4.1900	Merwinite	-31.3700

Enstatite	-4.2867	Foshagite	-32.2620
Cuprite	-4.5175	Tobermorite-11A	-32.2856
Rhodonite	-5.1958	Zn3O(SO4)2	-33.3391
Brucite	-5.3701	Afwillite	-33.8291
Brochantite	-5.3860	Todorokite	-35.4741
Antlerite	-5.9050	Tobermorite-9A	-35.7533
Epsomite	-5.9597	C	-40.9557
Chrysotile	-6.1171	Hatrurite	-43.3018
Hexahydrite	-6.1952	Zn	-44.3069
Wollastonite	-6.3177	Birnessite	-44.3427
Diopside	-6.4812	Xonotlite	-47.1697
Pentahydrite	-6.5348	Mn	-57.8584
Pseudowollastoni	-6.5569	Covellite	-60.4303
Huntite	-6.6765	S	-62.0584
Pyrolusite	-6.8116	Chalcocite	-62.1727
Okenite	-6.8264	Sphalerite	-71.2198
Mn(OH)2(am)	-6.8883	Wurtzite	-73.5192
Starkeyite	-6.9221	Alabandite	-81.6700
Bixbyite	-7.0229	Antigorite	-84.8362
Cu	-7.6166	Mg	-94.9385
Kieserite	-7.6550	Ca	-111.8459
Azurite	-7.7304	Si	-119.4533
Artinite	-7.9227	o-Phthalic_acid	-363.9855
MnO2(gamma)	-8.3294		

Gases	fugacity	log fug.
H2O(g)	0.02598	-1.585
CO2(g)	0.004911	-2.309
N2(g)	0.003670	-2.435
NO2(g)	1.264e-012	-11.898
H2(g)	4.661e-027	-26.331
O2(g)	3.615e-031	-30.442
NO(g)	2.503e-032	-31.602
CO(g)	7.150e-033	-32.146
NH3(g)	1.470e-038	-37.833
SO2(g)	1.234e-040	-39.909
Cu(g)	1.711e-060	-59.767
Zn(g)	1.210e-061	-60.917
H2S(g)	3.087e-083	-82.510
CH4(g)	1.850e-085	-84.733
Mg(g)	2.232e-115	-114.651
Ca(g)	8.372e-138	-137.077
S2(g)	9.783e-139	-138.010
C2H4(g)	3.107e-147	-146.508
C(g)	2.790e-159	-158.554
Si(g)	3.175e-191	-190.498

		In fluid		Sorbed		Kd
Original basis	total moles	moles	mg/kg	moles	mg/kg	L/kg
Ca++	0.000690	0.000690	27.6			
Cu++	6.37e-007	6.37e-007	0.0405			
H+	0.000161	0.000161	0.162			
H2O	55.5	55.5	1.00e+006			
HCO3-	0.00178	0.00178	109.			
Mg++	0.000272	0.000272	6.61			
Mn++	8.81e-007	8.81e-007	0.0484			
NH3(aq)	4.78e-006	4.78e-006	0.0814			
NO3-	2.89e-005	2.89e-005	1.79			
O2(aq)	3.24e-006	3.24e-006	0.104			
SO4--	7.81e-005	7.81e-005	7.50			
SiO2(aq)	0.000130	0.000130	7.80			

Zn++	2.27e-007	2.27e-007	0.0148

Elemental composition		In fluid		Sorbed	
	total moles	moles	mg/kg	moles	mg/kg
Calcium	0.0006899	0.0006899	27.64		
Carbon	0.001780	0.001780	21.38		
Copper	6.371e-007	6.371e-007	0.04048		
Hydrogen	111.0	111.0	1.119e+005		
Magnesium	0.0002722	0.0002722	6.615		
Manganese	8.807e-007	8.807e-007	0.04838		
Nitrogen	3.368e-005	3.368e-005	0.4717		
Oxygen	55.51	55.51	8.881e+005		
Silicon	0.0001298	0.0001298	3.646		
Sulfur	7.812e-005	7.812e-005	2.505		
Zinc	2.265e-007	2.265e-007	0.01481		

```
Temperature =  22.2 C    Pressure =  1.013 bars
pH =  7.300              log fO2 =  -24.587
Eh =   0.4420 volts      pe =   7.5432
Ionic strength      =    0.004698
Charge imbalance    =   -0.000095 eq/kg (-2.69% error)
Activity of water   =    0.999996
Solvent mass        =    1.000000 kg
Solution mass       =    1.000320 kg
Solution density    =    1.015    g/cm3
Chlorinity          =    0.000111 molal
Dissolved solids    =         320 mg/kg sol'n
Elect. conductivity =      358.14 uS/cm (or umho/cm)
Hardness            =       81.80 mg/kg sol'n as CaCO3
  carbonate         =       81.80 mg/kg sol'n as CaCO3
  non-carbonate     =        0.00 mg/kg sol'n as CaCO3
Rock mass           =    0.000000 kg
Carbonate alkalinity=       83.83 mg/kg sol'n as CaCO3
Water type          =    Na-HCO3
```

Nernst redox couples	Eh (volts)	pe
e- + .25*O2(aq) + H+ = .5*H2O	0.4420	7.5432
8*e- + 9*H+ + NO3- = 3*H2O + NH3(aq)	0.6033	10.2957

No minerals in system.

Aqueous species	molality	mg/kg sol'n	act. coef.	log act.
HCO3-	0.001658	101.2	0.9295	-2.8121
Na+	0.001326	30.48	0.9295	-2.9092
NO3-	0.0009922	61.50	0.9281	-3.0358
Ca++	0.0005886	23.58	0.7542	-3.3527
K+	0.0005534	21.63	0.9281	-3.2894
SO4--	0.0003922	37.66	0.7455	-3.5340
SiO2(aq)	0.0002013	12.09	1.0000	-3.6962
Mg++	0.0001897	4.609	0.7624	-3.8398
CO2(aq)	0.0001822	8.014	1.0000	-3.7396
N2(aq)	0.0001189	3.329	1.0000	-3.9249
Cl-	0.0001112	3.940	0.9281	-3.9865
CaSO4(aq)	1.662e-005	2.263	1.0000	-4.7792
F-	1.032e-005	0.1960	0.9288	-5.0185
MgSO4(aq)	1.019e-005	1.226	1.0000	-4.9918
Mn++	8.399e-006	0.4613	0.7542	-5.1983
CaHCO3+	8.360e-006	0.8449	0.9295	-5.1095
NaHCO3(aq)	2.875e-006	0.2414	1.0000	-5.5414
MgHCO3+	2.664e-006	0.2272	0.9295	-5.6062
CO3--	1.783e-006	0.1070	0.7477	-5.8751
KSO4-	1.234e-006	0.1668	0.9295	-5.9403
CaCO3(aq)	1.195e-006	0.1195	1.0000	-5.9228
Fe++	1.059e-006	0.05911	0.7542	-6.0977
Ba++	7.604e-007	0.1044	0.7499	-6.2439
HSiO3-	4.568e-007	0.03521	0.9295	-6.3720
MnSO4(aq)	4.088e-007	0.06171	1.0000	-6.3885
Sb(OH)3(aq)	2.105e-007	0.03635	1.0000	-6.6768
HPO4--	1.909e-007	0.01832	0.7455	-6.8467
MgCO3(aq)	1.801e-007	0.01518	1.0000	-6.7444
OH-	1.709e-007	0.002906	0.9288	-6.7993
H2PO4-	1.273e-007	0.01234	0.9295	-6.9269
Cu++	1.086e-007	0.006897	0.7542	-7.0868
H+	5.355e-008	5.396e-005	0.9359	-7.3000
MgF+	3.418e-008	0.001479	0.9295	-7.4980
NaHSiO3(aq)	2.498e-008	0.002499	1.0000	-7.6024

CaF+	2.196e-008	0.001297	0.9295	-7.6901
NaCl(aq)	2.101e-008	0.001227	1.0000	-7.6776
MgCl+	1.212e-008	0.0007240	0.9295	-7.9482
CaCl+	1.001e-008	0.0007558	0.9295	-8.0313
UO2(CO3)2--	6.828e-009	0.002663	0.7455	-8.2932
NaCO3-	6.275e-009	0.0005206	0.9295	-8.2342
KCl(aq)	1.603e-009	0.0001194	1.0000	-8.7952
HSO4-	1.419e-009	0.0001377	0.9295	-8.8798
MnCl+	1.335e-009	0.0001207	0.9295	-8.9061
UO2(CO3)3----	1.218e-009	0.0005480	0.3085	-9.4251
NaF(aq)	1.167e-009	4.900e-005	1.0000	-8.9328
HF(aq)	6.766e-010	1.353e-005	1.0000	-9.1697
BaCO3(aq)	3.180e-010	6.274e-005	1.0000	-9.4975
UO2CO3(aq)	2.308e-010	7.613e-005	1.0000	-9.6369
FeCl+	6.163e-011	5.625e-006	0.9295	-10.2419
NaOH(aq)	3.196e-011	1.278e-006	1.0000	-10.4955
BaCl+	1.948e-011	3.364e-006	0.9295	-10.7423
Sb(OH)4-	4.280e-012	8.119e-007	0.9295	-11.4003
UO2OH+	4.111e-012	1.180e-006	0.9295	-11.4178
BaF+	3.776e-012	5.901e-007	0.9295	-11.4547
PO4---	2.431e-012	2.308e-007	0.5161	-11.9015
HNO3(aq)	2.171e-012	1.368e-007	1.0000	-11.6633
Cu+	1.228e-012	7.804e-008	0.9295	-11.9424
Sb(OH)2F(aq)	1.181e-012	2.063e-007	1.0000	-11.9277
CaCl2(aq)	1.131e-012	1.255e-007	1.0000	-11.9466
HCl(aq)	1.062e-012	3.873e-008	1.0000	-11.9737
H3PO4(aq)	8.551e-013	8.377e-008	1.0000	-12.0680
Sb(OH)2+	3.917e-013	6.099e-008	0.9295	-12.4388
UO2++	4.946e-014	1.335e-008	0.7477	-13.4320
KHSO4(aq)	4.504e-014	6.131e-009	1.0000	-13.3464
UO2F+	4.266e-014	1.233e-008	0.9295	-13.4017
UO2SO4(aq)	1.191e-014	4.358e-009	1.0000	-13.9242
MgP2O7--	1.013e-014	2.007e-009	0.7455	-14.1221
HF2-	1.629e-015	6.350e-011	0.9295	-14.8199
UO2F2(aq)	1.182e-015	3.638e-010	1.0000	-14.9276
HP2O7---	5.049e-016	8.830e-011	0.5161	-15.5840
H2P2O7--	7.674e-017	1.350e-011	0.7455	-16.2425
UO2(SO4)2--	3.587e-017	1.657e-011	0.7455	-16.5729
FeCl2(aq)	3.000e-017	3.802e-012	1.0000	-16.5228
P2O7----	1.040e-017	1.809e-012	0.3085	-17.4937
UO2Cl+	5.719e-018	1.746e-012	0.9295	-17.2744
UO2F3-	2.116e-018	6.916e-013	0.9295	-17.7063
(UO2)2(OH)2++	1.440e-018	8.266e-013	0.7477	-17.9678
KP2O7---	6.594e-019	1.404e-013	0.5161	-18.4681
UO2+	3.255e-020	8.787e-015	0.9295	-19.5192
(UO2)3(OH)5+	2.942e-020	2.633e-014	0.9295	-19.5631
(UO2)3(CO3)6(6-)	4.524e-021	5.292e-015	0.0709	-21.4940
H3P2O7-	6.897e-022	1.220e-016	0.9295	-21.1931
UO2F4--	1.461e-022	5.055e-017	0.7455	-21.9628
UO2Cl2(aq)	2.802e-023	9.551e-018	1.0000	-22.5525
Mn+++	8.971e-024	4.927e-019	0.5231	-23.3286
FeCl4--	1.351e-024	2.670e-019	0.7455	-23.9969
U(OH)4(aq)	1.039e-024	3.179e-019	1.0000	-23.9834
NO2-	2.025e-027	9.315e-023	0.9281	-26.7259
H4P2O7(aq)	9.721e-028	1.729e-022	1.0000	-27.0123
O2(aq)	3.486e-028	1.115e-023	1.0000	-27.4577
HNO2(aq)	1.782e-031	8.376e-027	1.0000	-30.7491
Formate	4.934e-033	2.221e-028	0.9288	-32.3388
H2(aq)	1.411e-033	2.843e-030	1.0000	-32.8505
ClO-	1.238e-033	6.365e-029	0.9295	-32.9392
Ca(For)+	6.097e-035	5.187e-030	0.9295	-34.2466
Mg(For)+	2.068e-035	1.433e-030	0.9295	-34.7161
HO2-	1.154e-035	3.807e-031	0.9295	-34.9696

Na(For)(aq)	6.481e-036	4.406e-031	1.0000	-35.1883
K(For)(aq)	2.523e-036	2.122e-031	1.0000	-35.5980
Mn(For)+	1.648e-036	1.646e-031	0.9295	-35.8149
Formic_acid(aq)	1.317e-036	6.059e-032	1.0000	-35.8805
MnO4--	9.528e-037	1.133e-031	0.7455	-36.1485
SiF6--	3.694e-037	5.247e-032	0.7455	-36.5600
Fe(For)+	2.834e-037	2.858e-032	0.9295	-36.5793
SO3--	1.709e-037	1.368e-032	0.7477	-36.8936
HSO3-	1.092e-037	8.853e-033	0.9295	-36.9934
Ba(For)+	6.760e-038	1.232e-032	0.9295	-37.2018
Cu(For)+	4.123e-038	4.474e-033	0.9295	-37.4166
MnO4-	7.791e-039	9.264e-034	0.9288	-38.1405
NH4+	7.374e-039	1.330e-034	0.9273	-38.1650
CO(aq)	2.822e-039	7.903e-035	1.0000	-38.5494
Oxalate	2.026e-040	1.783e-035	0.7455	-39.8209
NH3(aq)	6.358e-041	1.083e-036	1.0000	-40.1966
UOH+++	2.947e-042	7.514e-037	0.5231	-41.8120
UF3+	9.565e-043	2.821e-037	0.9295	-42.0511
HSO5-	8.903e-043	1.006e-037	0.9295	-42.0822
UF2++	5.872e-043	1.620e-037	0.7477	-42.3575
SO2(aq)	3.508e-043	2.247e-038	1.0000	-42.4549
U(CO3)5(6-)	1.853e-043	9.968e-038	0.0709	-43.8816
H-Oxalate	1.458e-043	1.297e-038	0.9295	-42.8681
UF4(aq)	7.843e-044	2.462e-038	1.0000	-43.1055
UF+++	1.081e-044	2.777e-039	0.5231	-44.2476
U(SO4)2(aq)	5.590e-046	2.404e-040	1.0000	-45.2526
USO4++	3.991e-046	1.333e-040	0.7477	-45.5252
U++++	1.032e-048	2.456e-043	0.3196	-48.4817
Oxalic_acid(aq)	1.259e-049	1.134e-044	1.0000	-48.8998
UCl+++	3.574e-051	9.770e-046	0.5231	-50.7283
ClO2-	1.881e-055	1.268e-050	0.9295	-54.7573
S2O8--	8.068e-059	1.550e-053	0.7455	-58.2208
S2O6--	1.466e-060	2.347e-055	0.7455	-59.9613
ClO3-	2.799e-063	2.335e-058	0.9288	-62.5851
U+++	4.904e-066	1.167e-060	0.5231	-65.5909
Ca(For)2(aq)	2.021e-066	2.628e-061	1.0000	-65.6945
Mg(For)2(aq)	7.156e-067	8.179e-062	1.0000	-66.1454
Mn(For)2(aq)	9.210e-068	1.335e-062	1.0000	-67.0357
Fe(For)2(aq)	2.025e-068	2.953e-063	1.0000	-67.6936
Na(For)2-	1.809e-068	2.044e-063	0.9295	-67.7742
K(For)2-	6.539e-069	8.441e-064	0.9295	-68.2163
Cu(For)2(aq)	3.977e-069	6.106e-064	1.0000	-68.4004
Ba(For)2(aq)	1.966e-069	4.468e-064	1.0000	-68.7065
Formaldehyde(aq)	7.136e-071	2.142e-066	1.0000	-70.1466
N3-	6.595e-071	2.771e-066	0.9295	-70.2125
HN3(aq)	1.712e-073	7.365e-069	1.0000	-72.7665
ClO4-	1.989e-075	1.978e-070	0.9288	-74.7334
UO2ClO3+	3.268e-076	1.155e-070	0.9295	-75.5174
S2O5--	2.113e-079	3.045e-074	0.7455	-78.8026
Cu(NH3)2++	1.520e-080	1.483e-075	0.7477	-79.9445
Urea(aq)	1.561e-084	9.371e-080	1.0000	-83.8066
HCN(aq)	1.242e-084	3.356e-080	1.0000	-83.9058
CN-	1.271e-086	3.306e-082	0.9281	-85.9282
Methanol(aq)	8.791e-089	2.816e-084	1.0000	-88.0560
Glycolate	7.590e-095	5.694e-090	0.9295	-94.1515
HS-	2.020e-096	6.678e-092	0.9288	-95.7268
Ca(Glyc)+	1.576e-096	1.814e-091	0.9295	-95.8341
H2S(aq)	1.021e-096	3.477e-092	1.0000	-95.9911
Mg(Glyc)+	2.451e-097	2.434e-092	0.9295	-96.6424
Na(Glyc)(aq)	1.005e-097	9.846e-093	1.0000	-96.9980
K(Glyc)(aq)	3.911e-098	4.463e-093	1.0000	-97.4077
Glycolic_acid(aq	2.433e-098	1.850e-093	1.0000	-97.6139
Mn(Glyc)+	1.941e-098	2.523e-093	0.9295	-97.7436

Fe(Glyc)+	9.907e-099	1.296e-093	0.9295	-98.0358
Cu(Glyc)+	5.309e-099	7.355e-094	0.9295	-98.3068
Ba(Glyc)+	4.436e-100	9.418e-095	0.9295	-99.3847
S2O4--	7.693e-101	9.854e-096	0.7499	-100.2389
Methane(aq)	1.523e-101	2.443e-097	1.0000	-100.8172
S--	4.733e-102	1.517e-097	0.7499	-101.4499
S2O3--	2.357e-102	2.642e-097	0.7455	-101.7553
Acetate	5.989e-107	3.535e-102	0.9302	-106.2540
CaCH3COO+	2.330e-109	2.309e-104	0.9295	-108.6644
MgCH3COO+	1.767e-109	1.473e-104	0.9295	-108.7844
Acetic_acid(aq)	1.601e-109	9.610e-105	1.0000	-108.7957
NaCH3COO(aq)	5.554e-110	4.555e-105	1.0000	-109.2554
KCH3COO(aq)	1.558e-110	1.529e-105	1.0000	-109.8073
MnCH3COO+	6.557e-111	7.472e-106	0.9295	-110.2150
FeCH3COO+	9.787e-112	1.124e-106	0.9295	-111.0411
CuCH3COO+	9.066e-112	1.111e-106	0.9295	-111.0743
BaCH3COO+	3.333e-112	6.543e-107	0.9295	-111.5089
Malonate	1.236e-115	1.261e-110	0.7455	-115.0355
H-Malonate	2.435e-117	2.508e-112	0.9295	-116.6453
Cu(NH3)3++	6.997e-118	8.019e-113	0.7477	-117.2813
CuCH3COO(aq)	1.418e-118	1.738e-113	1.0000	-117.8483
Malonic_acid(aq)	8.113e-122	8.440e-117	1.0000	-121.0908
Methanamine(aq)	1.416e-126	4.397e-122	1.0000	-125.8489
Glycine(aq)	3.074e-129	2.307e-124	1.0000	-128.5123
Cu(Gly)+	3.182e-130	4.377e-125	0.9295	-129.5291
Mg(Gly)+	3.976e-132	3.910e-127	0.9295	-131.4323
S3O6--	3.148e-133	6.049e-128	0.7455	-132.6295
Mn(Gly)+	2.784e-133	3.590e-128	0.9295	-132.5871
Fe(Gly)+	1.595e-133	2.071e-128	0.9295	-132.8291
Ca(Gly)+	8.868e-134	1.012e-128	0.9295	-133.0839
Ba(Gly)+	1.528e-136	3.229e-131	0.9295	-135.8477
Acetaldehyde(aq)	1.239e-142	5.456e-138	1.0000	-141.9069
SCN-	9.791e-144	5.685e-139	0.9288	-143.0413
NH4CH3COO(aq)	6.311e-145	4.863e-140	1.0000	-144.1999
Acetamide(aq)	5.970e-145	3.525e-140	1.0000	-144.2241
UO2SCN+	9.150e-156	3.001e-150	0.9295	-155.0703
Ethyne(aq)	6.987e-164	1.819e-159	1.0000	-163.1557
Ethanol(aq)	5.005e-165	2.305e-160	1.0000	-164.3006
Ethylene(aq)	1.493e-169	4.187e-165	1.0000	-168.8259
Lactate	4.893e-171	4.357e-166	0.9295	-170.3422
Ca(Lac)+	6.020e-173	7.772e-168	0.9295	-172.2522
Mg(Lac)+	1.717e-173	1.946e-168	0.9295	-172.7971
Na(Lac)(aq)	6.546e-174	7.333e-169	1.0000	-173.1840
K(Lac)(aq)	2.549e-174	3.266e-169	1.0000	-173.5937
Lactic_acid(aq)	1.674e-174	1.508e-169	1.0000	-173.7761
Mn(Lac)+	8.889e-175	1.280e-169	0.9295	-174.0829
Fe(Lac)+	5.623e-175	8.146e-170	0.9295	-174.2818
Cu(Lac)+	1.603e-175	2.446e-170	0.9295	-174.8267
Ba(Lac)+	1.244e-176	2.814e-171	0.9295	-175.9371
Ethane(aq)	5.864e-182	1.763e-177	1.0000	-181.2318
Propanoate	2.998e-185	2.190e-180	0.9295	-184.5549
Propanoic_acid(a	1.084e-187	8.027e-183	1.0000	-186.9650
Ca(Prop)+	6.503e-188	7.356e-183	0.9295	-187.2186
Na(Prop)(aq)	3.953e-188	3.796e-183	1.0000	-187.4031
Mg(Prop)+	2.419e-188	2.355e-183	0.9295	-187.6481
K(Prop)(aq)	1.539e-188	1.726e-183	1.0000	-187.8127
USCN+++	6.061e-189	1.794e-183	0.5231	-188.4989
Mn(Prop)+	3.785e-189	4.843e-184	0.9295	-188.4537
Ca(Glyc)2(aq)	1.917e-189	3.644e-184	1.0000	-188.7174
Fe(Prop)+	1.037e-189	1.336e-184	0.9295	-189.0161
S4O6--	6.950e-190	1.558e-184	0.7455	-189.2856
Cu(Prop)+	4.399e-190	6.007e-185	0.9295	-189.3884
Mg(Glyc)2(aq)	1.643e-190	2.865e-185	1.0000	-189.7843

Fe(Glyc)2(aq)	3.360e-191	6.917e-186	1.0000	-190.4737
Ba(Prop)+	2.360e-191	4.964e-186	0.9295	-190.6588
Cu(Glyc)2(aq)	2.259e-191	4.825e-186	1.0000	-190.6460
Mn(Glyc)2(aq)	9.594e-192	1.966e-186	1.0000	-191.0180
Na(Glyc)2-	6.739e-192	1.166e-186	0.9295	-191.2032
K(Glyc)2-	2.447e-192	4.629e-187	0.9295	-191.6431
Succinate	2.244e-192	2.604e-187	0.7455	-191.7765
Ba(Glyc)2(aq)	1.492e-193	4.287e-188	1.0000	-192.8262
Serine(aq)	6.754e-194	7.096e-189	1.0000	-193.1704
H-Succinate	3.871e-194	4.531e-189	0.9295	-193.4439
Succinic_acid(aq	2.965e-197	3.500e-192	1.0000	-196.5280
Ethanamine(aq)	1.064e-204	4.795e-200	1.0000	-203.9731
Alanine(aq)	2.713e-206	2.417e-201	1.0000	-205.5665
Cu(Ala)+	6.386e-208	9.680e-203	0.9295	-207.2265
Fe(Ala)+	1.535e-210	2.209e-205	0.9295	-209.8456
Mg(Ala)+	2.844e-211	3.195e-206	0.9295	-210.5779
Mn(Ala)+	2.372e-211	3.391e-206	0.9295	-210.6567
Ca(Ala)+	1.571e-211	2.013e-206	0.9295	-210.8355
Ca(CH3COO)2(aq)	2.063e-214	3.262e-209	1.0000	-213.6855
Ba(Ala)+	1.042e-214	2.349e-209	0.9295	-214.0138
Mg(CH3COO)2(aq)	5.865e-215	8.349e-210	1.0000	-214.2317
Acetone(aq)	4.051e-216	2.352e-211	1.0000	-215.3924
Mn(CH3COO)2(aq)	2.549e-216	4.410e-211	1.0000	-215.5936
Aspartic_acid(aq	2.043e-216	2.719e-211	1.0000	-215.6896
Na(CH3COO)2-	1.506e-216	2.124e-211	0.9295	-215.8540
Cu(CH3COO)2(aq)	1.301e-216	2.363e-211	1.0000	-215.8857
Fe(CH3COO)2(aq)	8.807e-217	1.531e-211	1.0000	-216.0552
K(CH3COO)2-	3.038e-217	4.773e-212	0.9295	-216.5492
Ba(CH3COO)2(aq)	5.736e-218	1.465e-212	1.0000	-217.2414
Propanal(aq)	2.221e-220	1.290e-215	1.0000	-219.6534
Cu(CH3COO)2-	8.814e-225	1.601e-219	0.9295	-224.0865
1-Propyne(aq)	4.120e-238	1.650e-233	1.0000	-237.3851
S3--	2.643e-242	2.542e-237	0.7455	-241.7054
1-Propanol(aq)	2.829e-243	1.700e-238	1.0000	-242.5483
1-Propene(aq)	1.298e-245	5.461e-241	1.0000	-244.8867
2-Hydroxybutanoa	1.057e-249	1.090e-244	0.9295	-249.0076
NH4(CH3COO)2-	3.004e-251	4.088e-246	0.9295	-250.5540
Asparagine(aq)	9.670e-252	1.277e-246	1.0000	-251.0146
2-Hydroxybutanoi	3.218e-253	3.349e-248	1.0000	-252.4924
Cu(Gly)2(aq)	5.350e-254	1.132e-248	1.0000	-253.2717
Mg(Gly)2(aq)	3.485e-260	6.007e-255	1.0000	-259.4578
Diglycine(aq)	2.393e-260	3.161e-255	1.0000	-259.6210
Propane(aq)	1.403e-260	6.187e-256	1.0000	-259.8528
Fe(Gly)2(aq)	2.226e-261	4.540e-256	1.0000	-260.6524
Mn(Gly)2(aq)	2.164e-261	4.393e-256	1.0000	-260.6647
Diketopiperazine	1.592e-262	1.816e-257	1.0000	-261.7980
Butanoate	5.047e-264	4.395e-259	0.9295	-263.3287
Ca(Gly)2(aq)	3.982e-264	7.492e-259	1.0000	-263.3999
Butanoic_acid(aq	1.509e-266	1.329e-261	1.0000	-265.8213
Ba(Gly)2(aq)	8.735e-267	2.493e-261	1.0000	-266.0587
Ca(But)+	7.564e-267	9.617e-262	0.9295	-266.1530
Na(But)(aq)	6.367e-267	7.007e-262	1.0000	-266.1960
Mg(But)+	2.687e-267	2.993e-262	0.9295	-266.6024
K(But)(aq)	2.479e-267	3.128e-262	1.0000	-266.6057
Mn(But)+	5.429e-268	7.708e-263	0.9295	-267.2971
Fe(But)+	1.791e-268	2.559e-263	0.9295	-267.7787
Cu(But)+	5.873e-269	8.845e-264	0.9295	-268.2629
Glutarate	2.999e-270	3.900e-265	0.7455	-269.6506
Ba(But)+	2.680e-270	6.013e-265	0.9295	-269.6036
H-Glutarate	3.139e-272	4.115e-267	0.9295	-271.5349
Threonine(aq)	1.191e-272	1.418e-267	1.0000	-271.9241
Glutaric_acid(aq	3.220e-275	4.253e-270	1.0000	-274.4921
Ethylacetate(aq)	2.341e-275	2.062e-270	1.0000	-274.6305

S5O6--	1.321e-275	3.385e-270	0.7455	-275.0067
1-Propanamine(aq	2.000e-282	1.182e-277	1.0000	-281.6990
a-Aminobutyric_a	9.783e-285	1.009e-279	1.0000	-284.0095
Glutamic_acid(aq	3.425e-293	5.038e-288	1.0000	-292.4653
UO2(SCN)2(aq)	5.042e-299	1.947e-293	1.0000	-298.2974
Butanal(aq)	1.512e-300	1.090e-295	1.0000	-299.8206
S4--	1.089e-312	1.396e-307	0.7455	-300.0000
1-Butyne(aq)	6.690e-317	3.618e-312	1.0000	-300.0000
Cu(CH3COO)3-	1.665e-321	4.006e-316	0.9295	-300.0000
Mn(CH3COO)3-	3.755e-322	8.711e-317	0.9295	-300.0000
1-Butanol(aq)	9.387e-323	6.956e-318	1.0000	-300.0000
Ba(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
K(Prop)2-	0.0000	0.0000	0.9295	-300.0000
Cu(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
K(Pent)2-	0.0000	0.0000	0.9295	-300.0000
K(Pent)(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
K(Lac)2-	0.0000	0.0000	0.9295	-300.0000
2-Hexanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexyne(aq)	0.0000	0.0000	1.0000	-300.0000
K(But)2-	0.0000	0.0000	0.9295	-300.0000
Azelate	0.0000	0.0000	0.7455	-300.0000
Isoleucine(aq)	0.0000	0.0000	1.0000	-300.0000
Hexanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Hexanoate	0.0000	0.0000	0.9295	-300.0000
Azelaic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
2-Heptanone(aq)	0.0000	0.0000	1.0000	-300.0000
Hexanal(aq)	0.0000	0.0000	1.0000	-300.0000
Heptanoic_acid(a	0.0000	0.0000	1.0000	-300.0000
Heptanoate	0.0000	0.0000	0.9295	-300.0000
Heptanal(aq)	0.0000	0.0000	1.0000	-300.0000
p-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
o-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
HSb2S4-	0.0000	0.0000	0.9295	-300.0000
o-Toluate	0.0000	0.0000	0.9295	-300.0000
o-Phthalate	0.0000	0.0000	0.7455	-300.0000
n-Propylbenzene(	0.0000	0.0000	1.0000	-300.0000
n-Pentylbenzene(	0.0000	0.0000	1.0000	-300.0000
2-Butanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexene(aq)	0.0000	0.0000	1.0000	-300.0000
n-Octylbenzene(a	0.0000	0.0000	1.0000	-300.0000
n-Octane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Hexylbenzene(a	0.0000	0.0000	1.0000	-300.0000
n-Heptylbenzene(	0.0000	0.0000	1.0000	-300.0000
n-Heptane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Butylbenzene(a	0.0000	0.0000	1.0000	-300.0000
Alanylglycine(aq	0.0000	0.0000	1.0000	-300.0000
m-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
m-Toluate	0.0000	0.0000	0.9295	-300.0000
Valine(aq)	0.0000	0.0000	1.0000	-300.0000
Undecanoic_acid(	0.0000	0.0000	1.0000	-300.0000
Undecanoate	0.0000	0.0000	0.9295	-300.0000
Ca(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Adipic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(Pent)+	0.0000	0.0000	0.9295	-300.0000
Ca(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Adipate	0.0000	0.0000	0.7455	-300.0000
1-Hexanol(aq)	0.0000	0.0000	1.0000	-300.0000
UO2(SCN)3-	0.0000	0.0000	0.9295	-300.0000
H-Suberate	0.0000	0.0000	0.9295	-300.0000
U(SCN)2++	0.0000	0.0000	0.7477	-300.0000

H-Sebacate	0.0000	0.0000	0.9295	-300.0000
H-Pimelate	0.0000	0.0000	0.9295	-300.0000
Tryptophan(aq)	0.0000	0.0000	1.0000	-300.0000
Toluene(aq)	0.0000	0.0000	1.0000	-300.0000
Suberic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Suberate	0.0000	0.0000	0.7455	-300.0000
H-Azelate	0.0000	0.0000	0.9295	-300.0000
H-Adipate	0.0000	0.0000	0.9295	-300.0000
Sebacic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Sebacate	0.0000	0.0000	0.7455	-300.0000
Sb2S4--	0.0000	0.0000	0.7455	-300.0000
1-Hexanamine(aq)	0.0000	0.0000	1.0000	-300.0000
1-Butene(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
S5--	0.0000	0.0000	0.7455	-300.0000
Glutamine(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Pentanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Pentyne(aq)	0.0000	0.0000	1.0000	-300.0000
Pimelic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Pimelate	0.0000	0.0000	0.7455	-300.0000
2-Octanone(aq)	0.0000	0.0000	1.0000	-300.0000
Phenylalanine(aq	0.0000	0.0000	1.0000	-300.0000
Phenol(aq)	0.0000	0.0000	1.0000	-300.0000
Pentanoic_acid(a	0.0000	0.0000	1.0000	-300.0000
Pentanoate	0.0000	0.0000	0.9295	-300.0000
Fe(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Pentanal(aq)	0.0000	0.0000	1.0000	-300.0000
Fe(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxypentano	0.0000	0.0000	1.0000	-300.0000
1-Pentene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptyne(aq)	0.0000	0.0000	1.0000	-300.0000
Octanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Fe(Pent)+	0.0000	0.0000	0.9295	-300.0000
Octanoate	0.0000	0.0000	0.9295	-300.0000
Octanal(aq)	0.0000	0.0000	1.0000	-300.0000
Fe(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Nonanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Nonanoate	0.0000	0.0000	0.9295	-300.0000
2-Hydroxypentano	0.0000	0.0000	0.9295	-300.0000
Nonanal(aq)	0.0000	0.0000	1.0000	-300.0000
Benzoic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyoctanoi	0.0000	0.0000	1.0000	-300.0000
1-Pentanol(aq)	0.0000	0.0000	1.0000	-300.0000
Na(Prop)2-	0.0000	0.0000	0.9295	-300.0000
Na(Pent)2-	0.0000	0.0000	0.9295	-300.0000
Benzoate	0.0000	0.0000	0.9322	-300.0000
Na(Pent)(aq)	0.0000	0.0000	1.0000	-300.0000
Na(Lac)2-	0.0000	0.0000	0.9295	-300.0000
Tyrosine(aq)	0.0000	0.0000	1.0000	-300.0000
Fe(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Benzene(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyoctanoa	0.0000	0.0000	0.9295	-300.0000
Fe(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Na(But)2-	0.0000	0.0000	0.9295	-300.0000
2-Hydroxynonanoi	0.0000	0.0000	1.0000	-300.0000
1-Pentanamine(aq	0.0000	0.0000	1.0000	-300.0000
1-Heptene(aq)	0.0000	0.0000	1.0000	-300.0000
Ethylbenzene(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxynonanoa	0.0000	0.0000	0.9295	-300.0000
Mn(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Dodecanoic_acid(	0.0000	0.0000	1.0000	-300.0000
Mn(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000

Dodecanoate	0.0000	0.0000	0.9295	-300.0000
Ba(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyhexanoi	0.0000	0.0000	1.0000	-300.0000
1-Octyne(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Pent)+	0.0000	0.0000	0.9295	-300.0000
Mn(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Decanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Decanoate	0.0000	0.0000	0.9295	-300.0000
Ba(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyhexanoa	0.0000	0.0000	0.9295	-300.0000
Decanal(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Pent)+	0.0000	0.0000	0.9295	-300.0000
Mn(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyheptano	0.0000	0.0000	1.0000	-300.0000
1-Octene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptanol(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyheptano	0.0000	0.0000	0.9295	-300.0000
Mg(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Pent)+	0.0000	0.0000	0.9295	-300.0000
Mg(Pent)+	0.0000	0.0000	0.9295	-300.0000
Mg(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
n-Butane(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxydecanoi	0.0000	0.0000	1.0000	-300.0000
1-Octanol(aq)	0.0000	0.0000	1.0000	-300.0000
n-Hexane(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxydecanoa	0.0000	0.0000	0.9295	-300.0000
n-Pentane(aq)	0.0000	0.0000	1.0000	-300.0000
Methionine(aq)	0.0000	0.0000	1.0000	-300.0000
Leucylglycine(aq	0.0000	0.0000	1.0000	-300.0000
Leucine(aq)	0.0000	0.0000	1.0000	-300.0000
1-Octanamine(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptanamine(aq	0.0000	0.0000	1.0000	-300.0000
p-Toluate	0.0000	0.0000	0.9295	-300.0000
1-Butanamine(aq)	0.0000	0.0000	1.0000	-300.0000
(NH4)2Sb2S4(aq)	0.0000	0.0000	1.0000	-300.0000

Mineral saturation states

	log Q/K		log Q/K
Fluorapatite	4.4547s/sat	UO2F2	-16.2942
Witherite	1.2729s/sat	BaCl2	-16.5006
Quartz	0.3897s/sat	MgOHCl	-16.6410
Barite	0.2517s/sat	Natrosilite	-16.7756
Tridymite	0.1935s/sat	MnCl2:2H2O	-17.2331
Chalcedony	0.1158s/sat	Na2SiO3	-17.2704
Ice	-0.1278	Ba2Si3O8	-17.7791
Cristobalite(alp	-0.1674	Hydromagnesite	-18.0045
Tenorite	-0.2538	Hillebrandite	-18.3446
Coesite	-0.4278	Dicalcium_silica	-18.7223
Rhodochrosite	-0.5504	MnCl2:H2O	-18.8051
Cristobalite(bet	-0.6194	CuCl2	-18.8686
Calcite	-0.7543	UO2SO4	-19.0692
Dolomite	-0.8253	MgCl2:4H2O	-19.2401
Dolomite-ord	-0.8253	Akermanite	-19.8965
Aragonite	-0.8987	Larnite	-20.0326

SiO2(am)	-0.9211	UO2.3333(beta)	-20.0910
Malachite	-1.1531	Na2UO4(alpha)	-20.3766
Siderite	-1.4690	Ningyoite	-21.1976
Monohydrocalcite	-1.5807	Anthophyllite	-21.6380
Magnesite	-1.7176	Lime	-21.6653
Bixbyite	-2.2272	UO2(NO3)2:6H2O	-21.7848
Dioptase	-2.2938	Scacchite	-22.0679
Dolomite-dis	-2.3910	UOFOH:.5H2O	-22.3350
Gypsum	-2.3961	UOFOH	-22.8005
Anhydrite	-2.5994	UO2Cl	-23.0213
Ferrosilite	-2.7104	UO2(NO3)2:3H2O	-23.2317
Pyrolusite	-2.8799	Hydrophilite	-23.2499
Bassanite	-3.2454	Lawrencite	-23.3025
Minnesotaite	-3.3193	UO2(NO3)2:2H2O	-24.4872
Fluorite	-3.3208	MgCl2:2H2O	-24.7399
CaSO4:0.5H2O(bet	-3.4171	K2UO4	-24.9758
Schoepite	-3.7538	UOF2:H2O	-25.2756
CaUO4	-3.7567	UO2(PO3)2	-25.5274
UO3:2H2O	-3.7567	(UO2)3(PO4)2	-25.6110
Talc	-3.7783	UOF2	-25.8492
Brochantite	-3.7876	Rankinite	-26.0237
UO2(OH)2(beta)	-3.8789	(UO2)2P2O7	-26.0379
UO3:.9H2O(alpha)	-3.9434	UO2Cl2:3H2O	-27.0967
Schoepite-dehy(.	-3.9480	UO2(NO3)2:H2O	-28.1034
Schoepite-dehy(.	-4.0246	MgCl2:H2O	-28.1290
Schoepite-dehy(1	-4.0326	UP2O7	-29.2314
Hausmannite	-4.0858	U(HPO4)2:4H2O	-29.2675
Rhodonite	-4.1070	UO2Cl2:H2O	-29.8236
Sb2O3	-4.2838	Tobermorite-14A	-30.0174
Enstatite	-4.3756	UO2(NO3)2	-31.5982
Sellaite	-4.5025	Tobermorite-11A	-31.8766
Nesquehonite	-4.7243	Ba2SiO4	-31.9576
Greenalite	-4.7811	Merwinite	-32.0898
UO2CO3	-4.8489	Foshagite	-32.5575
Rutherfordine	-4.8701	KMgCl3:2H2O	-33.1885
Whitlockite	-5.1054	UO2Cl2	-33.7288
Schoepite-dehy(.	-5.1491	Chloromagnesite	-33.9389
FeO	-5.2121	Afwillite	-34.1880
Hydroxylapatite	-5.3279	UO2SO3	-34.3260
Fe(OH)2	-5.5669	UF4:2.5H2O	-35.1321
Nahcolite	-5.5804	Tobermorite-9A	-35.4173
Schoepite-dehy(.	-5.6734	BaSiF6	-36.8928
Brucite	-5.7304	Fe	-37.4435
Fayalite	-6.0349	UF4	-39.3737
Niter	-6.0523	BaO	-39.9161
Mn(OH)2(am)	-6.0722	KMgCl3	-40.5681
Wollastonite	-6.3127	U(SO4)2:8H2O	-43.0557
Okenite	-6.5054	Hatrurite	-44.0852
Diopside	-6.5211	U(SO4)2:4H2O	-44.1418
Chrysotile	-6.5536	U(SO4)2	-44.2019
Pseudowollastoni	-6.5569	Ba2U2O7	-44.5887
UO3(gamma)	-6.6821	Xonotlite	-47.2993
Atacamite	-7.0223	U(CO3)2	-47.3224
Azurite	-7.0482	C	-47.5000
UO2HPO4:4H2O	-7.2276	UOCl2	-47.5549
Melanterite	-7.2530	UClF3	-50.1276
UO3(beta)	-7.2908	UOF4	-52.9249
Cuprite	-7.3348	U5O12Cl	-53.5951
Hedenbergite	-7.4048	Na3UO4	-55.8125
Huntite	-7.4994	Na	-56.7817
UO3(alpha)	-7.6251	Na4SiO4	-57.3170
Chalcanthite	-7.9858	(UO2)2Cl3	-57.8778
Mirabilite	-8.0789	UOCl3	-58.8764

Sylvite	-8.0864	Na2O	-59.2564
Tephroite	-8.2194	Mn	-60.6862
Arcanite	-8.2577	UF5(beta)	-60.6958
Artinite	-8.4696	K	-60.7858
Halite	-8.4699	UF5(alpha)	-61.0437
Sanbornite	-8.5051	UF3	-61.2138
UO2FOH:2H2O	-8.5262	UCl2F2	-63.1970
Manganosite	-8.7320	UOCl	-65.5539
BaUO4	-8.9111	Ba3UO6	-69.0843
UO2FOH:H2O	-8.9188	U2O3F6	-69.3692
Thenardite	-9.0336	S	-71.1977
Nantokite	-9.0945	Covellite	-72.4994
UO2FOH	-9.3768	UCl3F	-76.0894
Sepiolite	-9.6744	K2O	-76.7607
Nitrobarite	-9.7821	Chalcocite	-77.2196
Mg1.25SO4(OH)0.5	-10.0986	Na6Si2O7	-83.4274
Forsterite	-10.3629	U(SO3)2	-85.4773
Saleeite	-10.5181	UCl4	-86.8123
Cu	-10.6376	UF6	-90.6009
Periclase	-10.8344	Troilite	-90.7117
Natron	-10.8550	UCl3	-90.7695
UO2.25	-10.9973	Pyrrhotite	-90.8117
UO2SO4:H2O	-11.0019	Antigorite	-91.1631
UO2.25(beta)	-11.0596	U3O5F8	-92.7224
Na2CO3:7H2O	-11.2313	Alabandite	-93.2655
MgUO4	-11.4207	U2F9	-96.9070
Mg1.5SO4(OH)	-11.4530	Mg	-99.3397
MnSO4	-11.4883	UCl5	-106.3783
Portlandite	-11.5319	U2O2Cl5	-107.6342
Gyrolite	-11.5617	UN1.73(alpha)	-110.6359
Monticellite	-11.5824	BaS	-111.0869
BaU2O7	-11.5956	UN1.59(alpha)	-113.3393
Na2U2O7	-11.7777	Ca	-116.2982
Thermonatrite	-12.3372	Ba	-120.5791
MgSO4	-12.3956	P	-120.6842
FeSO4	-12.4013	UCl6	-124.7834
(UO2)3(PO4)2:4H2	-12.4256	UN	-126.1350
UO2ClOH:2H2O	-12.4805	Si	-126.6145
Uranocircite	-12.5094	Pyrite	-151.4714
Na2CO3	-12.5768	Chalcopyrite	-157.2407
Torbernite	-12.8778	U	-172.6566
UO2.6667	-13.1946	U4F17	-174.7821
Chalcocyanite	-13.6621	US	-187.0692
FeF2	-13.8313	UC	-202.6594
UPO5	-14.0213	UH3(beta)	-204.3249
BaCl2:2H2O	-14.4252	US1.9	-217.7894
Bassetite	-14.5164	US2	-223.1791
Uraninite	-14.5859	UP	-246.2837
Tremolite	-14.9731	UC1.94(alpha)	-249.3459
Coffinite	-15.0078	Stibnite	-268.7128
BaCl2:H2O	-15.0630	US3	-291.1878
Autunite-H	-15.2668	Bornite	-311.2840
UO2SO4:3.5H2O	-15.5292	UP2	-361.8918
UO2SO4:2.5H2O	-15.5328	U2S3	-403.2440
UO2SO4:3H2O	-15.6189	o-Phthalic_acid	-413.5692
MnCl2:4H2O	-15.9436	U2C3	-454.3266
UO2F2:3H2O	-16.1192	U3S5	-621.8341
Ba(OH)2:8H2O	-16.2318	U3P4	-854.4535
NaUO3	-16.2612		

Gases	fugacity	log fug.
N2(g)	0.1724	-0.763

H2O(g)	0.02175	-1.663
CO2(g)	0.004857	-2.314
NO2(g)	1.096e-012	-11.960
HF(g)	2.925e-014	-13.534
HCl(g)	1.921e-018	-17.716
O2(g)	2.586e-025	-24.587
NO(g)	1.045e-028	-27.981
H2(g)	1.750e-030	-29.757
CO(g)	2.691e-036	-35.570
SiF4(g)	1.531e-038	-37.815
Cl2(g)	4.159e-040	-39.381
NH3(g)	8.807e-043	-42.055
SO2(g)	2.105e-043	-42.677
UO2F2(g)	1.923e-059	-58.716
Cu(g)	4.395e-064	-63.357
UO2Cl2(g)	9.420e-071	-70.026
Na(g)	3.679e-071	-70.434
UO3(g)	2.176e-071	-70.662
K(g)	3.014e-072	-71.521
UOF4(g)	1.208e-073	-72.918
UF5(g)	2.820e-081	-80.550
UF4(g)	1.919e-084	-83.717
UF6(g)	3.083e-092	-91.511
F2(g)	1.860e-095	-94.731
H2S(g)	9.132e-096	-95.039
CH4(g)	1.004e-098	-97.998
UCl4(g)	2.608e-112	-111.584
UO2(g)	7.356e-113	-112.133
Mg(g)	5.345e-120	-119.272
UCl5(g)	1.356e-124	-123.868
UF3(g)	2.300e-129	-128.638
UCl6(g)	1.543e-131	-130.812
U2F10(g)	1.996e-136	-135.700
UCl3(g)	1.083e-137	-136.966
Ca(g)	1.602e-142	-141.795
S2(g)	3.080e-157	-156.511
C(g)	4.893e-167	-166.310
C2H4(g)	2.892e-167	-166.539
UF2(g)	4.461e-171	-170.351
UCl2(g)	1.676e-180	-179.776
UO(g)	4.664e-186	-185.331
Si(g)	3.858e-199	-198.414
UF(g)	2.561e-206	-205.592
U2Cl8(g)	2.642e-213	-212.578
UCl(g)	6.228e-221	-220.206
U2Cl10(g)	8.280e-222	-221.082
U(g)	7.106e-260	-259.148

		In fluid		Sorbed		Kd
Original basis	total moles	moles	mg/kg	moles	mg/kg	L/kg
Ba++	7.61e-007	7.61e-007	0.104			
Ca++	0.000615	0.000615	24.6			
Cl-	0.000111	0.000111	3.94			
Cu++	1.09e-007	1.09e-007	0.00690			
F-	1.04e-005	1.04e-005	0.197			
Fe++	1.06e-006	1.06e-006	0.0591			
H+	0.000178	0.000178	0.180			
H2O	55.5	55.5	1.00e+006			
HCO3-	0.00186	0.00186	113.			
HPO4--	3.18e-007	3.18e-007	0.0305			
K+	0.000555	0.000555	21.7			
Mg++	0.000203	0.000203	4.93			

Mn++	8.81e-006	8.81e-006	0.484
NH3(aq)	0.000238	0.000238	4.05
NO3-	0.000992	0.000992	61.5
Na+	0.00133	0.00133	30.5
O2(aq)	0.000178	0.000178	5.70
SO4--	0.000421	0.000421	40.4
Sb(OH)3(aq)	2.10e-007	2.10e-007	0.0364
SiO2(aq)	0.000202	0.000202	12.1
UO2++	8.28e-009	8.28e-009	0.00224

Elemental composition		In fluid		Sorbed	
	total moles	moles	mg/kg	moles	mg/kg
Antimony	2.105e-007	2.105e-007	0.02562		
Barium	7.608e-007	7.608e-007	0.1044		
Calcium	0.0006148	0.0006148	24.63		
Carbon	0.001858	0.001858	22.30		
Chlorine	0.0001112	0.0001112	3.941		
Copper	1.086e-007	1.086e-007	0.006897		
Fluorine	1.038e-005	1.038e-005	0.1971		
Hydrogen	111.0	111.0	1.119e+005		
Iron	1.059e-006	1.059e-006	0.05912		
Magnesium	0.0002028	0.0002028	4.926		
Manganese	8.809e-006	8.809e-006	0.4838		
Nitrogen	0.001230	0.001230	17.22		
Oxygen	55.52	55.52	8.880e+005		
Phosphorus	3.182e-007	3.182e-007	0.009853		
Potassium	0.0005546	0.0005546	21.68		
Silicon	0.0002018	0.0002018	5.665		
Sodium	0.001329	0.001329	30.54		
Sulfur	0.0004207	0.0004207	13.48		
Uranium	8.281e-009	8.281e-009	0.001971		

```
Temperature =   4.1 C    Pressure =  1.013 bars
pH =  7.500              log fO2 =  -34.124
Eh =   0.3510 volts      pe =   6.3808
Ionic strength      =    0.004546
Charge imbalance    =   -0.000016 eq/kg (-0.4658% error)
Activity of water   =    0.999996
Solvent mass        =    1.000000 kg
Solution mass       =    1.000307 kg
Solution density    =    1.027    g/cm3
Chlorinity          =    0.000110 molal
Dissolved solids    =         307 mg/kg sol'n
Hardness            =       75.96 mg/kg sol'n as CaCO3
  carbonate         =       75.61 mg/kg sol'n as CaCO3
  non-carbonate     =        0.35 mg/kg sol'n as CaCO3
Rock mass           =    0.000000 kg
Carbonate alkalinity=       75.61 mg/kg sol'n as CaCO3
Water type          =    Na-HCO3
```

Nernst redox couples	Eh (volts)	pe
e- + .25*O2(aq) + H+ = .5*H2O	0.3510	6.3808
8*e- + 9*H+ + NO3- = 3*H2O + NH3(aq)	0.5785	10.5161
14*e- + 16*H+ + 2*SO4-- = 8*H2O + S2--	-0.2387	-4.3391

No minerals in system.

Aqueous species	molality	mg/kg sol'n	act. coef.	log act.
HCO3-	0.001495	91.19	0.9320	-2.8560
Na+	0.001352	31.06	0.9320	-2.8997
NO3-	0.001008	62.49	0.9306	-3.0277
K+	0.0005716	22.34	0.9306	-3.2741
Ca++	0.0005365	21.50	0.7619	-3.3885
SO4--	0.0003931	37.75	0.7535	-3.5284
Mg++	0.0001910	4.640	0.7697	-3.8327
SiO2(aq)	0.0001844	11.08	1.0000	-3.7342
CO2(aq)	0.0001488	6.548	1.0000	-3.8273
N2(aq)	0.0001340	3.754	1.0000	-3.8727
Cl-	0.0001098	3.893	0.9306	-3.9905
F-	1.529e-005	0.2905	0.9313	-4.8464
CaSO4(aq)	1.432e-005	1.949	1.0000	-4.8440
Mn++	7.946e-006	0.4364	0.7619	-5.2180
CaHCO3+	7.307e-006	0.7385	0.9320	-5.1669
MgSO4(aq)	6.614e-006	0.7959	1.0000	-5.1795
NaHCO3(aq)	3.798e-006	0.3189	1.0000	-5.4205
MgHCO3+	2.537e-006	0.2164	0.9320	-5.6263
CO3--	1.589e-006	0.09530	0.7557	-5.9207
KSO4-	1.277e-006	0.1725	0.9320	-5.9244
Ba++	7.586e-007	0.1041	0.7578	-6.2405
CaCO3(aq)	6.970e-007	0.06974	1.0000	-6.1568
S2--	6.074e-007	0.03894	0.7535	-6.3394
HPO4--	5.220e-007	0.05009	0.7535	-6.4052
HSiO3-	3.416e-007	0.02632	0.9320	-6.4971
MnSO4(aq)	3.313e-007	0.05001	1.0000	-6.4798
H2PO4-	2.640e-007	0.02560	0.9320	-6.6090
Sb(OH)3(aq)	2.320e-007	0.04006	1.0000	-6.6346
MgCO3(aq)	1.386e-007	0.01168	1.0000	-6.8584
Cu++	1.379e-007	0.008761	0.7619	-6.9785
OH-	5.803e-008	0.0009866	0.9313	-7.2673
MgF+	5.289e-008	0.002290	0.9320	-7.3072
H+	3.371e-008	3.397e-005	0.9381	-7.5000
NaHSiO3(aq)	2.904e-008	0.002905	1.0000	-7.5370

CaF+	2.800e-008	0.001654	0.9320	-7.5834
NaCl(aq)	1.936e-008	0.001131	1.0000	-7.7132
MgCl+	1.360e-008	0.0008122	0.9320	-7.8972
NaCO3-	9.432e-009	0.0007826	0.9320	-8.0560
CaCl+	9.285e-009	0.0007011	0.9320	-8.0628
UO2(CO3)2--	4.031e-009	0.001572	0.7535	-8.5175
UO2(CO3)3----	3.131e-009	0.001409	0.3220	-8.9964
NaF(aq)	1.525e-009	6.402e-005	1.0000	-8.8167
KCl(aq)	1.154e-009	8.600e-005	1.0000	-8.9378
MnCl+	8.440e-010	7.627e-005	0.9320	-9.1042
HSO4-	5.738e-010	5.568e-005	0.9320	-9.2719
HF(aq)	4.633e-010	9.266e-006	1.0000	-9.3342
UO2CO3(aq)	1.999e-010	6.596e-005	1.0000	-9.6992
BaCO3(aq)	1.978e-010	3.901e-005	1.0000	-9.7038
BaCl+	1.538e-011	2.656e-006	0.9320	-10.8437
NaOH(aq)	1.271e-011	5.081e-007	1.0000	-10.8959
Cu+	1.196e-011	7.600e-007	0.9320	-10.9527
PO4---	6.659e-012	6.323e-007	0.5288	-11.4533
BaF+	4.741e-012	7.409e-007	0.9320	-11.3547
Sb(OH)2F(aq)	3.159e-012	5.518e-007	1.0000	-11.5005
UO2OH+	2.020e-012	5.795e-007	0.9320	-11.7253
Sb(OH)4-	1.794e-012	3.404e-007	0.9320	-11.7768
CaCl2(aq)	1.357e-012	1.506e-007	1.0000	-11.8674
H3PO4(aq)	9.443e-013	9.251e-008	1.0000	-12.0249
HNO3(aq)	9.387e-013	5.913e-008	1.0000	-12.0275
HCl(aq)	7.053e-013	2.571e-008	1.0000	-12.1516
Sb(OH)2+	5.560e-013	8.658e-008	0.9320	-12.2855
UO2F+	6.240e-014	1.803e-008	0.9320	-13.2354
UO2++	4.815e-014	1.300e-008	0.7557	-13.4390
MgP2O7--	3.046e-014	6.038e-009	0.7535	-13.6391
KHSO4(aq)	1.539e-014	2.095e-009	1.0000	-13.8129
UO2SO4(aq)	7.532e-015	2.756e-009	1.0000	-14.1231
UO2F2(aq)	2.652e-015	8.166e-010	1.0000	-14.5765
HP2O7---	1.580e-015	2.764e-010	0.5288	-15.0779
HF2-	1.343e-015	5.239e-011	0.9320	-14.9024
H2P2O7--	1.549e-016	2.725e-011	0.7535	-15.9328
P2O7----	4.202e-017	7.307e-012	0.3220	-16.8687
UO2(SO4)2--	1.641e-017	7.583e-012	0.7535	-16.9077
UO2F3-	6.854e-018	2.241e-012	0.9320	-17.1946
UO2Cl+	4.738e-018	1.447e-012	0.9320	-17.3550
KP2O7---	2.445e-018	5.208e-013	0.5288	-17.8884
(UO2)2(OH)2++	1.216e-018	6.978e-013	0.7557	-18.0367
UO2+	3.337e-019	9.009e-014	0.9320	-18.5072
(UO2)3(CO3)6(6-)	2.204e-020	2.578e-014	0.0781	-20.7643
(UO2)3(OH)5+	1.919e-020	1.717e-014	0.9320	-19.7476
H3P2O7-	9.054e-022	1.602e-016	0.9320	-21.0738
UO2F4--	7.818e-022	2.704e-016	0.7535	-21.2298
U(OH)4(aq)	5.049e-022	1.545e-016	1.0000	-21.2968
UO2Cl2(aq)	1.861e-023	6.343e-018	1.0000	-22.7303
Mn+++	1.360e-025	7.469e-021	0.5355	-25.1377
H4P2O7(aq)	6.429e-028	1.144e-022	1.0000	-27.1918
Formate	2.407e-031	1.083e-026	0.9313	-30.6494
H2(aq)	5.011e-032	1.010e-028	1.0000	-31.3001
Ca(For)+	3.120e-033	2.654e-028	0.9320	-32.5364
Mg(For)+	1.480e-033	1.026e-028	0.9320	-32.8603
Na(For)(aq)	3.448e-034	2.344e-029	1.0000	-33.4624
K(For)(aq)	1.210e-034	1.018e-029	1.0000	-33.9171
Mn(For)+	9.620e-035	9.613e-030	0.9320	-34.0474
NO2-	7.017e-035	3.227e-030	0.9306	-34.1851
Formic_acid(aq)	4.296e-035	1.976e-030	1.0000	-34.3670
NH4+	2.398e-035	4.325e-031	0.9299	-34.6517
SO3--	7.165e-036	5.735e-031	0.7557	-35.2665
SiF6--	4.921e-036	6.989e-031	0.7535	-35.4308

Cu(For)+	3.581e-036	3.886e-031	0.9320	-35.4766
Ba(For)+	3.091e-036	5.634e-031	0.9320	-35.5406
HSO3-	2.503e-036	2.028e-031	0.9320	-35.6322
O2(aq)	1.483e-037	4.743e-033	1.0000	-36.8289
NH3(aq)	8.412e-038	1.432e-033	1.0000	-37.0751
CO(aq)	6.136e-038	1.718e-033	1.0000	-37.2121
Oxalate	7.566e-039	6.657e-034	0.7535	-38.2440
HNO2(aq)	5.645e-039	2.653e-034	1.0000	-38.2483
ClO-	4.224e-039	2.172e-034	0.9320	-38.4049
UF3+	1.946e-039	5.738e-034	0.9320	-38.7416
UF2++	8.459e-040	2.334e-034	0.7557	-39.1943
UOH+++	7.124e-040	1.816e-034	0.5355	-39.4186
UF4(aq)	3.024e-040	9.495e-035	1.0000	-39.5193
U(CO3)5(6-)	1.496e-040	8.045e-035	0.0781	-40.9326
HO2-	1.061e-041	3.501e-037	0.9320	-41.0049
UF+++	1.046e-041	2.689e-036	0.5355	-41.2515
SO2(aq)	3.542e-042	2.268e-037	1.0000	-41.4508
H-Oxalate	3.105e-042	2.763e-037	0.9320	-41.5386
USO4++	1.976e-043	6.601e-038	0.7557	-42.8258
U(SO4)2(aq)	1.571e-043	6.754e-038	1.0000	-42.8039
U++++	5.465e-046	1.300e-040	0.3329	-45.7400
MnO4--	3.810e-047	4.530e-042	0.7535	-46.5420
UCl+++	3.339e-048	9.129e-043	0.5355	-47.7476
Oxalic_acid(aq)	1.662e-048	1.496e-043	1.0000	-47.7794
HSO5-	3.147e-049	3.558e-044	0.9320	-48.5326
MnO4-	1.979e-051	2.353e-046	0.9313	-50.7345
S2O6--	2.738e-060	4.383e-055	0.7535	-59.6854
Ca(For)2(aq)	6.304e-063	8.200e-058	1.0000	-62.2004
Mg(For)2(aq)	4.112e-063	4.700e-058	1.0000	-62.3860
U+++	1.557e-063	3.704e-058	0.5355	-63.0791
Mn(For)2(aq)	3.618e-064	5.244e-059	1.0000	-63.4415
Na(For)2-	6.929e-065	7.829e-060	0.9320	-64.1899
Cu(For)2(aq)	2.590e-065	3.976e-060	1.0000	-64.5867
K(For)2-	1.915e-065	2.472e-060	0.9320	-64.7484
S2O8--	4.438e-066	8.524e-061	0.7535	-65.4757
Ba(For)2(aq)	4.321e-066	9.821e-061	1.0000	-65.3644
ClO2-	3.767e-066	2.540e-061	0.9320	-65.4546
Formaldehyde(aq)	8.256e-068	2.478e-063	1.0000	-67.0832
N3-	2.786e-073	1.171e-068	0.9320	-72.5855
Cu(NH3)2++	1.033e-073	1.008e-068	0.7557	-73.1076
HN3(aq)	6.608e-076	2.843e-071	1.0000	-75.1799
S2O5--	1.176e-076	1.695e-071	0.7535	-76.0524
Urea(aq)	4.305e-078	2.585e-073	1.0000	-77.3660
ClO3-	2.616e-078	2.183e-073	0.9313	-77.6132
HCN(aq)	1.818e-080	4.913e-076	1.0000	-79.7403
CN-	8.490e-083	2.208e-078	0.9306	-82.1023
Methanol(aq)	4.560e-083	1.461e-078	1.0000	-82.3410
HS-	9.329e-088	3.085e-083	0.9313	-87.0611
H2S(aq)	5.909e-088	2.013e-083	1.0000	-87.2284
Glycolate	3.281e-089	2.461e-084	0.9320	-88.5146
Ca(Glyc)+	7.623e-091	8.773e-086	0.9320	-90.1485
UO2ClO3+	3.407e-091	1.204e-085	0.9320	-90.4983
Mg(Glyc)+	1.250e-091	1.242e-086	0.9320	-90.9335
Na(Glyc)(aq)	4.886e-092	4.789e-087	1.0000	-91.3110
K(Glyc)(aq)	1.715e-092	1.957e-087	1.0000	-91.7657
Mn(Glyc)+	1.018e-092	1.323e-087	0.9320	-92.0229
Methane(aq)	7.419e-093	1.190e-088	1.0000	-92.1297
Glycolic_acid(aq	7.154e-093	5.439e-088	1.0000	-92.1454
Cu(Glyc)+	4.835e-093	6.698e-088	0.9320	-92.3462
S2O3--	1.017e-093	1.140e-088	0.7535	-93.1157
S--	9.645e-094	3.092e-089	0.7578	-93.1361
Ba(Glyc)+	2.068e-094	4.389e-089	0.9320	-93.7151
ClO4-	6.217e-095	6.181e-090	0.9313	-94.2373

S2O4--	8.136e-096	1.042e-090	0.7578	-95.2101
Acetate	2.160e-098	1.275e-093	0.9326	-97.6958
MgCH3COO+	8.947e-101	7.455e-096	0.9320	-100.0789
CaCH3COO+	8.268e-101	8.193e-096	0.9320	-100.1132
Acetic_acid(aq)	3.779e-101	2.268e-096	1.0000	-100.4227
NaCH3COO(aq)	2.204e-101	1.807e-096	1.0000	-100.6569
KCH3COO(aq)	5.447e-102	5.344e-097	1.0000	-101.2639
MnCH3COO+	2.715e-102	3.094e-097	0.9320	-101.5968
CuCH3COO+	6.232e-103	7.638e-098	0.9320	-102.2360
BaCH3COO+	1.094e-103	2.147e-098	0.9320	-102.9917
Malonate	2.502e-107	2.553e-102	0.7535	-106.7245
Cu(NH3)3++	1.087e-107	1.245e-102	0.7557	-107.0856
CuCH3COO(aq)	6.021e-109	7.378e-104	1.0000	-108.2204
H-Malonate	2.981e-109	3.071e-104	0.9320	-108.5562
Malonic_acid(aq)	6.660e-114	6.929e-109	1.0000	-113.1765
Methanamine(aq)	1.972e-117	6.123e-113	1.0000	-116.7050
Glycine(aq)	7.311e-120	5.486e-115	1.0000	-119.1360
Cu(Gly)+	9.714e-121	1.336e-115	0.9320	-120.0432
Mg(Gly)+	6.006e-123	5.906e-118	0.9320	-122.2520
Mn(Gly)+	3.656e-124	4.715e-119	0.9320	-123.4675
Ca(Gly)+	6.985e-125	7.970e-120	0.9320	-124.1864
S3O6--	3.557e-126	6.834e-121	0.7535	-125.5718
Ba(Gly)+	1.107e-127	2.339e-122	0.9320	-126.9864
SCN-	3.008e-132	1.747e-127	0.9313	-131.5526
Acetaldehyde(aq)	1.208e-132	5.319e-128	1.0000	-131.9180
NH4CH3COO(aq)	7.443e-133	5.735e-128	1.0000	-132.1283
Acetamide(aq)	5.648e-133	3.335e-128	1.0000	-132.2481
UO2SCN+	2.649e-144	8.690e-139	0.9320	-143.6075
Ethanol(aq)	1.158e-152	5.331e-148	1.0000	-151.9365
Ethyne(aq)	1.907e-155	4.965e-151	1.0000	-154.7195
Ethylene(aq)	1.317e-157	3.694e-153	1.0000	-156.8803
Lactate	8.864e-159	7.893e-154	0.9320	-158.0830
Ca(Lac)+	1.211e-160	1.563e-155	0.9320	-159.9476
Mg(Lac)+	3.270e-161	3.707e-156	0.9320	-160.5160
Na(Lac)(aq)	1.361e-161	1.525e-156	1.0000	-160.8660
K(Lac)(aq)	4.779e-162	6.123e-157	1.0000	-161.3207
Lactic_acid(aq)	2.007e-162	1.807e-157	1.0000	-161.6974
Mn(Lac)+	1.948e-162	2.805e-157	0.9320	-161.7410
Cu(Lac)+	5.941e-163	9.065e-158	0.9320	-162.2567
Ba(Lac)+	2.250e-164	5.091e-159	0.9320	-163.6785
Ethane(aq)	6.359e-167	1.912e-162	1.0000	-166.1966
Propanoate	3.309e-170	2.417e-165	0.9320	-169.5109
Propanoic_acid(a	7.737e-173	5.730e-168	1.0000	-172.1114
Ca(Prop)+	7.089e-173	8.019e-168	0.9320	-172.1800
Na(Prop)(aq)	5.016e-173	4.817e-168	1.0000	-172.2996
Mg(Prop)+	3.709e-173	3.610e-168	0.9320	-172.4613
K(Prop)(aq)	1.761e-173	1.974e-168	1.0000	-172.7543
Mn(Prop)+	4.947e-174	6.331e-169	0.9320	-173.3362
USCN+++	2.157e-174	6.386e-169	0.5355	-173.9374
Cu(Prop)+	9.447e-175	1.290e-169	0.9320	-174.0553
S4O6--	2.310e-175	5.178e-170	0.7535	-174.7593
Ba(Prop)+	2.139e-176	4.499e-171	0.9320	-175.7004
Succinate	1.686e-177	1.957e-172	0.7535	-176.8959
Ca(Glyc)2(aq)	5.346e-178	1.016e-172	1.0000	-177.2720
Mg(Glyc)2(aq)	5.692e-179	9.923e-174	1.0000	-178.2447
H-Succinate	2.001e-179	2.342e-174	0.9320	-178.7294
Cu(Glyc)2(aq)	1.477e-179	3.155e-174	1.0000	-178.8306
Mn(Glyc)2(aq)	2.920e-180	5.985e-175	1.0000	-179.5346
Na(Glyc)2-	2.120e-180	3.668e-175	0.9320	-179.7043
Serine(aq)	8.063e-181	8.471e-176	1.0000	-180.0935
K(Glyc)2-	6.086e-181	1.151e-175	0.9320	-180.2462
Ba(Glyc)2(aq)	3.088e-182	8.872e-177	1.0000	-181.5103
Succinic_acid(aq	1.101e-182	1.299e-177	1.0000	-181.9583

Ethanamine(aq)	5.061e-189	2.281e-184	1.0000	-188.2957
Alanine(aq)	2.681e-190	2.388e-185	1.0000	-189.5717
Cu(Ala)+	8.088e-192	1.226e-186	0.9320	-191.1228
Mg(Ala)+	1.355e-195	1.522e-190	0.9320	-194.8987
Mn(Ala)+	1.074e-195	1.536e-190	0.9320	-194.9995
Ca(Ala)+	4.806e-196	6.158e-191	0.9320	-195.3488
Ca(CH3COO)2(aq)	3.685e-197	5.827e-192	1.0000	-196.4336
Mg(CH3COO)2(aq)	1.824e-197	2.597e-192	1.0000	-196.7389
Mn(CH3COO)2(aq)	5.407e-199	9.352e-194	1.0000	-198.2671
Cu(CH3COO)2(aq)	5.370e-199	9.751e-194	1.0000	-198.2700
Na(CH3COO)2-	3.226e-199	4.550e-194	0.9320	-198.5220
Ba(Ala)+	2.757e-199	6.212e-194	0.9320	-198.5902
Acetone(aq)	2.063e-199	1.198e-194	1.0000	-198.6856
K(CH3COO)2-	4.955e-200	7.786e-195	0.9320	-199.3356
Aspartic_acid(aq	9.147e-201	1.217e-195	1.0000	-200.0387
Ba(CH3COO)2(aq)	6.832e-201	1.744e-195	1.0000	-200.1655
Propanal(aq)	6.968e-204	4.046e-199	1.0000	-203.1569
Cu(CH3COO)2-	2.265e-206	4.112e-201	0.9320	-205.6756
S3--	2.523e-220	2.427e-215	0.7535	-219.7209
1-Propyne(aq)	6.120e-223	2.451e-218	1.0000	-222.2133
1-Propanol(aq)	2.035e-224	1.223e-219	1.0000	-223.6913
1-Propene(aq)	4.545e-227	1.912e-222	1.0000	-226.3424
NH4(CH3COO)2-	1.761e-230	2.397e-225	0.9320	-229.7848
2-Hydroxybutanoa	5.375e-231	5.540e-226	0.9320	-230.3002
Asparagine(aq)	1.569e-232	2.072e-227	1.0000	-231.8045
2-Hydroxybutanoi	1.074e-234	1.118e-229	1.0000	-233.9690
Cu(Gly)2(aq)	4.542e-235	9.610e-230	1.0000	-234.3428
Propane(aq)	4.325e-239	1.907e-234	1.0000	-238.3640
Diglycine(aq)	1.121e-241	1.481e-236	1.0000	-240.9503
Mg(Gly)2(aq)	8.881e-242	1.531e-236	1.0000	-241.0515
Butanoate	1.593e-242	1.387e-237	0.9320	-241.8285
Mn(Gly)2(aq)	3.950e-243	8.017e-238	1.0000	-242.4035
Diketopiperazine	3.188e-244	3.636e-239	1.0000	-243.4965
Butanoic_acid(aq	2.928e-245	2.579e-240	1.0000	-244.5334
Na(But)(aq)	2.338e-245	2.573e-240	1.0000	-244.6311
Ca(But)+	2.337e-245	2.971e-240	0.9320	-244.6620
Mg(But)+	1.164e-245	1.296e-240	0.9320	-244.9646
K(But)(aq)	8.208e-246	1.036e-240	1.0000	-245.0858
Ca(Gly)2(aq)	2.861e-246	5.383e-241	1.0000	-245.5435
Mn(But)+	2.038e-246	2.894e-241	0.9320	-245.7213
Cu(But)+	3.607e-247	5.432e-242	0.9320	-246.4734
Glutarate	7.032e-249	9.145e-244	0.7535	-248.2758
Ba(But)+	6.873e-249	1.542e-243	0.9320	-248.1935
Ba(Gly)2(aq)	4.661e-249	1.330e-243	1.0000	-248.3315
H-Glutarate	4.745e-251	6.219e-246	0.9320	-250.3543
Threonine(aq)	3.944e-253	4.696e-248	1.0000	-252.4041
Glutaric_acid(aq	3.208e-254	4.237e-249	1.0000	-253.4938
Ethylacetate(aq)	1.356e-254	1.194e-249	1.0000	-253.8678
S5O6--	8.226e-255	2.108e-249	0.7535	-254.2077
1-Propanamine(aq	3.024e-260	1.787e-255	1.0000	-259.5195
a-Aminobutyric_a	2.799e-262	2.886e-257	1.0000	-261.5530
Glutamic_acid(aq	4.211e-271	6.194e-266	1.0000	-270.3756
UO2(SCN)2(aq)	3.856e-276	1.489e-270	1.0000	-275.4139
Butanal(aq)	1.063e-277	7.663e-273	1.0000	-276.9734
S4--	7.332e-284	9.401e-279	0.7535	-283.2577
Cu(CH3COO)3-	5.804e-295	1.396e-289	0.9320	-294.2669
1-Butyne(aq)	2.738e-295	1.480e-290	1.0000	-294.5626
Mn(CH3COO)3-	5.437e-296	1.261e-290	0.9320	-295.2952
1-Butanol(aq)	1.786e-297	1.324e-292	1.0000	-296.7481
1-Butene(aq)	1.292e-299	7.246e-295	1.0000	-298.8888
2-Hydroxypentano	4.949e-303	5.795e-298	0.9320	-300.0000
Glutamine(aq)	8.314e-305	1.215e-299	1.0000	-300.0000
U(SCN)2++	6.744e-305	2.388e-299	0.7557	-300.0000

2-Hydroxypentano	5.747e-307	6.787e-302	1.0000	-300.0000
n-Butane(aq)	2.559e-311	1.487e-306	1.0000	-300.0000
Alanylglycine(aq	2.159e-312	3.154e-307	1.0000	-300.0000
Pentanoate	9.110e-315	9.210e-310	0.9320	-300.0000
Pentanoic_acid(a	1.816e-317	1.854e-312	1.0000	-300.0000
Na(Pent)(aq)	1.453e-317	1.802e-312	1.0000	-300.0000
Ca(Lac)2(aq)	1.452e-317	3.168e-312	1.0000	-300.0000
Ca(Pent)+	8.004e-318	1.130e-312	0.9320	-300.0000
K(Pent)(aq)	5.098e-318	7.147e-313	1.0000	-300.0000
Mg(Lac)2(aq)	4.271e-318	8.645e-313	1.0000	-300.0000
Mg(Pent)+	3.894e-318	4.883e-313	0.9320	-300.0000
Mn(Pent)+	9.183e-319	1.433e-313	0.9320	-300.0000
Cu(Lac)2(aq)	3.109e-319	7.511e-314	1.0000	-300.0000
Mn(Lac)2(aq)	2.583e-319	6.018e-314	1.0000	-300.0000
Cu(Pent)+	2.134e-319	3.512e-314	0.9320	-300.0000
Na(Lac)2-	1.635e-319	3.288e-314	0.9320	-300.0000
K(Lac)2-	4.695e-320	1.020e-314	0.9320	-300.0000
Ba(Pent)+	2.604e-321	6.207e-316	0.9320	-300.0000
Ba(Lac)2(aq)	4.298e-322	1.356e-316	1.0000	-300.0000
Adipate	9.387e-323	1.353e-317	0.7535	-300.0000
Ba(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Methionine(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hexanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexyne(aq)	0.0000	0.0000	1.0000	-300.0000
Azelate	0.0000	0.0000	0.7535	-300.0000
Leucylglycine(aq	0.0000	0.0000	1.0000	-300.0000
Leucine(aq)	0.0000	0.0000	1.0000	-300.0000
Azelaic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
2-Heptanone(aq)	0.0000	0.0000	1.0000	-300.0000
K(Prop)2-	0.0000	0.0000	0.9320	-300.0000
2-Butanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexene(aq)	0.0000	0.0000	1.0000	-300.0000
K(Pent)2-	0.0000	0.0000	0.9320	-300.0000
p-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
p-Toluate	0.0000	0.0000	0.9320	-300.0000
Ca(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
o-Toluate	0.0000	0.0000	0.9320	-300.0000
n-Propylbenzene(	0.0000	0.0000	1.0000	-300.0000
K(But)2-	0.0000	0.0000	0.9320	-300.0000
n-Pentane(aq)	0.0000	0.0000	1.0000	-300.0000
Isoleucine(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Adipic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Hexanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
n-Heptane(aq)	0.0000	0.0000	1.0000	-300.0000
Hexanoate	0.0000	0.0000	0.9320	-300.0000
Hexanal(aq)	0.0000	0.0000	1.0000	-300.0000
m-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
m-Toluate	0.0000	0.0000	0.9320	-300.0000
Heptanoic_acid(a	0.0000	0.0000	1.0000	-300.0000
1-Hexanol(aq)	0.0000	0.0000	1.0000	-300.0000
Heptanoate	0.0000	0.0000	0.9320	-300.0000
Undecanoic_acid(	0.0000	0.0000	1.0000	-300.0000
Heptanal(aq)	0.0000	0.0000	1.0000	-300.0000
Undecanoate	0.0000	0.0000	0.9320	-300.0000
HSb2S4-	0.0000	0.0000	0.9320	-300.0000
UO2(SCN)3-	0.0000	0.0000	0.9320	-300.0000
1-Hexanamine(aq)	0.0000	0.0000	1.0000	-300.0000

Ca(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Tyrosine(aq)	0.0000	0.0000	1.0000	-300.0000
Tryptophan(aq)	0.0000	0.0000	1.0000	-300.0000
Toluene(aq)	0.0000	0.0000	1.0000	-300.0000
Suberic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Suberate	0.0000	0.0000	0.7535	-300.0000
2-Pentanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Pentyne(aq)	0.0000	0.0000	1.0000	-300.0000
Sebacate	0.0000	0.0000	0.7535	-300.0000
Sb2S4--	0.0000	0.0000	0.7535	-300.0000
H-Suberate	0.0000	0.0000	0.9320	-300.0000
2-Octanone(aq)	0.0000	0.0000	1.0000	-300.0000
H-Sebacate	0.0000	0.0000	0.9320	-300.0000
H-Pimelate	0.0000	0.0000	0.9320	-300.0000
S5--	0.0000	0.0000	0.7535	-300.0000
1-Pentene(aq)	0.0000	0.0000	1.0000	-300.0000
Sebacic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptyne(aq)	0.0000	0.0000	1.0000	-300.0000
H-Azelate	0.0000	0.0000	0.9320	-300.0000
H-Adipate	0.0000	0.0000	0.9320	-300.0000
Pimelic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Pimelate	0.0000	0.0000	0.7535	-300.0000
Phenylalanine(aq	0.0000	0.0000	1.0000	-300.0000
Phenol(aq)	0.0000	0.0000	1.0000	-300.0000
Benzoic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyoctanoi	0.0000	0.0000	1.0000	-300.0000
1-Pentanol(aq)	0.0000	0.0000	1.0000	-300.0000
Pentanal(aq)	0.0000	0.0000	1.0000	-300.0000
Benzoate	0.0000	0.0000	0.9345	-300.0000
Octanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Benzene(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyoctanoa	0.0000	0.0000	0.9320	-300.0000
Octanoate	0.0000	0.0000	0.9320	-300.0000
Octanal(aq)	0.0000	0.0000	1.0000	-300.0000
Nonanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Nonanoate	0.0000	0.0000	0.9320	-300.0000
Nonanal(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxynonanoi	0.0000	0.0000	1.0000	-300.0000
1-Pentanamine(aq	0.0000	0.0000	1.0000	-300.0000
1-Heptene(aq)	0.0000	0.0000	1.0000	-300.0000
Ethylbenzene(aq)	0.0000	0.0000	1.0000	-300.0000
Na(Prop)2-	0.0000	0.0000	0.9320	-300.0000
2-Hydroxynonanoa	0.0000	0.0000	0.9320	-300.0000
Na(Pent)2-	0.0000	0.0000	0.9320	-300.0000
Dodecanoic_acid(	0.0000	0.0000	1.0000	-300.0000
Dodecanoate	0.0000	0.0000	0.9320	-300.0000
Ba(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyhexanoi	0.0000	0.0000	1.0000	-300.0000
1-Octyne(aq)	0.0000	0.0000	1.0000	-300.0000
Na(But)2-	0.0000	0.0000	0.9320	-300.0000
Decanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Decanoate	0.0000	0.0000	0.9320	-300.0000
Ba(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyhexanoa	0.0000	0.0000	0.9320	-300.0000
Decanal(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyheptano	0.0000	0.0000	1.0000	-300.0000
1-Octene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptanol(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000

2-Hydroxyheptano	0.0000	0.0000	0.9320	-300.0000
Valine(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxydecanoi	0.0000	0.0000	1.0000	-300.0000
1-Octanol(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
n-Butylbenzene(a	0.0000	0.0000	1.0000	-300.0000
2-Hydroxydecanoa	0.0000	0.0000	0.9320	-300.0000
n-Heptylbenzene(	0.0000	0.0000	1.0000	-300.0000
n-Hexane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Hexylbenzene(a	0.0000	0.0000	1.0000	-300.0000
n-Octane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Octylbenzene(a	0.0000	0.0000	1.0000	-300.0000
Mg(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
n-Pentylbenzene(	0.0000	0.0000	1.0000	-300.0000
Mg(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
o-Phthalate	0.0000	0.0000	0.7535	-300.0000
1-Octanamine(aq)	0.0000	0.0000	1.0000	-300.0000
o-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
1-Heptanamine(aq	0.0000	0.0000	1.0000	-300.0000
1-Butanamine(aq)	0.0000	0.0000	1.0000	-300.0000
(NH4)2Sb2S4(aq)	0.0000	0.0000	1.0000	-300.0000

Mineral saturation states

	log Q/K		log Q/K
Fluorapatite	5.5120s/sat	Tremolite	-16.8320
Witherite	1.6380s/sat	Natrosilite	-16.9484
Quartz	0.7738s/sat	Ningyoite	-17.5644
Barite	0.6143s/sat	MnCl2:2H2O	-17.6389
Tridymite	0.5758s/sat	MgOHCl	-17.7819
Chalcedony	0.4822s/sat	Na2SiO3	-17.8039
Cristobalite(alp	0.1738s/sat	Ba2Si3O8	-18.0405
Ice	-0.0609	CuCl2	-19.2890
Coesite	-0.0935	MnCl2:H2O	-19.3889
Cristobalite(bet	-0.3322	UOFOH:.5H2O	-19.5740
Tenorite	-0.4876	MgCl2:4H2O	-19.7238
Rhodochrosite	-0.6399	Hillebrandite	-19.9457
SiO2(am)	-0.6928	UO2SO4	-19.9754
Calcite	-0.9079	UOFOH	-20.1087
Aragonite	-1.0535	Hydromagnesite	-20.3401
Dolomite-ord	-1.1900	Dicalcium_silica	-20.4838
Dolomite	-1.1901	UO2(NO3)2:6H2O	-21.5323
Malachite	-1.2442	Na2UO4(alpha)	-21.5660
Monohydrocalcite	-1.6978	Larnite	-21.9019
Magnesite	-2.0461	Akermanite	-22.0572
Dioptase	-2.0742	UOF2:H2O	-22.1338
Gypsum	-2.4023	UO2Cl	-22.2361
Anhydrite	-2.7884	UOF2	-22.8298
Fluorite	-2.8289	Scacchite	-22.8930
Dolomite-dis	-2.8962	UO2(NO3)2:3H2O	-23.3073
Bassanite	-3.4406	Lime	-23.5226
Sb2O3	-3.4598	Hydrophilite	-24.1812
CaSO4:0.5H2O(bet	-3.6363	Anthophyllite	-24.2980
UO3:2H2O	-3.9508	UO2(NO3)2:2H2O	-24.7401
Schoepite	-3.9528	U(HPO4)2:4H2O	-25.3725
Brochantite	-4.0416	UO2(PO3)2	-25.6159
UO2(OH)2(beta)	-4.1413	MgCl2:2H2O	-25.7602
Schoepite-dehy(.	-4.1971	UP2O7	-25.9364
UO3:.9H2O(alpha)	-4.2174	(UO2)3(PO4)2	-25.9630
Talc	-4.2460	K2UO4	-26.1869
Sellaite	-4.2528	(UO2)2P2O7	-26.2530
Schoepite-dehy(.	-4.3051	UO2Cl2:3H2O	-27.6399

Schoepite-dehy(1	-4.3271	Rankinite	-28.3833
Rhodonite	-4.4644	UO2(NO3)2:H2O	-28.7154
CaUO4	-4.5077	MgCl2:H2O	-29.4573
Cuprite	-4.6456	UO2Cl2:H2O	-30.7291
Enstatite	-4.9128	Tobermorite-14A	-30.8774
UO2CO3	-4.9201	UF4:2.5H2O	-31.3523
Rutherfordine	-4.9246	UO2(NO3)2	-32.5124
Whitlockite	-5.1600	UO2SO3	-32.5898
Nesquehonite	-5.2666	Tobermorite-11A	-33.3366
Nahcolite	-5.4040	Ba2SiO4	-33.8571
Hydroxylapatite	-5.4252	KMgCl3:2H2O	-34.0260
Schoepite-dehy(.	-5.5318	UO2Cl2	-34.9547
Niter	-5.6020	Foshagite	-35.2174
Schoepite-dehy(.	-6.0973	BaSiF6	-35.4029
Okenite	-6.3835	Merwinite	-35.5080
Brucite	-6.6056	Chloromagnesite	-35.7154
UO2HPO4:4H2O	-6.6237	UF4	-36.0769
Wollastonite	-6.8197	Afwillite	-36.7229
Mn(OH)2(am)	-6.8297	Tobermorite-9A	-37.3548
Bixbyite	-6.8546	U(SO4)2:8H2O	-40.6987
Atacamite	-6.9355	KMgCl3	-42.0283
Pseudowollastoni	-7.0980	U(SO4)2:4H2O	-42.1566
Pyrolusite	-7.1140	U(SO4)2	-42.5218
Mirabilite	-7.2149	BaO	-42.6063
UO3(gamma)	-7.2176	C	-42.8205
Diopside	-7.2734	Ba2U2O7	-44.1981
Azurite	-7.3849	UOCl2	-46.0105
Nantokite	-7.6155	U(CO3)2	-46.2182
Chalcanthite	-7.8064	UClF3	-47.6463
Chrysotile	-7.8339	U5O12Cl	-47.9193
Sylvite	-7.8510	Hatrurite	-47.9706
UO3(beta)	-7.8679	Xonotlite	-50.7442
Cu	-7.8882	UOF4	-54.2945
Arcanite	-7.8980	Na3UO4	-57.3586
UO3(alpha)	-8.2342	UF3	-58.0532
Halite	-8.4026	(UO2)2Cl3	-58.4343
UO2FOH:2H2O	-8.4315	Na	-58.5898
Sanbornite	-8.4429	UOCl3	-59.3634
Huntite	-8.7749	UF5(beta)	-60.0586
UO2FOH:H2O	-8.9248	Na4SiO4	-60.2508
Thenardite	-8.9945	UF5(alpha)	-60.4971
UO2.25	-9.0532	Mn	-61.3455
UO2.25(beta)	-9.1253	UCl2F2	-61.5295
Hausmannite	-9.2259	Covellite	-62.3370
Nitrobarite	-9.2503	K	-62.7230
Tephroite	-9.2980	Na2O	-62.8778
Artinite	-9.3921	UOCl	-63.8666
UO2FOH	-9.4892	Chalcocite	-63.9896
BaUO4	-9.6544	S	-64.3852
Manganosite	-9.7428	U2O3F6	-70.7747
Sepiolite	-9.8481	Ba3UO6	-74.0109
Natron	-10.1348	UCl3F	-75.2242
Saleeite	-10.4461	U(SO3)2	-79.1458
Na2CO3:7H2O	-10.8149	K2O	-81.2223
Mg1.25SO4(OH)0.5	-11.0515	Alabandite	-84.6651
UO2SO4:H2O	-11.4066	UCl4	-86.7629
(UO2)3(PO4)2:4H2	-11.6659	Na6Si2O7	-87.5980
Gyrolite	-11.7807	UCl3	-89.6568
UO2.6667	-11.8272	U2F9	-92.7604
Forsterite	-11.9031	UF6	-93.2455
Uraninite	-11.9462	U3O5F8	-94.5936
Uranocircite	-11.9937	Mg	-102.7848
Coffinite	-12.0279	BaS	-103.2570

Periclase	-12.1502	UN1.73(alpha)	-106.4319
MnSO4	-12.1956	U2O2Cl5	-106.7122
UPO5	-12.3439	UCl5	-108.9382
Thermonatrite	-12.4739	UN1.59(alpha)	-109.3512
Torbernite	-12.5522	Antigorite	-110.2060
Na2U2O7	-12.5604	P	-118.5649
Mg1.5SO4(OH)	-12.6324	Ca	-120.6693
Portlandite	-12.6474	UN	-123.3331
UO2ClOH:2H2O	-12.6918	Ba	-124.8449
BaU2O7	-12.6948	Si	-127.1337
Na2CO3	-12.8500	UCl6	-129.8696
MgUO4	-12.9075	U4F17	-163.9804
Monticellite	-13.0498	U	-172.9200
MgSO4	-13.3717	US	-176.8263
BaCl2:2H2O	-14.1988	UC	-197.1193
Chalcocyanite	-14.3398	US1.9	-199.2629
Autunite-H	-14.6971	UH3(beta)	-200.9508
BaCl2:H2O	-14.9889	US2	-203.8512
NaUO3	-15.4952	Stibnite	-239.5054
UO2SO4:3.5H2O	-15.8471	UC1.94(alpha)	-239.5509
UO2F2:3H2O	-15.9310	UP	-241.3346
UO2SO4:2.5H2O	-15.9408	US3	-264.8275
UO2SO4:3H2O	-16.0141	UP2	-354.4305
MnCl2:4H2O	-16.0978	U2S3	-373.2549
UO2F2	-16.3301	o-Phthalic_acid	-381.7928
Ba(OH)2:8H2O	-16.5668	U2C3	-438.7104
BaCl2	-16.6059	U3S5	-572.1616
UO2.3333(beta)	-16.6822	U3P4	-837.1014

Gases	fugacity	log fug.
N2(g)	0.1393	-0.856
H2O(g)	0.006731	-2.172
CO2(g)	0.002191	-2.659
NO2(g)	3.139e-011	-10.503
HF(g)	5.503e-015	-14.259
HCl(g)	1.723e-019	-18.764
H2(g)	5.370e-029	-28.270
NO(g)	2.062e-034	-33.686
O2(g)	7.522e-035	-34.124
CO(g)	4.063e-035	-34.391
SiF4(g)	6.486e-039	-38.188
NH3(g)	4.511e-040	-39.346
SO2(g)	1.004e-042	-41.998
Cl2(g)	8.270e-046	-45.083
UO2F2(g)	6.241e-063	-62.205
Cu(g)	3.174e-065	-64.498
Na(g)	3.178e-074	-73.498
UO2Cl2(g)	4.247e-075	-74.372
K(g)	3.174e-075	-74.498
UO3(g)	8.530e-077	-76.069
UOF4(g)	7.294e-077	-76.137
UF5(g)	1.257e-082	-81.901
UF4(g)	9.766e-085	-84.010
H2S(g)	3.129e-087	-86.505
CH4(g)	3.228e-090	-89.491
UF6(g)	1.891e-095	-94.723
F2(g)	1.097e-104	-103.960
UCl4(g)	1.456e-114	-113.837
UO2(g)	3.506e-117	-116.455
Mg(g)	3.578e-125	-124.446
UCl5(g)	5.956e-129	-128.225
UF3(g)	2.473e-131	-130.607

U2F10(g)	8.017e-137	-136.096
UCl6(g)	1.559e-137	-136.807
UCl3(g)	2.520e-140	-139.599
S2(g)	4.386e-145	-144.358
Ca(g)	5.557e-149	-148.255
C2H4(g)	1.546e-155	-154.811
C(g)	1.297e-170	-169.887
UF2(g)	1.853e-174	-173.732
UCl2(g)	1.394e-184	-183.856
UO(g)	1.939e-191	-190.712
Si(g)	7.475e-205	-204.126
UF(g)	1.392e-210	-209.856
U2Cl8(g)	1.649e-216	-215.783
UCl(g)	3.394e-226	-225.469
U2Cl10(g)	3.371e-228	-227.472
U(g)	3.001e-266	-265.523

		In fluid		Sorbed		Kd
Original basis	total moles	moles	mg/kg	moles	mg/kg	L/kg
Ba++	7.59e-007	7.59e-007	0.104			
Ca++	0.000559	0.000559	22.4			
Cl-	0.000110	0.000110	3.89			
Cu++	1.38e-007	1.38e-007	0.00876			
F-	1.54e-005	1.54e-005	0.292			
H+	0.000146	0.000146	0.147			
H2O	55.5	55.5	1.00e+006			
HCO3-	0.00166	0.00166	101.			
HPO4--	7.86e-007	7.86e-007	0.0754			
K+	0.000573	0.000573	22.4			
Mg++	0.000200	0.000200	4.87			
Mn++	8.28e-006	8.28e-006	0.455			
NH3(aq)	0.000268	0.000268	4.56			
NO3-	0.00101	0.00101	62.5			
Na+	0.00136	0.00136	31.2			
O2(aq)	0.000201	0.000201	6.43			
S2--	6.07e-007	6.07e-007	0.0389			
SO4--	0.000416	0.000416	39.9			
Sb(OH)3(aq)	2.32e-007	2.32e-007	0.0401			
SiO2(aq)	0.000185	0.000185	11.1			
UO2++	7.36e-009	7.36e-009	0.00199			

Elemental composition		In fluid		Sorbed	
	total moles	moles	mg/kg	moles	mg/kg
Antimony	2.320e-007	2.320e-007	0.02823		
Barium	7.588e-007	7.588e-007	0.1042		
Calcium	0.0005589	0.0005589	22.39		
Carbon	0.001660	0.001660	19.93		
Chlorine	0.0001099	0.0001099	3.894		
Copper	1.379e-007	1.379e-007	0.008762		
Fluorine	1.538e-005	1.538e-005	0.2921		
Hydrogen	111.0	111.0	1.119e+005		
Magnesium	0.0002003	0.0002003	4.868		
Manganese	8.278e-006	8.278e-006	0.4546		
Nitrogen	0.001276	0.001276	17.87		
Oxygen	55.52	55.52	8.880e+005		
Phosphorus	7.860e-007	7.860e-007	0.02434		
Potassium	0.0005729	0.0005729	22.39		
Silicon	0.0001848	0.0001848	5.188		
Sodium	0.001356	0.001356	31.15		
Sulfur	0.0004168	0.0004168	13.36		
Uranium	7.364e-009	7.364e-009	0.001752		

```
Temperature =  10.9 C    Pressure =  1.013 bars
pH =  7.300              log fO2 =  -29.990
Eh =   0.3980 volts      pe =   7.0633
Ionic strength      =    0.004293
Charge imbalance    =   -0.000046 eq/kg (-1.379% error)
Activity of water   =    0.999996
Solvent mass        =    1.000000 kg
Solution mass       =    1.000303 kg
Solution density    =    1.023    g/cm3
Chlorinity          =    0.000110 molal
Dissolved solids    =         303 mg/kg sol'n
Hardness            =       69.83 mg/kg sol'n as CaCO3
  carbonate         =       69.83 mg/kg sol'n as CaCO3
  non-carbonate     =        0.00 mg/kg sol'n as CaCO3
Rock mass           =    0.000000 kg
Carbonate alkalinity=       72.13 mg/kg sol'n as CaCO3
Water type          =    Na-HCO3
```

Nernst redox couples	Eh (volts)	pe
e- + .25*O2(aq) + H+ = .5*H2O	0.3980	7.0633
8*e- + 9*H+ + NO3- = 3*H2O + NH3(aq)	0.5981	10.6148
14*e- + 16*H+ + 2*SO4-- = 8*H2O + S2--	-0.2362	-4.1924

No minerals in system.

Aqueous species	molality	mg/kg sol'n	act. coef.	log act.
HCO3-	0.001428	87.13	0.9332	-2.8751
Na+	0.001358	31.22	0.9332	-2.8970
NO3-	0.001173	72.72	0.9319	-2.9612
K+	0.0005495	21.48	0.9319	-3.2907
Ca++	0.0005189	20.79	0.7657	-3.4009
SO4--	0.0002987	28.69	0.7576	-3.6453
CO2(aq)	0.0001932	8.499	1.0000	-3.7141
SiO2(aq)	0.0001788	10.74	1.0000	-3.7477
Mg++	0.0001541	3.744	0.7732	-3.9239
N2(aq)	0.0001416	3.966	1.0000	-3.8489
Cl-	0.0001103	3.910	0.9319	-3.9880
CaSO4(aq)	1.087e-005	1.479	1.0000	-4.9638
F-	1.025e-005	0.1947	0.9326	-5.0196
Mn++	7.834e-006	0.4302	0.7657	-5.2220
CaHCO3+	6.561e-006	0.6631	0.9332	-5.2131
MgSO4(aq)	4.851e-006	0.5837	1.0000	-5.3142
NaHCO3(aq)	3.187e-006	0.2677	1.0000	-5.4966
MgHCO3+	1.908e-006	0.1628	0.9332	-5.7494
HPO4--	1.322e-006	0.1268	0.7576	-5.9995
CO3--	1.155e-006	0.06930	0.7597	-6.0567
AlO2-	1.102e-006	0.06499	0.9332	-5.9877
Cu++	1.047e-006	0.06649	0.7657	-6.0962
Fe++	1.040e-006	0.05804	0.7657	-6.0991
H2PO4-	9.837e-007	0.09538	0.9332	-6.0371
KSO4-	9.332e-007	0.1261	0.9332	-6.0600
S2--	7.626e-007	0.04889	0.7576	-6.2383
Ba++	7.192e-007	0.09874	0.7617	-6.2614
CaCO3(aq)	5.617e-007	0.05620	1.0000	-6.2505
HAlO2(aq)	3.159e-007	0.01894	1.0000	-6.5005
HSiO3-	2.692e-007	0.02075	0.9332	-6.5999
MnSO4(aq)	2.662e-007	0.04019	1.0000	-6.5748
Sb(OH)3(aq)	2.571e-007	0.04440	1.0000	-6.5899
Zn++	1.457e-007	0.009522	0.7657	-6.9526
MgCO3(aq)	8.697e-008	0.007330	1.0000	-7.0606

OH-	6.694e-008	0.001138	0.9326	-7.2046
H+	5.337e-008	5.378e-005	0.9391	-7.3000
Al(OH)2+	2.960e-008	0.001805	0.9332	-7.5587
MgF+	2.806e-008	0.001215	0.9332	-7.5820
NaCl(aq)	2.020e-008	0.001180	1.0000	-7.6946
NaHSiO3(aq)	1.952e-008	0.001953	1.0000	-7.7095
CaF+	1.849e-008	0.001092	0.9332	-7.7630
FeCO3+	1.116e-008	0.001293	0.9332	-7.9824
MgCl+	1.045e-008	0.0006244	0.9332	-8.0108
CaCl+	8.897e-009	0.0006718	0.9332	-8.0808
Cd++	7.830e-009	0.0008799	0.7617	-8.2245
UO2(CO3)2--	6.046e-009	0.002358	0.7576	-8.3391
NaCO3-	5.792e-009	0.0004806	0.9332	-8.2672
Pb++	5.182e-009	0.001073	0.7597	-8.4049
ZnSO4(aq)	3.914e-009	0.0006317	1.0000	-8.4074
AlOH++	2.101e-009	9.240e-005	0.7597	-8.7969
UO2(CO3)3----	1.790e-009	0.0008052	0.3291	-9.2299
KCl(aq)	1.277e-009	9.521e-005	1.0000	-8.8936
NaF(aq)	1.086e-009	4.557e-005	1.0000	-8.9643
MnCl+	9.690e-010	8.756e-005	0.9332	-9.0437
HSO4-	8.167e-010	7.925e-005	0.9332	-9.1180
HF(aq)	5.519e-010	1.104e-005	1.0000	-9.2581
UO2CO3(aq)	3.774e-010	0.0001245	1.0000	-9.4232
NaAlO2(aq)	2.031e-010	1.664e-005	1.0000	-9.6923
BaCO3(aq)	1.579e-010	3.115e-005	1.0000	-9.8017
FeCl+	6.005e-011	5.481e-006	0.9332	-10.2515
Al+++	3.406e-011	9.188e-007	0.5662	-10.7148
Cu+	2.423e-011	1.539e-006	0.9332	-10.6456
BaCl+	1.595e-011	2.755e-006	0.9332	-10.8272
NaOH(aq)	1.387e-011	5.546e-007	1.0000	-10.8579
PO4---	1.269e-011	1.205e-006	0.5352	-11.1681
PbCl+	1.129e-011	2.738e-006	0.9332	-10.9774
ZnCl+	8.544e-012	8.613e-007	0.9332	-11.0984
H3PO4(aq)	5.932e-012	5.811e-007	1.0000	-11.2268
UO2OH+	5.185e-012	1.488e-006	0.9332	-11.3153
BaF+	3.208e-012	5.013e-007	0.9332	-11.5238
Sb(OH)2F(aq)	2.576e-012	4.501e-007	1.0000	-11.5891
Sb(OH)4-	2.205e-012	4.184e-007	0.9332	-11.6865
HNO3(aq)	2.006e-012	1.264e-007	1.0000	-11.6976
CdSO4(aq)	1.364e-012	2.842e-007	1.0000	-11.8653
CaCl2(aq)	1.172e-012	1.301e-007	1.0000	-11.9310
HCl(aq)	1.093e-012	3.983e-008	1.0000	-11.9614
Fe+++	9.710e-013	5.421e-008	0.5662	-12.2599
Sb(OH)2+	7.391e-013	1.151e-007	0.9332	-12.1613
MgP2O7--	2.268e-013	4.495e-008	0.7576	-12.7649
CdCl2(aq)	1.261e-013	2.310e-008	1.0000	-12.8994
UO2++	1.248e-013	3.368e-008	0.7597	-13.0233
UO2F+	1.079e-013	3.119e-008	0.9332	-12.9968
FeF++	7.570e-014	5.664e-009	0.7597	-13.2403
KHSO4(aq)	2.273e-014	3.094e-009	1.0000	-13.6434
HP2O7---	1.811e-014	3.168e-009	0.5352	-14.0134
UO2SO4(aq)	1.767e-014	6.468e-009	1.0000	-13.7527
FeF2+	8.119e-015	7.617e-010	0.9332	-14.1205
FeSO4+	7.202e-015	1.094e-009	0.9332	-14.1726
PbCl2(aq)	3.787e-015	1.053e-009	1.0000	-14.4217
UO2F2(aq)	3.027e-015	9.320e-010	1.0000	-14.5190
H2P2O7--	2.862e-015	5.034e-010	0.7576	-14.6639
ZnCl2(aq)	1.234e-015	1.682e-010	1.0000	-14.9086
HF2-	1.167e-015	4.549e-011	0.9332	-14.9630
P2O7----	3.292e-016	5.725e-011	0.3291	-15.9652
UO2(SO4)2--	3.275e-017	1.513e-011	0.7576	-16.6054
FeCl2(aq)	2.835e-017	3.592e-012	1.0000	-16.5474
KP2O7---	1.950e-017	4.152e-012	0.5352	-16.9815

UO2Cl+	1.308e-017	3.993e-012	0.9332	-16.9135
FeCl++	5.857e-018	5.346e-013	0.7597	-17.3517
UO2F3-	5.323e-018	1.740e-012	0.9332	-17.3038
(UO2)2(OH)2++	4.944e-018	2.838e-012	0.7597	-17.4253
CdCl3-	2.675e-018	5.850e-013	0.9332	-17.6027
PbCl3-	2.056e-019	6.446e-014	0.9332	-18.7169
UO2+	2.041e-019	5.510e-014	0.9332	-18.7202
ZnCl3-	1.074e-019	1.843e-014	0.9332	-18.9992
(UO2)3(OH)5+	9.726e-020	8.703e-014	0.9332	-19.0421
H3P2O7-	2.613e-020	4.623e-015	0.9332	-19.6128
(UO2)3(CO3)6(6-)	2.024e-020	2.367e-014	0.0820	-20.7802
UO2F4--	3.845e-022	1.330e-016	0.7576	-21.5357
ZnCl4--	1.253e-022	2.596e-017	0.7576	-22.0226
UO2Cl2(aq)	5.649e-023	1.925e-017	1.0000	-22.2480
U(OH)4(aq)	3.983e-023	1.219e-017	1.0000	-22.3998
PbCl4--	2.354e-023	8.212e-018	0.7576	-22.7488
FeCl4--	1.196e-024	2.363e-019	0.7576	-24.0429
Mn+++	1.119e-024	6.144e-020	0.5418	-24.2174
H4P2O7(aq)	3.221e-026	5.730e-021	1.0000	-25.4920
NO2-	9.318e-032	4.285e-027	0.9319	-31.0613
Formate	2.947e-032	1.326e-027	0.9326	-31.5609
H2(aq)	7.513e-033	1.514e-029	1.0000	-32.1242
O2(aq)	1.724e-033	5.515e-029	1.0000	-32.7635
Ca(For)+	3.493e-034	2.972e-029	0.9332	-33.4867
Mg(For)+	1.261e-034	8.738e-030	0.9332	-33.9293
Na(For)(aq)	4.129e-035	2.807e-030	1.0000	-34.3842
K(For)(aq)	1.453e-035	1.222e-030	1.0000	-34.8378
Mn(For)+	1.058e-035	1.057e-030	0.9332	-35.0056
HNO2(aq)	1.037e-035	4.873e-031	1.0000	-34.9843
Formic_acid(aq)	8.100e-036	3.727e-031	1.0000	-35.0915
Cu(For)+	2.916e-036	3.165e-031	0.9332	-35.5652
Fe(For)+	2.062e-036	2.079e-031	0.9332	-35.7157
SiF6--	1.142e-036	1.622e-031	0.7576	-36.0630
ClO-	9.214e-037	4.739e-032	0.9332	-36.0656
SO3--	7.715e-037	6.175e-032	0.7597	-36.2321
NH4+	6.829e-037	1.232e-032	0.9313	-36.1965
HSO3-	4.482e-037	3.633e-032	0.9332	-36.3785
Ba(For)+	3.674e-037	6.697e-032	0.9332	-36.4649
Zn(For)+	2.516e-037	2.777e-032	0.9332	-36.6292
Cd(For)+	1.474e-038	2.320e-033	0.9332	-37.8616
CO(aq)	1.339e-038	3.750e-034	1.0000	-37.8732
Pb(For)+	8.908e-039	2.246e-033	0.9332	-38.0802
HO2-	2.909e-039	9.599e-035	0.9332	-38.5662
NH3(aq)	2.563e-039	4.363e-035	1.0000	-38.5913
Oxalate	9.441e-040	8.308e-035	0.7576	-39.1455
UOH+++	1.721e-040	4.388e-035	0.5418	-40.0304
UF3+	1.300e-040	3.833e-035	0.9332	-39.9162
UF2++	8.261e-041	2.280e-035	0.7597	-40.2023
UF4(aq)	1.211e-041	3.803e-036	1.0000	-40.9168
U(CO3)5(6-)	4.432e-042	2.384e-036	0.0820	-42.4396
UF+++	1.517e-042	3.899e-037	0.5418	-42.0851
SO2(aq)	1.143e-042	7.319e-038	1.0000	-41.9420
H-Oxalate	6.356e-043	5.657e-038	0.9332	-42.2268
MnO4--	3.549e-043	4.220e-038	0.7576	-42.5704
USO4++	3.647e-044	1.218e-038	0.7597	-43.5574
U(SO4)2(aq)	2.763e-044	1.188e-038	1.0000	-43.5587
MnO4-	2.222e-046	2.642e-041	0.9326	-45.6835
HSO5-	1.642e-046	1.856e-041	0.9332	-45.8146
U++++	1.268e-046	3.018e-041	0.3398	-46.3656
UCl+++	6.269e-049	1.714e-043	0.5418	-48.4690
Oxalic_acid(aq)	5.399e-049	4.859e-044	1.0000	-48.2677
S2O6--	1.299e-060	2.079e-055	0.7576	-60.0070
ClO2-	1.444e-061	9.736e-057	0.9332	-60.8705

S2O8--	4.783e-063	9.187e-058	0.7576	-62.4408
U+++	2.615e-064	6.223e-059	0.5418	-63.8487
Ca(For)2(aq)	7.891e-065	1.026e-059	1.0000	-64.1029
Mg(For)2(aq)	3.517e-065	4.021e-060	1.0000	-64.4538
Mn(For)2(aq)	4.276e-066	6.197e-061	1.0000	-65.3690
Cu(For)2(aq)	2.175e-066	3.340e-061	1.0000	-65.6625
Fe(For)2(aq)	1.145e-066	1.671e-061	1.0000	-65.9410
Na(For)2-	8.677e-067	9.804e-062	0.9332	-66.0917
K(For)2-	2.569e-067	3.316e-062	0.9332	-66.6203
Zn(For)2(aq)	1.283e-067	1.994e-062	1.0000	-66.8918
Ba(For)2(aq)	6.307e-068	1.434e-062	1.0000	-67.2002
Cd(For)2(aq)	5.378e-068	1.088e-062	1.0000	-67.2694
Pb(For)2(aq)	4.142e-069	1.231e-063	1.0000	-68.3828
Formaldehyde(aq)	2.349e-069	7.050e-065	1.0000	-68.6292
ClO3-	7.899e-072	6.590e-067	0.9326	-71.1327
N3-	1.603e-072	6.735e-068	0.9332	-71.8250
HN3(aq)	5.267e-075	2.266e-070	1.0000	-74.2784
Cu(NH3)2++	4.775e-076	4.659e-071	0.7597	-75.4404
S2O5--	3.691e-078	5.319e-073	0.7576	-77.5534
Cd(NH3)2++	6.643e-081	9.728e-076	0.7597	-80.2970
Urea(aq)	4.064e-081	2.440e-076	1.0000	-80.3910
HCN(aq)	1.577e-082	4.261e-078	1.0000	-81.8021
UO2ClO3+	2.544e-084	8.988e-079	0.9332	-83.6246
CN-	7.610e-085	1.979e-080	0.9319	-84.1492
Methanol(aq)	7.320e-086	2.345e-081	1.0000	-85.1355
ClO4-	1.685e-086	1.675e-081	0.9326	-85.8037
HS-	5.389e-092	1.782e-087	0.9326	-91.2988
Glycolate	5.195e-092	3.897e-087	0.9332	-91.3145
H2S(aq)	4.105e-092	1.399e-087	1.0000	-91.3867
Ca(Glyc)+	1.071e-093	1.232e-088	0.9332	-93.0003
Mg(Glyc)+	1.491e-094	1.480e-089	0.9332	-93.8567
Na(Glyc)(aq)	7.436e-095	7.288e-090	1.0000	-94.1287
Cu(Glyc)+	4.746e-095	6.575e-090	0.9332	-94.3537
K(Glyc)(aq)	2.616e-095	2.985e-090	1.0000	-94.5823
Glycolic_acid(aq	1.733e-095	1.318e-090	1.0000	-94.7611
Mn(Glyc)+	1.432e-095	1.861e-090	0.9332	-94.8740
Fe(Glyc)+	8.649e-096	1.132e-090	0.9332	-95.0931
Zn(Glyc)+	1.980e-096	2.780e-091	0.9332	-95.7333
Methane(aq)	5.027e-097	8.063e-093	1.0000	-96.2987
Ba(Glyc)+	2.995e-097	6.358e-092	0.9332	-96.5536
S2O3--	6.041e-098	6.772e-093	0.7576	-97.3394
S--	5.701e-098	1.827e-093	0.7617	-97.3623
Pb(Glyc)+	4.328e-098	1.221e-092	0.9332	-97.3938
Cd(Glyc)+	2.855e-098	5.350e-093	0.9332	-97.5744
S2O4--	2.011e-098	2.576e-093	0.7617	-97.8148
Acetate	1.519e-102	8.964e-098	0.9339	-101.8483
CaCH3COO+	5.420e-105	5.371e-100	0.9332	-104.2960
MgCH3COO+	4.429e-105	3.690e-100	0.9332	-104.3837
Acetic_acid(aq)	4.130e-105	2.480e-100	1.0000	-104.3840
NaCH3COO(aq)	1.502e-105	1.232e-100	1.0000	-104.8233
KCH3COO(aq)	3.755e-106	3.684e-101	1.0000	-105.4254
CuCH3COO+	2.824e-106	3.461e-101	0.9332	-105.5792
MnCH3COO+	1.733e-106	1.975e-101	0.9332	-105.7912
FeCH3COO+	2.739e-107	3.145e-102	0.9332	-106.5925
BaCH3COO+	7.512e-108	1.475e-102	0.9332	-107.1543
ZnCH3COO+	6.127e-108	7.622e-103	0.9332	-107.2428
PbCH3COO+	1.600e-108	4.260e-103	0.9332	-107.8258
CdCH3COO+	9.597e-109	1.645e-103	0.9332	-108.0479
AlCH3COO++	6.755e-111	5.809e-106	0.7597	-110.2897
Malonate	2.029e-111	2.070e-106	0.7576	-110.8133
Cu(NH3)3++	1.246e-111	1.428e-106	0.7597	-111.0239
CuCH3COO(aq)	7.907e-113	9.691e-108	1.0000	-112.1020
H-Malonate	3.872e-113	3.989e-108	0.9332	-112.4420

Malonic_acid(aq)	1.330e-117	1.384e-112	1.0000	-116.8761
Methanamine(aq)	7.337e-122	2.278e-117	1.0000	-121.1345
Glycine(aq)	2.698e-124	2.025e-119	1.0000	-123.5689
Cu(Gly)+	2.037e-124	2.802e-119	0.9332	-123.7210
Mg(Gly)+	1.605e-127	1.578e-122	0.9332	-126.8246
Zn(Gly)+	1.404e-128	1.957e-123	0.9332	-127.8827
Mn(Gly)+	1.230e-128	1.586e-123	0.9332	-127.9400
Fe(Gly)+	7.443e-129	9.665e-124	0.9332	-128.1583
Ca(Gly)+	2.771e-129	3.162e-124	0.9332	-128.5873
S3O6--	1.147e-129	2.204e-124	0.7576	-129.0610
Pb(Gly)+	4.922e-130	1.384e-124	0.9332	-129.3378
Cd(Gly)+	1.411e-130	2.630e-125	0.9332	-129.8805
Ba(Gly)+	4.611e-132	9.743e-127	0.9332	-131.3662
Acetaldehyde(aq)	1.877e-137	8.266e-133	1.0000	-136.7266
SCN-	8.366e-138	4.858e-133	0.9326	-137.1078
NH4CH3COO(aq)	1.475e-138	1.137e-133	1.0000	-137.8311
Acetamide(aq)	1.226e-138	7.238e-134	1.0000	-137.9116
UO2SCN+	1.938e-149	6.358e-144	0.9332	-148.7426
Zn(NH3)4++	4.313e-153	5.756e-148	0.7597	-152.4846
Cd(NH3)4++	1.694e-155	3.056e-150	0.7597	-154.8906
Ethanol(aq)	1.297e-158	5.973e-154	1.0000	-157.8871
Ethyne(aq)	1.174e-159	3.056e-155	1.0000	-158.9303
Ethylene(aq)	2.137e-163	5.992e-159	1.0000	-162.6703
Lactate	1.004e-164	8.941e-160	0.9332	-164.0282
Ca(Lac)+	1.217e-166	1.571e-161	0.9332	-165.9447
Mg(Lac)+	2.908e-167	3.296e-162	0.9332	-166.5664
Na(Lac)(aq)	1.467e-167	1.643e-162	1.0000	-166.8337
K(Lac)(aq)	5.160e-168	6.612e-163	1.0000	-167.2873
Cu(Lac)+	4.209e-168	6.422e-163	0.9332	-167.4058
Lactic_acid(aq)	3.517e-168	3.167e-163	1.0000	-167.4539
Mn(Lac)+	1.958e-168	2.819e-163	0.9332	-167.7382
Fe(Lac)+	1.478e-168	2.141e-163	0.9332	-167.8604
Zn(Lac)+	1.862e-169	2.875e-164	0.9332	-168.7601
Ba(Lac)+	2.395e-170	5.420e-165	0.9332	-169.6507
Pb(Lac)+	8.123e-171	2.406e-165	0.9332	-170.1203
Cd(Lac)+	3.732e-171	7.518e-166	0.9332	-170.4580
Ethane(aq)	3.938e-174	1.184e-169	1.0000	-173.4048
Propanoate	1.877e-177	1.371e-172	0.9332	-176.7565
Propanoic_acid(a	6.864e-180	5.083e-175	1.0000	-179.1634
Ca(Prop)+	3.733e-180	4.223e-175	0.9332	-179.4579
Na(Prop)(aq)	2.704e-180	2.597e-175	1.0000	-179.5680
Mg(Prop)+	1.483e-180	1.444e-175	0.9332	-179.8589
USCN+++	1.038e-180	3.074e-175	0.5418	-180.2498
K(Prop)(aq)	9.514e-181	1.067e-175	1.0000	-180.0216
Cu(Prop)+	3.416e-181	4.666e-176	0.9332	-180.4965
Mn(Prop)+	2.510e-181	3.212e-176	0.9332	-180.6303
Fe(Prop)+	7.936e-182	1.023e-176	0.9332	-181.1304
S4O6--	2.736e-182	6.134e-177	0.7576	-181.6834
Zn(Prop)+	4.683e-183	6.482e-178	0.9332	-182.3595
Pb(Prop)+	1.732e-183	4.853e-178	0.9332	-182.7914
Ba(Prop)+	1.230e-183	2.587e-178	0.9332	-182.9402
Cd(Prop)+	1.089e-183	2.019e-178	0.9332	-182.9930
Ca(Glyc)2(aq)	1.049e-183	1.994e-178	1.0000	-182.9792
Cu(Glyc)2(aq)	1.860e-184	3.972e-179	1.0000	-183.7306
Succinate	1.026e-184	1.191e-179	0.7576	-184.1093
Mg(Glyc)2(aq)	8.891e-185	1.550e-179	1.0000	-184.0510
Fe(Glyc)2(aq)	2.723e-185	5.607e-180	1.0000	-184.5649
Zn(Glyc)2(aq)	9.723e-186	2.094e-180	1.0000	-185.0122
Mn(Glyc)2(aq)	5.718e-186	1.172e-180	1.0000	-185.2428
Na(Glyc)2-	4.300e-186	7.440e-181	0.9332	-185.3965
H-Succinate	1.856e-186	2.173e-181	0.9332	-185.7613
K(Glyc)2-	1.306e-186	2.469e-181	0.9332	-185.9142
Serine(aq)	4.799e-187	5.042e-182	1.0000	-186.3189

Pb(Glyc)2(aq)	1.281e-187	4.575e-182	1.0000	-186.8925
Ba(Glyc)2(aq)	6.926e-188	1.990e-182	1.0000	-187.1595
Cd(Glyc)2(aq)	4.536e-188	1.190e-182	1.0000	-187.3433
Succinic_acid(aq	1.529e-189	1.805e-184	1.0000	-188.8156
Ethanamine(aq)	1.458e-196	6.573e-192	1.0000	-195.8361
Alanine(aq)	7.099e-198	6.323e-193	1.0000	-197.1488
Cu(Ala)+	1.213e-198	1.839e-193	0.9332	-197.9461
Fe(Ala)+	2.351e-202	3.383e-197	0.9332	-201.6587
Zn(Ala)+	3.502e-203	5.374e-198	0.9332	-202.4856
Mg(Ala)+	2.878e-203	3.234e-198	0.9332	-202.5708
Mn(Ala)+	2.777e-203	3.970e-198	0.9332	-202.5865
Ca(Ala)+	1.399e-203	1.793e-198	0.9332	-202.8842
Cd(Ala)+	2.090e-204	4.189e-199	0.9332	-203.7099
Pb(Ala)+	1.041e-204	3.072e-199	0.9332	-204.0127
Ca(CH3COO)2(aq)	1.473e-205	2.329e-200	1.0000	-204.8319
Mg(CH3COO)2(aq)	5.092e-206	7.249e-201	1.0000	-205.2931
Cu(CH3COO)2(aq)	1.385e-206	2.514e-201	1.0000	-205.8587
Ba(Ala)+	8.629e-207	1.944e-201	0.9332	-206.0941
Acetone(aq)	2.105e-207	1.223e-202	1.0000	-206.6766
Mn(CH3COO)2(aq)	2.087e-207	3.610e-202	1.0000	-206.6805
Na(CH3COO)2-	1.301e-207	1.835e-202	0.9332	-206.9156
Zn(CH3COO)2(aq)	9.395e-208	1.723e-202	1.0000	-207.0271
Fe(CH3COO)2(aq)	8.662e-208	1.506e-202	1.0000	-207.0624
Aspartic_acid(aq	3.995e-208	5.316e-203	1.0000	-207.3984
K(CH3COO)2-	2.145e-208	3.370e-203	0.9332	-207.6986
Ba(CH3COO)2(aq)	3.253e-209	8.305e-204	1.0000	-208.4878
Cd(CH3COO)2(aq)	2.900e-209	6.683e-204	1.0000	-208.5375
Pb(CH3COO)2(aq)	1.875e-209	6.097e-204	1.0000	-208.7270
Al(CH3COO)2+	1.080e-210	1.566e-205	0.9332	-209.9966
Propanal(aq)	8.582e-212	4.983e-207	1.0000	-211.0664
Cu(CH3COO)2-	1.681e-214	3.053e-209	0.9332	-213.8044
1-Propyne(aq)	2.437e-230	9.760e-226	1.0000	-229.6132
S3--	6.341e-231	6.098e-226	0.7576	-230.3184
1-Propanol(aq)	1.831e-233	1.100e-228	1.0000	-232.7374
1-Propene(aq)	5.388e-236	2.266e-231	1.0000	-235.2686
2-Hydroxybutanoa	5.086e-240	5.242e-235	0.9332	-239.3236
NH4(CH3COO)2-	2.127e-240	2.895e-235	0.9332	-239.7022
Asparagine(aq)	1.414e-241	1.867e-236	1.0000	-240.8496
Cu(Gly)2(aq)	2.472e-243	5.230e-238	1.0000	-242.6070
2-Hydroxybutanoi	1.577e-243	1.642e-238	1.0000	-242.8021
Propane(aq)	2.227e-249	9.816e-245	1.0000	-248.6524
Zn(Gly)2(aq)	1.861e-250	3.973e-245	1.0000	-249.7302
Diglycine(aq)	1.631e-250	2.155e-245	1.0000	-249.7875
Mg(Gly)2(aq)	7.470e-251	1.288e-245	1.0000	-250.1267
Fe(Gly)2(aq)	5.147e-252	1.049e-246	1.0000	-251.2884
Mn(Gly)2(aq)	4.507e-252	9.150e-247	1.0000	-251.3461
Butanoate	7.508e-253	6.538e-248	0.9332	-252.1545
Diketopiperazine	6.447e-253	7.354e-248	1.0000	-252.1907
Pb(Gly)2(aq)	3.821e-253	1.357e-247	1.0000	-252.4178
Cd(Gly)2(aq)	3.225e-253	8.398e-248	1.0000	-252.4915
Ca(Gly)2(aq)	4.537e-255	8.536e-250	1.0000	-254.3432
Butanoic_acid(aq	2.199e-255	1.937e-250	1.0000	-254.6578
Na(But)(aq)	1.040e-255	1.145e-250	1.0000	-254.9829
Ca(But)+	1.024e-255	1.302e-250	0.9332	-255.0198
Mg(But)+	3.876e-256	4.317e-251	0.9332	-255.4416
K(But)(aq)	3.660e-256	4.618e-251	1.0000	-255.4365
Cu(But)+	1.081e-256	1.629e-251	0.9332	-255.9960
Mn(But)+	8.559e-257	1.215e-251	0.9332	-256.0976
Fe(But)+	3.283e-257	4.692e-252	0.9332	-256.5137
Ba(Gly)2(aq)	8.446e-258	2.410e-252	1.0000	-257.0733
Zn(But)+	3.066e-258	4.674e-253	0.9332	-257.5434
Glutarate	3.439e-259	4.472e-254	0.7576	-258.5842
Ba(But)+	3.289e-259	7.380e-254	0.9332	-258.5129

Pb(But)+	1.944e-259	5.720e-254	0.9332	-258.7413
Cd(But)+	1.844e-259	3.678e-254	0.9332	-258.7642
H-Glutarate	3.627e-261	4.754e-256	0.9332	-260.4704
Threonine(aq)	1.969e-262	2.345e-257	1.0000	-261.7057
Glutaric_acid(aq	3.797e-264	5.014e-259	1.0000	-263.4206
Ethylacetate(aq)	1.621e-264	1.428e-259	1.0000	-263.7902
S5O6--	1.046e-264	2.681e-259	0.7576	-264.1009
1-Propanamine(aq	6.937e-271	4.099e-266	1.0000	-270.1588
a-Aminobutyric_a	6.120e-273	6.309e-268	1.0000	-272.2133
Glutamic_acid(aq	1.552e-281	2.283e-276	1.0000	-280.8091
UO2(SCN)2(aq)	8.345e-287	3.222e-281	1.0000	-286.0786
Butanal(aq)	1.193e-288	8.601e-284	1.0000	-287.9233
S4--	1.179e-297	1.512e-292	0.7576	-297.0490
1-Butyne(aq)	9.175e-306	4.962e-301	1.0000	-300.0000
Cu(CH3COO)3-	7.411e-307	1.783e-301	0.9332	-300.0000
Zn(CH3COO)3-	1.592e-308	3.861e-303	0.9332	-300.0000
Mn(CH3COO)3-	1.129e-308	2.619e-303	0.9332	-300.0000
Pb(CH3COO)3-	3.226e-309	1.240e-303	0.9332	-300.0000
1-Butanol(aq)	1.386e-309	1.027e-304	1.0000	-300.0000
Cd(CH3COO)3-	1.316e-310	3.810e-305	0.9332	-300.0000
1-Butene(aq)	1.302e-311	7.306e-307	1.0000	-300.0000
2-Hydroxypentano	3.873e-315	4.535e-310	0.9332	-300.0000
U(SCN)2++	9.761e-317	3.456e-311	0.7597	-300.0000
Glutamine(aq)	6.305e-317	9.211e-312	1.0000	-300.0000
2-Hydroxypentano	7.074e-319	8.355e-314	1.0000	-300.0000
Zn(CN)4--	0.0000	0.0000	0.7576	-300.0000
Cd(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Zn(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Zn(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Valine(aq)	0.0000	0.0000	1.0000	-300.0000
Undecanoic_acid(	0.0000	0.0000	1.0000	-300.0000
Undecanoate	0.0000	0.0000	0.9332	-300.0000
Cd(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Alanylglycine(aq	0.0000	0.0000	1.0000	-300.0000
2-Hexanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexyne(aq)	0.0000	0.0000	1.0000	-300.0000
H-Suberate	0.0000	0.0000	0.9332	-300.0000
H-Sebacate	0.0000	0.0000	0.9332	-300.0000
H-Pimelate	0.0000	0.0000	0.9332	-300.0000
H-Azelate	0.0000	0.0000	0.9332	-300.0000
H-Adipate	0.0000	0.0000	0.9332	-300.0000
2-Heptanone(aq)	0.0000	0.0000	1.0000	-300.0000
Tryptophan(aq)	0.0000	0.0000	1.0000	-300.0000
Toluene(aq)	0.0000	0.0000	1.0000	-300.0000
Suberic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Suberate	0.0000	0.0000	0.7576	-300.0000
Ca(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Sebacic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Sebacate	0.0000	0.0000	0.7576	-300.0000
Sb2S4--	0.0000	0.0000	0.7576	-300.0000
Ca(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Butanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexene(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(Pent)+	0.0000	0.0000	0.9332	-300.0000
S5--	0.0000	0.0000	0.7576	-300.0000
Ca(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Pimelic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Adipic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Phenylalanine(aq	0.0000	0.0000	1.0000	-300.0000
Phenol(aq)	0.0000	0.0000	1.0000	-300.0000
Pentanoic_acid(a	0.0000	0.0000	1.0000	-300.0000
Pentanoate	0.0000	0.0000	0.9332	-300.0000
Pentanal(aq)	0.0000	0.0000	1.0000	-300.0000

Fe(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Adipate	0.0000	0.0000	0.7576	-300.0000
1-Hexanol(aq)	0.0000	0.0000	1.0000	-300.0000
Fe(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Fe(Pent)+	0.0000	0.0000	0.9332	-300.0000
Pb(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Fe(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Pb(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Pb(Pent)+	0.0000	0.0000	0.9332	-300.0000
Pb(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Pimelate	0.0000	0.0000	0.7576	-300.0000
Ca(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Pb(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Pb(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Fe(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Octanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Octanoate	0.0000	0.0000	0.9332	-300.0000
Fe(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Octanal(aq)	0.0000	0.0000	1.0000	-300.0000
Nonanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
1-Hexanamine(aq)	0.0000	0.0000	1.0000	-300.0000
Nonanoate	0.0000	0.0000	0.9332	-300.0000
Nonanal(aq)	0.0000	0.0000	1.0000	-300.0000
Ethylbenzene(aq)	0.0000	0.0000	1.0000	-300.0000
Na(Prop)2-	0.0000	0.0000	0.9332	-300.0000
Na(Pent)2-	0.0000	0.0000	0.9332	-300.0000
Na(Pent)(aq)	0.0000	0.0000	1.0000	-300.0000
Na(Lac)2-	0.0000	0.0000	0.9332	-300.0000
Dodecanoic_acid(	0.0000	0.0000	1.0000	-300.0000
2-Pentanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Pentyne(aq)	0.0000	0.0000	1.0000	-300.0000
Dodecanoate	0.0000	0.0000	0.9332	-300.0000
Na(But)2-	0.0000	0.0000	0.9332	-300.0000
Decanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Benzoic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
2-Octanone(aq)	0.0000	0.0000	1.0000	-300.0000
Decanoate	0.0000	0.0000	0.9332	-300.0000
Decanal(aq)	0.0000	0.0000	1.0000	-300.0000
Benzoate	0.0000	0.0000	0.9357	-300.0000
Benzene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Pentene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptyne(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Pent)+	0.0000	0.0000	0.9332	-300.0000
Mn(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Pent)+	0.0000	0.0000	0.9332	-300.0000
Tyrosine(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyoctanoi	0.0000	0.0000	1.0000	-300.0000
1-Pentanol(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mn(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyoctanoa	0.0000	0.0000	0.9332	-300.0000
Ba(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxynonanoi	0.0000	0.0000	1.0000	-300.0000
1-Pentanamine(aq	0.0000	0.0000	1.0000	-300.0000
1-Heptene(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000

Mg(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Pent)+	0.0000	0.0000	0.9332	-300.0000
UO2(SCN)3-	0.0000	0.0000	0.9332	-300.0000
Mg(Pent)+	0.0000	0.0000	0.9332	-300.0000
Mg(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxynonanoa	0.0000	0.0000	0.9332	-300.0000
Cu(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyhexanoi	0.0000	0.0000	1.0000	-300.0000
1-Octyne(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Methionine(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyhexanoa	0.0000	0.0000	0.9332	-300.0000
Leucylglycine(aq	0.0000	0.0000	1.0000	-300.0000
Leucine(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyheptano	0.0000	0.0000	1.0000	-300.0000
1-Octene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptanol(aq)	0.0000	0.0000	1.0000	-300.0000
K(Prop)2-	0.0000	0.0000	0.9332	-300.0000
Cd(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
K(Pent)2-	0.0000	0.0000	0.9332	-300.0000
K(Pent)(aq)	0.0000	0.0000	1.0000	-300.0000
K(Lac)2-	0.0000	0.0000	0.9332	-300.0000
Cd(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyheptano	0.0000	0.0000	0.9332	-300.0000
Cd(Pent)+	0.0000	0.0000	0.9332	-300.0000
Ba(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
K(But)2-	0.0000	0.0000	0.9332	-300.0000
p-Toluate	0.0000	0.0000	0.9332	-300.0000
Isoleucine(aq)	0.0000	0.0000	1.0000	-300.0000
Cd(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxydecanoi	0.0000	0.0000	1.0000	-300.0000
1-Octanol(aq)	0.0000	0.0000	1.0000	-300.0000
Hexanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
n-Propylbenzene(	0.0000	0.0000	1.0000	-300.0000
Hexanoate	0.0000	0.0000	0.9332	-300.0000
Hexanal(aq)	0.0000	0.0000	1.0000	-300.0000
n-Octane(aq)	0.0000	0.0000	1.0000	-300.0000
Heptanoic_acid(a	0.0000	0.0000	1.0000	-300.0000
Ba(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Heptanoate	0.0000	0.0000	0.9332	-300.0000
n-Heptane(aq)	0.0000	0.0000	1.0000	-300.0000
Heptanal(aq)	0.0000	0.0000	1.0000	-300.0000
n-Butane(aq)	0.0000	0.0000	1.0000	-300.0000
m-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
m-Toluate	0.0000	0.0000	0.9332	-300.0000
HSb2S4-	0.0000	0.0000	0.9332	-300.0000
2-Hydroxydecanoa	0.0000	0.0000	0.9332	-300.0000
Azelate	0.0000	0.0000	0.7576	-300.0000
Zn(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Zn(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Zn(Pent)+	0.0000	0.0000	0.9332	-300.0000
Zn(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
n-Butylbenzene(a	0.0000	0.0000	1.0000	-300.0000
Azelaic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
n-Heptylbenzene(	0.0000	0.0000	1.0000	-300.0000
n-Hexane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Hexylbenzene(a	0.0000	0.0000	1.0000	-300.0000
1-Octanamine(aq)	0.0000	0.0000	1.0000	-300.0000
n-Octylbenzene(a	0.0000	0.0000	1.0000	-300.0000
n-Pentane(aq)	0.0000	0.0000	1.0000	-300.0000

n-Pentylbenzene(	0.0000	0.0000	1.0000	-300.0000
1-Heptanamine(aq	0.0000	0.0000	1.0000	-300.0000
o-Phthalate	0.0000	0.0000	0.7576	-300.0000
o-Toluate	0.0000	0.0000	0.9332	-300.0000
o-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
1-Butanamine(aq)	0.0000	0.0000	1.0000	-300.0000
p-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
(NH4)2Sb2S4(aq)	0.0000	0.0000	1.0000	-300.0000

Mineral saturation states

	log Q/K		log Q/K
Nontronite-Ca	22.5179s/sat	UO2SO4:H2O	-10.9589
Nontronite-Mg	22.4428s/sat	Mg1.25SO4(OH)0.5	-10.9763
Nontronite-K	22.3771s/sat	Na2CO3:7H2O	-11.1091
Nontronite-Na	22.1240s/sat	Cotunnite	-11.2863
Nontronite-H	21.6949s/sat	Sepiolite	-11.3114
Hematite	18.0566s/sat	Clinochlore-7A	-11.4276
Ferrite-Cu	15.6318s/sat	Periclase	-11.9744
Magnetite	15.4316s/sat	Forsterite	-12.0074
Cronstedtite-7A	14.2024s/sat	MnSO4	-12.0560
Ferrite-Zn	13.2270s/sat	UPO5	-12.1227
Delafossite	12.5533s/sat	Na2U2O7	-12.1524
Clinoptilolite-h	10.8820s/sat	UO2.6667	-12.1687
Clinoptilolite-C	10.8010s/sat	BaU2O7	-12.1915
Muscovite	10.7775s/sat	CdSO4	-12.1938
Clinoptilolite-K	10.4740s/sat	UO2ClOH:2H2O	-12.3153
Clinoptilolite-h	10.1509s/sat	Gyrolite	-12.3379
Stilbite	9.4227s/sat	Przhevalskite	-12.3873
Goethite	8.5681s/sat	Portlandite	-12.4866
Clinoptilolite-N	7.4472s/sat	MgUO4	-12.4978
Clinoptilolite-h	7.4455s/sat	Mg1.5SO4(OH)	-12.5531
Illite	7.3442s/sat	Thermonatrite	-12.5675
Beidellite-Ca	7.3407s/sat	Bassetite	-12.7820
Beidellite-Mg	7.2655s/sat	Na2CO3	-12.8916
Beidellite-K	7.2000s/sat	Autunite-H	-12.9484
Epidote-ord	7.0263s/sat	FeSO4	-13.0037
Epidote	7.0253s/sat	Uraninite	-13.0216
Paragonite	6.9505s/sat	Monticellite	-13.1205
Beidellite-Na	6.9467s/sat	MgSO4	-13.2049
Kaolinite	6.8452s/sat	PbF2	-13.2565
Ferrite-Ca	6.6568s/sat	Coffinite	-13.2700
Beidellite-H	6.5181s/sat	Chalcocyanite	-13.2740
Ferrite-Mg	6.4695s/sat	Mordenite-dehy	-14.0418
Mesolite	6.2770s/sat	FeF2	-14.1784
Pyrophyllite	6.2608s/sat	BaCl2:2H2O	-14.3104
Fluorapatite	6.1990s/sat	CdCl2:H2O	-14.5739
Montmor-Ca	5.8990s/sat	ZnSO4	-14.8177
Montmor-Mg	5.8987s/sat	BaCl2:H2O	-15.0422
Montmor-K	5.8331s/sat	UO2SO4:3.5H2O	-15.4251
Andradite	5.8325s/sat	UO2SO4:2.5H2O	-15.4856
Montmor-Na	5.5751s/sat	UO2SO4:3H2O	-15.5630
Scolecite	4.8121s/sat	CdCl2	-15.6928
Jarosite	4.1942s/sat	UO2F2:3H2O	-15.8035
Maximum_Microcli	4.1780s/sat	NaUO3	-15.8500
K-Feldspar	4.1761s/sat	MnCl2:4H2O	-16.0469
Laumontite	3.5056s/sat	Zn(NO3)2:6H2O	-16.0858
Fe(OH)3	3.2515s/sat	UO2F2	-16.1231
Smectite-low-Fe-	3.1200s/sat	Alum-K	-16.2500
Diaspore	3.0632s/sat	Pb4SO7	-16.3633
Celadonite	2.9747s/sat	BaCl2	-16.5905
Margarite	2.9303s/sat	Ba(OH)2:8H2O	-16.6849
Sanidine_high	2.8816s/sat	ZnF2	-17.0448

Boehmite	2.6348s/sat	Natrosilite	-17.1798
Gibbsite	2.5380s/sat	CaAl2O4	-17.1978
Mordenite	1.9827s/sat	MnCl2:2H2O	-17.4939
Smectite-high-Fe	1.8589s/sat	CdF2	-17.4979
Corundum	1.8347s/sat	MgOHCl	-17.5534
Lawsonite	1.8281s/sat	Ningyoite	-17.6631
Witherite	1.3148s/sat	Na2SiO3	-17.8619
Albite_low	1.2846s/sat	UO2.3333(beta)	-17.9614
Albite	1.2845s/sat	CuCl2	-18.2058
Kyanite	0.9900s/sat	Ba2Si3O8	-18.5712
Andalusite	0.6821s/sat	Tremolite	-18.5909
Analcime	0.6217s/sat	CaAl4O7	-18.9408
Quartz	0.5914s/sat	MnCl2:H2O	-19.1767
Dawsonite	0.4022s/sat	Ferrite-Dicalciu	-19.3015
Tridymite	0.3911s/sat	UO2SO4	-19.3347
Barite	0.3313s/sat	Gehlenite	-19.5063
Chalcedony	0.3066s/sat	MgCl2:4H2O	-19.6273
Sillimanite	0.2901s/sat	Hillebrandite	-19.9018
Tenorite	0.2825s/sat	Dicalcium_silica	-20.3788
Malachite	0.2344s/sat	UOFOH:.5H2O	-20.6806
Strengite	0.0976s/sat	Hydromagnesite	-20.7662
Cristobalite(alp	0.0080s/sat	UO2(NO3)2:6H2O	-21.0805
Natrolite	-0.0692	Na2UO4(alpha)	-21.1686
Ice	-0.0850	UOFOH	-21.1894
Albite_high	-0.1306	Larnite	-21.7553
Coesite	-0.2566	Akermanite	-22.1649
Kalsilite	-0.3438	UO2Cl	-22.3631
Chamosite-7A	-0.3466	Scacchite	-22.5904
Cristobalite(bet	-0.4768	ZnCl2	-22.6273
Alunite	-0.5227	UO2(NO3)2:3H2O	-22.7303
Cerussite	-0.6325	Lime	-23.0754
Rhodochrosite	-0.7784	UOF2:H2O	-23.3757
SiO2(am)	-0.8136	(UO2)3(PO4)2	-23.6964
Jadeite	-0.9287	UO2(PO3)2	-23.7870
Hercynite	-0.9929	Hydrophilite	-23.8525
Calcite	-1.0365	Lawrencite	-23.8812
Brochantite	-1.0919	UOF2	-24.0261
Aragonite	-1.1816	UO2(NO3)2:2H2O	-24.0952
Wairakite	-1.3658	(UO2)2P2O7	-24.2072
Dolomite-ord	-1.4869	U(HPO4)2:4H2O	-25.3050
Dolomite	-1.4869	MgCl2:2H2O	-25.4576
Dioptase	-1.5130	UP2O7	-25.6390
Siderite	-1.7518	KAl(SO4)2	-25.8045
Monohydrocalcite	-1.8371	K2UO4	-25.8108
Prehnite	-1.9717	Anthophyllite	-25.8709
Annite	-2.1285	UO2Cl2:3H2O	-27.0142
Magnesite	-2.1689	Pb	-27.0422
Amesite-14A	-2.3712	Clinoptilolite-d	-27.0498
Clinozoisite	-2.3838	Clinoptilolite-d	-27.4133
Zoisite	-2.4319	UO2(NO3)2:H2O	-27.9267
Gypsum	-2.5475	Rankinite	-28.3522
Anhydrite	-2.8643	Pargasite	-28.8060
Berlinite	-3.0094	MgCl2:H2O	-29.0362
Daphnite-14A	-3.0210	UO2Cl2:H2O	-29.9665
Anorthite	-3.0426	Clinoptilolite-d	-30.4168
Nepheline	-3.0869	Ettringite	-31.1412
Dolomite-dis	-3.1387	UO2(NO3)2	-31.6083
Ferrosilite	-3.1471	Tobermorite-14A	-32.0936
Smithsonite	-3.2451	UF4:2.5H2O	-32.8176
Fluorite	-3.2654	UO2SO3	-33.1911
Alamosite	-3.3328	Ba2SiO4	-33.6865
Zn2SiO4	-3.3337	KMgCl3:2H2O	-33.8030
Bassanite	-3.5136	UO2Cl2	-34.0727

Sb2O3	-3.6565	Tobermorite-11A	-34.3274
CaSO4:0.5H2O(bet	-3.7001	Zn3O(SO4)2	-34.8752
Schoepite	-3.7066	Chloromagnesite	-35.1216
UO3:2H2O	-3.7066	Foshagite	-35.3740
UO2(OH)2(beta)	-3.8716	Merwinite	-35.4006
Schoepite-dehy(.	-3.9327	Al2(SO4)3:6H2O	-35.7729
UO3:.9H2O(alpha)	-3.9390	BaSiF6	-36.2070
Atacamite	-4.0006	Afwillite	-36.6216
Phlogopite	-4.0197	Cd	-36.9583
Schoepite-dehy(.	-4.0244	UF4	-37.3562
Schoepite-dehy(1	-4.0407	Fe	-37.4012
Anglesite	-4.0568	Tobermorite-9A	-38.1626
Saponite-Ca	-4.1107	Molysite	-39.0486
Saponite-Mg	-4.1841	Fe2(SO4)3	-40.7282
Minnesotaite	-4.1842	U(SO4)2:8H2O	-41.4045
Saponite-K	-4.2514	KMgCl3	-41.5674
Hydroxylapatite	-4.3039	BaO	-41.8308
CaUO4	-4.3206	U(SO4)2:4H2O	-42.7254
Whitlockite	-4.3262	U(SO4)2	-42.9794
Zincite	-4.3390	Ba2U2O7	-44.7571
Saponite-Na	-4.5045	C	-44.9919
Cuprite	-4.5486	UOCl2	-46.4224
Rhodonite	-4.6163	U(CO3)2	-46.5293
UO2CO3	-4.6383	Hatrurite	-47.3155
Rutherfordine	-4.6523	UClF3	-48.5028
Sellaite	-4.6573	Zn	-48.5629
Zn(OH)2(epsilon)	-4.7375	U5O12Cl	-49.6996
Saponite-H	-4.9334	Xonotlite	-51.2462
Zn(OH)2(beta)	-5.0216	UOF4	-53.5437
Azurite	-5.0483	Al2(SO4)3	-54.4862
Enstatite	-5.0719	Na3UO4	-57.0495
Wustite	-5.1352	(UO2)2Cl3	-57.6348
Talc	-5.1993	Na	-58.1163
Schoepite-dehy(.	-5.2118	UOCl3	-58.7584
Paralaurionite	-5.2124	UF3	-59.4035
Nesquehonite	-5.2775	Na4SiO4	-59.6109
CdSiO3	-5.2914	UF5(beta)	-60.1853
Bixbyite	-5.3554	UF5(alpha)	-60.5887
Nahcolite	-5.5044	Mn	-61.5690
Pyrolusite	-5.5103	Na2O	-61.7075
Lanarkite	-5.5491	Pb2Cl5NH4	-61.9315
Ripidolite-14A	-5.6618	UCl2F2	-61.9638
Niter	-5.7204	K	-62.2170
Schoepite-dehy(.	-5.7618	Ca4Al2Fe2O10	-64.0088
UO2HPO4:4H2O	-5.8660	Ca3Al2O6	-64.3608
FeO	-5.9584	UOCl	-64.5648
Greenalite	-6.0107	Covellite	-66.3551
Analcime-dehy	-6.0967	S	-67.5649
Fe(OH)2	-6.2402	Chalcocite	-68.7373
Daphnite-7A	-6.5255	U2O3F6	-69.8148
Brucite	-6.5994	Ba3UO6	-72.7219
Okenite	-6.7647	UCl3F	-75.2408
Mn(OH)2(am)	-6.7894	CdS	-75.6954
UO3(gamma)	-6.8429	Galena	-76.8007
Wollastonite	-6.9288	Sphalerite	-79.1840
Litharge	-7.0191	K2O	-79.7627
Chalcanthite	-7.0641	Wurtzite	-81.5989
Fayalite	-7.1373	U(SO3)2	-81.8483
Pseudowollastoni	-7.1939	CdCl2(NH3)2	-84.0325
Massicot	-7.2161	ZnCl2(NH3)2	-84.8687
NaFeO2	-7.2720	Troilite	-86.3262
Melanterite	-7.2738	UCl4	-86.3566
UO3(beta)	-7.4768	Pyrrhotite	-86.4301

Nantokite	-7.4987	Na6Si2O7	-86.7443
Cordierite_hydr	-7.5218	PbSO4(NH3)2	-86.9491
Mirabilite	-7.6389	Alabandite	-89.0150
Diopside	-7.6543	UCl3	-89.8928
Hausmannite	-7.7845	UF6	-91.9793
UO3(alpha)	-7.8307	U3O5F8	-93.2646
PbCO3.PbO	-7.9306	U2F9	-94.2487
Clinochlore-14A	-7.9351	Mg	-102.0075
Sylvite	-7.9552	U2O2Cl5	-106.4670
Spinel	-8.0569	UCl5	-107.2916
PbFCl	-8.1152	BaS	-107.3176
Cd(OH)2	-8.1311	UN1.73(alpha)	-108.5115
FeF3	-8.1575	UN1.59(alpha)	-111.3506
Arcanite	-8.1808	P	-119.1270
UO2FOH:2H2O	-8.2810	Ca	-119.4719
Hedenbergite	-8.3890	Antigorite	-119.9565
Chrysotile	-8.4042	Al	-122.5509
Halite	-8.4240	Ba	-123.6820
Cu	-8.4943	UN	-124.8551
ZnSO4:7H2O	-8.6183	UCl6	-127.0148
Cd(OH)Cl	-8.7144	Si	-127.4112
UO2FOH:H2O	-8.7370	Pb(N3)2(orth)	-142.5498
Sanbornite	-8.7998	Pyrite	-142.9572
AlF3	-8.8116	Pb(N3)2(mono)	-143.0062
Saleeite	-8.8384	Chalcopyrite	-146.4809
ZnSO4:6H2O	-8.9230	ZnCl2(NH3)4	-162.1114
Thenardite	-9.1177	CdCl2(NH3)4	-163.0509
Ripidolite-7A	-9.1583	PbSO4(NH3)4	-167.6436
Huntite	-9.2192	U4F17	-168.0511
Ca-Al_Pyroxene	-9.2569	U	-173.3167
UO2FOH	-9.2619	US	-181.8316
Nitrobarite	-9.3433	Zn(ClO4)2:6H2O	-184.1124
Tephroite	-9.4263	UC	-200.1224
BaUO4	-9.4641	UH3(beta)	-203.0792
Manganosite	-9.6083	US1.9	-207.9627
Artinite	-9.6158	US2	-212.9154
Monteponite	-9.6278	Mayenite	-238.6686
UO2.25	-9.8039	ZnCl2(NH3)6	-241.0863
(UO2)3(PO4)2:4H2	-9.8150	CdCl2(NH3)6	-242.1634
UO2.25(beta)	-9.8724	UP	-243.4900
Torbernite	-10.0297	UC1.94(alpha)	-244.5394
Pb2SiO4	-10.0904	Stibnite	-252.9960
Cordierite_anhyd	-10.1525	US3	-277.1565
CdSO4:2.667H2O	-10.2190	Pb(SCN)2	-282.4818
Phosgenite	-10.2618	Bornite	-283.6417
ZnSO4:H2O	-10.4262	UP2	-357.3001
CdSO4:H2O	-10.4734	U2S3	-387.4864
Uranocircite	-10.4898	o-Phthalic_acid	-396.7500
Natron	-10.5542	U2C3	-446.8323
Grossular	-10.8156	U3S5	-595.5970
Pb3SO6	-10.9216	U3P4	-844.2789

Gases	fugacity	log fug.
N2(g)	0.1690	-0.772
H2O(g)	0.01061	-1.974
CO2(g)	0.003611	-2.442
NO2(g)	8.919e-012	-11.050
HF(g)	1.084e-014	-13.965
HCl(g)	5.792e-019	-18.237
H2(g)	8.575e-030	-29.067
O2(g)	1.023e-030	-29.990
NO(g)	5.533e-032	-31.257

CO(g)	1.032e-035	-34.986
SiF4(g)	9.321e-039	-38.031
NH3(g)	1.988e-041	-40.702
SO2(g)	4.360e-043	-42.361
Cl2(g)	3.874e-043	-42.412
Cd(g)	3.437e-052	-51.464
Pb(g)	6.741e-058	-57.171
UO2F2(g)	2.179e-061	-60.662
Cu(g)	2.537e-064	-63.596
Zn(g)	4.906e-067	-66.309
UO2Cl2(g)	5.216e-073	-72.283
Na(g)	2.919e-073	-72.535
K(g)	2.592e-074	-73.586
UO3(g)	1.551e-074	-73.809
UOF4(g)	2.123e-075	-74.673
UF5(g)	5.523e-082	-81.258
UF4(g)	1.258e-084	-83.900
H2S(g)	2.681e-091	-90.572
UF6(g)	5.799e-094	-93.237
CH4(g)	2.597e-094	-93.586
F2(g)	7.310e-101	-100.136
UCl4(g)	2.888e-113	-112.539
UO2(g)	1.454e-115	-114.838
Mg(g)	1.016e-123	-122.993
UCl5(g)	1.311e-126	-125.883
UF3(g)	1.065e-130	-129.972
UCl6(g)	2.512e-134	-133.600
U2F10(g)	1.984e-136	-135.703
UCl3(g)	4.118e-139	-138.385
Ca(g)	5.737e-147	-146.241
S2(g)	7.113e-151	-150.148
C2H4(g)	3.077e-161	-160.512
C(g)	1.387e-169	-168.858
UF2(g)	2.114e-173	-172.675
Al(g)	7.644e-177	-176.117
UCl2(g)	4.857e-183	-182.314
UO(g)	1.238e-189	-188.907
Si(g)	4.080e-203	-202.389
UF(g)	2.622e-209	-208.581
U2Cl8(g)	2.033e-214	-213.692
U2Cl10(g)	2.060e-224	-223.686
UCl(g)	1.993e-224	-223.700
U(g)	2.784e-264	-263.555

		In fluid		Sorbed		Kd
Original basis	total moles	moles	mg/kg	moles	mg/kg	L/kg
Al+++	1.45e-006	1.45e-006	0.0391			
Ba++	7.19e-007	7.19e-007	0.0988			
Ca++	0.000537	0.000537	21.5			
Cd++	7.83e-009	7.83e-009	0.000880			
Cl-	0.000110	0.000110	3.91			
Cu++	1.05e-006	1.05e-006	0.0665			
F-	1.03e-005	1.03e-005	0.196			
Fe++	1.05e-006	1.05e-006	0.0587			
H+	0.000187	0.000187	0.188			
H2O	55.5	55.5	1.00e+006			
HCO3-	0.00164	0.00164	99.7			
HPO4--	2.31e-006	2.31e-006	0.221			
K+	0.000550	0.000550	21.5			
Mg++	0.000161	0.000161	3.91			
Mn++	8.10e-006	8.10e-006	0.445			
NH3(aq)	0.000283	0.000283	4.82			

NO3-	0.00117	0.00117	72.7
Na+	0.00136	0.00136	31.3
O2(aq)	0.000212	0.000212	6.80
Pb++	5.19e-009	5.19e-009	0.00108
S2--	7.63e-007	7.63e-007	0.0489
SO4--	0.000316	0.000316	30.3
Sb(OH)3(aq)	2.57e-007	2.57e-007	0.0444
SiO2(aq)	0.000179	0.000179	10.8
UO2++	8.22e-009	8.22e-009	0.00222
Zn++	1.50e-007	1.50e-007	0.00978

Elemental composition		In fluid		Sorbed	
	total moles	moles	mg/kg	moles	mg/kg
Aluminum	1.450e-006	1.450e-006	0.03911		
Antimony	2.571e-007	2.571e-007	0.03129		
Barium	7.194e-007	7.194e-007	0.09876		
Cadmium	7.831e-009	7.831e-009	0.0008801		
Calcium	0.0005369	0.0005369	21.51		
Carbon	0.001635	0.001635	19.63		
Chlorine	0.0001104	0.0001104	3.911		
Copper	1.047e-006	1.047e-006	0.06649		
Fluorine	1.030e-005	1.030e-005	0.1956		
Hydrogen	111.0	111.0	1.119e+005		
Iron	1.051e-006	1.051e-006	0.05867		
Lead	5.193e-009	5.193e-009	0.001076		
Magnesium	0.0001610	0.0001610	3.911		
Manganese	8.101e-006	8.101e-006	0.4449		
Nitrogen	0.001456	0.001456	20.39		
Oxygen	55.52	55.52	8.880e+005		
Phosphorus	2.305e-006	2.305e-006	0.07138		
Potassium	0.0005504	0.0005504	21.51		
Silicon	0.0001791	0.0001791	5.028		
Sodium	0.001361	0.001361	31.29		
Sulfur	0.0003172	0.0003172	10.17		
Uranium	8.219e-009	8.219e-009	0.001956		
Zinc	1.496e-007	1.496e-007	0.009778		

```
Temperature =  10.3 C    Pressure =  1.013 bars
pH =  7.700              log fO2 =  -26.089
Eh =   0.4320 volts      pe =   7.6810
Ionic strength      =    0.007290
Charge imbalance    =    0.000189 eq/kg (3.77% error)
Activity of water   =    0.999996
Solvent mass        =    1.000000 kg
Solution mass       =    1.000427 kg
Solution density    =    1.023    g/cm3
Chlorinity          =    0.000110 molal
Dissolved solids    =         427 mg/kg sol'n
Hardness            =      198.19 mg/kg sol'n as CaCO3
  carbonate         =      128.90 mg/kg sol'n as CaCO3
  non-carbonate     =       69.30 mg/kg sol'n as CaCO3
Rock mass           =    0.000000 kg
Carbonate alkalinity=      128.90 mg/kg sol'n as CaCO3
Water type          =    Ca-HCO3
```

Nernst redox couples	Eh (volts)	pe
e- + .25*O2(aq) + H+ = .5*H2O	0.4320	7.6810

No minerals in system.

Aqueous species	molality	mg/kg sol'n	act. coef.	log act.
HCO3-	0.002517	153.5	0.9160	-2.6372
Ca++	0.001584	63.44	0.7146	-2.9463
NO3-	0.001543	95.63	0.9139	-2.8508
Na+	0.001101	25.31	0.9160	-2.9962
SO4--	0.0003711	35.64	0.7026	-3.5837
Mg++	0.0003047	7.401	0.7257	-3.6555
K+	0.0001997	7.804	0.9139	-3.7387
SiO2(aq)	0.0001897	11.39	1.0000	-3.7220
CO2(aq)	0.0001345	5.918	1.0000	-3.8712
Cl-	0.0001103	3.908	0.9139	-3.9966
CaSO4(aq)	3.560e-005	4.844	1.0000	-4.4486
CaHCO3+	3.300e-005	3.335	0.9160	-4.5196
MgSO4(aq)	1.023e-005	1.231	1.0000	-4.9900
CaCO3(aq)	6.785e-006	0.6788	1.0000	-5.1685
MgHCO3+	6.250e-006	0.5330	0.9160	-5.2422
CO3--	5.327e-006	0.3195	0.7057	-5.4249
F-	5.095e-006	0.09675	0.9150	-5.3315
NaHCO3(aq)	4.435e-006	0.3724	1.0000	-5.3531
Ba++	9.604e-007	0.1318	0.7087	-6.1670
HSiO3-	7.167e-007	0.05523	0.9160	-6.1828
MgCO3(aq)	6.879e-007	0.05798	1.0000	-6.1625
KSO4-	3.904e-007	0.05275	0.9160	-6.4466
OH-	1.637e-007	0.002782	0.9150	-6.8246
Cu++	1.077e-007	0.006842	0.7146	-7.1136
NaHSiO3(aq)	4.111e-008	0.004113	1.0000	-7.3860
CaF+	2.613e-008	0.001543	0.9160	-7.6209
MgF+	2.590e-008	0.001121	0.9160	-7.6248
CaCl+	2.533e-008	0.001913	0.9160	-7.6344
H+	2.157e-008	2.173e-005	0.9251	-7.7000
NaCO3-	2.041e-008	0.001693	0.9160	-7.7283
MgCl+	1.944e-008	0.001161	0.9160	-7.7494
NaCl(aq)	1.572e-008	0.0009184	1.0000	-7.8035
UO2(CO3)3----	1.278e-009	0.0005749	0.2433	-9.5074
BaCO3(aq)	8.312e-010	0.0001640	1.0000	-9.0803
UO2(CO3)2--	7.655e-010	0.0002985	0.7026	-9.2693
KCl(aq)	4.417e-010	3.291e-005	1.0000	-9.3549

NaF(aq)	4.196e-010	1.761e-005	1.0000	-9.3772
HSO4-	3.767e-010	3.655e-005	0.9160	-9.4621
HF(aq)	1.062e-010	2.124e-006	1.0000	-9.9739
NaOH(aq)	2.659e-011	1.063e-006	1.0000	-10.5752
BaCl+	1.966e-011	3.396e-006	0.9160	-10.7444
UO2CO3(aq)	1.042e-011	3.438e-006	1.0000	-10.9820
CaCl2(aq)	3.238e-012	3.592e-007	1.0000	-11.4897
BaF+	1.971e-012	3.080e-007	0.9160	-11.7434
HNO3(aq)	1.018e-012	6.414e-008	1.0000	-11.9921
Cu+	5.610e-013	3.563e-008	0.9160	-12.2892
HCl(aq)	4.273e-013	1.557e-008	1.0000	-12.3693
UO2OH+	8.267e-014	2.372e-008	0.9160	-13.1208
KHSO4(aq)	3.646e-015	4.963e-010	1.0000	-14.4382
UO2++	8.660e-016	2.337e-010	0.7057	-15.2138
UO2F+	3.459e-016	9.994e-011	0.9160	-15.4991
UO2SO4(aq)	1.296e-016	4.742e-011	1.0000	-15.8875
HF2-	1.108e-016	4.321e-012	0.9160	-15.9934
UO2F2(aq)	4.649e-018	1.431e-012	1.0000	-17.3327
UO2(SO4)2--	2.955e-019	1.365e-013	0.7026	-18.6826
UO2Cl+	8.382e-020	2.560e-014	0.9160	-19.1147
UO2F3-	4.058e-021	1.327e-015	0.9160	-20.4297
(UO2)2(OH)2++	1.353e-021	7.763e-016	0.7057	-21.0201
UO2+	3.202e-022	8.643e-017	0.9160	-21.5327
(UO2)3(CO3)6(6-)	7.126e-023	8.335e-017	0.0415	-23.5288
(UO2)3(OH)5+	2.451e-024	2.193e-018	0.9160	-23.6488
UO2Cl2(aq)	3.461e-025	1.180e-019	1.0000	-24.4607
UO2F4--	1.519e-025	5.252e-020	0.7026	-24.9719
U(OH)4(aq)	1.533e-026	4.689e-021	1.0000	-25.8145
O2(aq)	1.390e-029	4.446e-025	1.0000	-28.8570
Formate	4.727e-034	2.127e-029	0.9150	-33.3640
ClO-	7.832e-035	4.028e-030	0.9160	-34.1442
H2(aq)	6.751e-035	1.360e-031	1.0000	-34.1706
Ca(For)+	1.602e-035	1.363e-030	0.9160	-34.8334
Mg(For)+	3.793e-036	2.629e-031	0.9160	-35.4591
HO2-	6.008e-037	1.982e-032	0.9160	-36.2593
Na(For)(aq)	5.182e-037	3.522e-032	1.0000	-36.2855
K(For)(aq)	8.135e-038	6.840e-033	1.0000	-37.0897
Formic_acid(aq)	5.084e-038	2.339e-033	1.0000	-37.2938
SO3--	8.638e-039	6.913e-034	0.7057	-38.2150
Ba(For)+	7.305e-039	1.331e-033	0.9160	-38.1745
Cu(For)+	4.536e-039	4.923e-034	0.9160	-38.3814
HSO3-	1.883e-039	1.526e-034	0.9160	-38.7632
SiF6--	4.712e-040	6.692e-035	0.7026	-39.4800
CO(aq)	8.307e-041	2.326e-036	1.0000	-40.0806
Oxalate	2.757e-041	2.426e-036	0.7026	-40.7128
U(CO3)5(6-)	1.336e-043	7.183e-038	0.0415	-44.2560
H-Oxalate	6.963e-045	6.196e-040	0.9160	-44.1953
HSO5-	6.191e-045	6.997e-040	0.9160	-44.2464
UOH+++	5.017e-045	1.279e-039	0.4605	-44.6363
SO2(aq)	1.857e-045	1.189e-040	1.0000	-44.7312
UF2++	2.179e-046	6.013e-041	0.7057	-45.8130
UF3+	1.580e-046	4.660e-041	0.9160	-45.8394
UF+++	8.970e-048	2.305e-042	0.4605	-47.3839
UF4(aq)	7.106e-048	2.230e-042	1.0000	-47.1484
USO4++	4.622e-049	1.544e-043	0.7057	-48.4865
U(SO4)2(aq)	3.684e-049	1.584e-043	1.0000	-48.4337
Oxalic_acid(aq)	2.310e-051	2.079e-046	1.0000	-50.6364
U++++	1.724e-051	4.102e-046	0.2561	-51.3551
UCl+++	7.533e-054	2.059e-048	0.4605	-53.4598
ClO2-	1.062e-057	7.157e-053	0.9160	-57.0122
S2O8--	8.396e-062	1.612e-056	0.7026	-61.2292
S2O6--	2.493e-063	3.990e-058	0.7026	-62.7566
ClO3-	5.345e-066	4.459e-061	0.9150	-65.3106

Ca(For)2(aq)	5.627e-068	7.319e-063	1.0000	-67.2497
Mg(For)2(aq)	1.659e-068	1.896e-063	1.0000	-67.7801
U+++	6.909e-070	1.644e-064	0.4605	-69.4974
Na(For)2-	1.766e-070	1.996e-065	0.9160	-69.7910
Cu(For)2(aq)	5.294e-071	8.128e-066	1.0000	-70.2762
K(For)2-	2.322e-071	2.997e-066	0.9160	-70.6722
Ba(For)2(aq)	1.936e-071	4.400e-066	1.0000	-70.7130
Formaldehyde(aq)	1.324e-073	3.974e-069	1.0000	-72.8780
ClO4-	1.039e-078	1.032e-073	0.9150	-78.0222
UO2ClO3+	1.114e-080	3.935e-075	0.9160	-79.9914
S2O5--	6.781e-083	9.770e-078	0.7026	-82.3220
Methanol(aq)	3.999e-092	1.281e-087	1.0000	-91.3981
Glycolate	4.989e-098	3.742e-093	0.9160	-97.3401
Ca(Glyc)+	2.948e-099	3.393e-094	0.9160	-98.5685
Mg(Glyc)+	2.670e-100	2.651e-095	0.9160	-99.6117
HS-	1.970e-100	6.513e-096	0.9150	-99.7441
H2S(aq)	5.984e-101	2.039e-096	1.0000	-100.2230
Na(Glyc)(aq)	5.597e-101	5.484e-096	1.0000	-100.2521
K(Glyc)(aq)	8.787e-102	1.003e-096	1.0000	-101.0562
Glycolic_acid(aq	6.521e-102	4.957e-097	1.0000	-101.1857
Cu(Glyc)+	4.446e-102	6.159e-097	0.9160	-101.3902
Ba(Glyc)+	3.583e-103	7.606e-098	0.9160	-102.4839
S2O4--	3.477e-105	4.454e-100	0.7087	-104.6083
Methane(aq)	2.720e-105	4.362e-101	1.0000	-104.5654
S--	5.315e-106	1.704e-101	0.7087	-105.4240
S2O3--	1.084e-106	1.215e-101	0.7026	-106.1181
Acetate	1.439e-110	8.492e-106	0.9170	-109.8796
CaCH3COO+	1.467e-112	1.454e-107	0.9160	-111.8716
MgCH3COO+	7.869e-113	6.556e-108	0.9160	-112.1422
Acetic_acid(aq)	1.532e-113	9.195e-109	1.0000	-112.8148
NaCH3COO(aq)	1.115e-113	9.143e-109	1.0000	-112.9527
KCH3COO(aq)	1.243e-114	1.219e-109	1.0000	-113.9055
CuCH3COO+	2.603e-115	3.189e-110	0.9160	-114.6227
BaCH3COO+	8.825e-116	1.732e-110	0.9160	-115.0924
Malonate	3.471e-119	3.540e-114	0.7026	-118.6128
H-Malonate	2.489e-121	2.564e-116	0.9160	-120.6421
CuCH3COO(aq)	1.682e-122	2.061e-117	1.0000	-121.7743
Malonic_acid(aq)	3.348e-126	3.482e-121	1.0000	-125.4752
S3O6--	3.468e-139	6.662e-134	0.7026	-138.6132
Acetaldehyde(aq)	6.281e-148	2.766e-143	1.0000	-147.2020
Ethyne(aq)	3.534e-170	9.197e-166	1.0000	-169.4518
Ethanol(aq)	4.127e-171	1.900e-166	1.0000	-170.3844
Ethylene(aq)	6.606e-176	1.852e-171	1.0000	-175.1801
Lactate	5.606e-177	4.991e-172	0.9160	-176.2894
Ca(Lac)+	1.948e-178	2.514e-173	0.9160	-177.7486
Mg(Lac)+	3.018e-179	3.420e-174	0.9160	-178.5584
Na(Lac)(aq)	6.422e-180	7.193e-175	1.0000	-179.1924
K(Lac)(aq)	1.008e-180	1.292e-175	1.0000	-179.9964
Lactic_acid(aq)	7.685e-181	6.920e-176	1.0000	-180.1143
Cu(Lac)+	2.290e-181	3.494e-176	0.9160	-180.6782
Ba(Lac)+	1.662e-182	3.761e-177	0.9160	-181.8175
Ethane(aq)	1.216e-188	3.654e-184	1.0000	-187.9152
Propanoate	1.025e-191	7.486e-187	0.9160	-191.0274
Ca(Prop)+	5.821e-194	6.584e-189	0.9160	-193.2731
Mg(Prop)+	1.517e-194	1.477e-189	0.9160	-193.8571
Propanoic_acid(a	1.465e-194	1.085e-189	1.0000	-193.8340
Na(Prop)(aq)	1.158e-194	1.112e-189	1.0000	-193.9364
Ca(Glyc)2(aq)	2.697e-195	5.126e-190	1.0000	-194.5691
K(Prop)(aq)	1.818e-195	2.038e-190	1.0000	-194.7405
Cu(Prop)+	1.815e-196	2.478e-191	0.9160	-195.7792
Mg(Glyc)2(aq)	1.494e-196	2.605e-191	1.0000	-195.8256
Cu(Glyc)2(aq)	1.637e-197	3.496e-192	1.0000	-196.7859
Ba(Prop)+	8.296e-198	1.745e-192	0.9160	-197.1192

Na(Glyc)2-	3.148e-198	5.446e-193	0.9160	-197.5401
S4O6--	1.366e-198	3.063e-193	0.7026	-198.0178
Succinate	1.017e-198	1.180e-193	0.7026	-198.1460
K(Glyc)2-	4.247e-199	8.032e-194	0.9160	-198.4100
Ba(Glyc)2(aq)	7.677e-200	2.205e-194	1.0000	-199.1148
H-Succinate	6.938e-201	8.120e-196	0.9160	-200.1968
Succinic_acid(aq	2.242e-204	2.647e-199	1.0000	-203.6493
Ca(CH3COO)2(aq)	3.678e-221	5.815e-216	1.0000	-220.4344
Mg(CH3COO)2(aq)	8.398e-222	1.195e-216	1.0000	-221.0758
Cu(CH3COO)2(aq)	1.184e-223	2.149e-218	1.0000	-222.9267
Na(CH3COO)2-	9.273e-224	1.308e-218	0.9160	-223.0709
Acetone(aq)	4.123e-224	2.394e-219	1.0000	-223.3848
K(CH3COO)2-	6.785e-225	1.066e-219	0.9160	-224.2066
Ba(CH3COO)2(aq)	3.491e-225	8.914e-220	1.0000	-224.4570
Propanal(aq)	1.657e-228	9.617e-224	1.0000	-227.7808
Cu(CH3COO)2-	3.444e-232	6.252e-227	0.9160	-231.5011
1-Propyne(aq)	4.296e-247	1.721e-242	1.0000	-246.3669
1-Propanol(aq)	3.356e-252	2.016e-247	1.0000	-251.4741
S3--	1.482e-252	1.425e-247	0.7026	-251.9823
1-Propene(aq)	9.668e-255	4.067e-250	1.0000	-254.0146
2-Hydroxybutanoa	1.631e-258	1.681e-253	0.9160	-257.8256
2-Hydroxybutanoi	1.980e-262	2.060e-257	1.0000	-261.7034
Propane(aq)	3.950e-270	1.741e-265	1.0000	-269.4034
Butanoate	2.356e-273	2.051e-268	0.9160	-272.6660
Ca(But)+	9.173e-276	1.166e-270	0.9160	-275.0756
Butanoic_acid(aq	2.694e-276	2.373e-271	1.0000	-275.5695
Na(But)(aq)	2.561e-276	2.818e-271	1.0000	-275.5916
Mg(But)+	2.279e-276	2.538e-271	0.9160	-275.6804
K(But)(aq)	4.021e-277	5.072e-272	1.0000	-276.3957
Cu(But)+	3.302e-278	4.972e-273	0.9160	-277.5193
Glutarate	1.963e-279	2.553e-274	0.7026	-278.8603
Ba(But)+	1.275e-279	2.860e-274	0.9160	-278.9326
H-Glutarate	7.797e-282	1.022e-276	0.9160	-281.1462
Glutaric_acid(aq	3.194e-285	4.218e-280	1.0000	-284.4957
Ethylacetate(aq)	1.916e-285	1.687e-280	1.0000	-284.7176
S5O6--	7.947e-288	2.036e-282	0.7026	-287.2530
Butanal(aq)	1.314e-311	9.473e-307	1.0000	-300.0000
Pimelate	0.0000	0.0000	0.7026	-300.0000
Dodecanoic_acid(	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyhexanoi	0.0000	0.0000	1.0000	-300.0000
Dodecanoate	0.0000	0.0000	0.9160	-300.0000
Pentanal(aq)	0.0000	0.0000	1.0000	-300.0000
Decanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Decanoate	0.0000	0.0000	0.9160	-300.0000
Decanal(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyhexanoa	0.0000	0.0000	0.9160	-300.0000
1-Pentanol(aq)	0.0000	0.0000	1.0000	-300.0000
Octanal(aq)	0.0000	0.0000	1.0000	-300.0000
Nonanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Nonanal(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyheptano	0.0000	0.0000	1.0000	-300.0000
Cu(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Pent)+	0.0000	0.0000	0.9160	-300.0000
Cu(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Na(Prop)2-	0.0000	0.0000	0.9160	-300.0000
Cu(Pent)+	0.0000	0.0000	0.9160	-300.0000
Ba(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyheptano	0.0000	0.0000	0.9160	-300.0000
1-Octyne(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptene(aq)	0.0000	0.0000	1.0000	-300.0000
Na(Pent)2-	0.0000	0.0000	0.9160	-300.0000

Na(Pent)(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Na(Lac)2-	0.0000	0.0000	0.9160	-300.0000
2-Hydroxydecanoi	0.0000	0.0000	1.0000	-300.0000
Na(But)2-	0.0000	0.0000	0.9160	-300.0000
Cu(CH3COO)3-	0.0000	0.0000	0.9160	-300.0000
2-Hydroxydecanoa	0.0000	0.0000	0.9160	-300.0000
1-Octene(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Nonanoate	0.0000	0.0000	0.9160	-300.0000
Cu(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Pent)+	0.0000	0.0000	0.9160	-300.0000
Mg(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Octanoate	0.0000	0.0000	0.9160	-300.0000
Octanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Ba(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
1-Octanol(aq)	0.0000	0.0000	1.0000	-300.0000
Pentanoate	0.0000	0.0000	0.9160	-300.0000
Pentanoic_acid(a	0.0000	0.0000	1.0000	-300.0000
Phenol(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptanol(aq)	0.0000	0.0000	1.0000	-300.0000
Pimelic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
1-Butanol(aq)	0.0000	0.0000	1.0000	-300.0000
Azelate	0.0000	0.0000	0.7026	-300.0000
Azelaic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hexanone(aq)	0.0000	0.0000	1.0000	-300.0000
K(Prop)2-	0.0000	0.0000	0.9160	-300.0000
Adipic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
K(Pent)2-	0.0000	0.0000	0.9160	-300.0000
K(Pent)(aq)	0.0000	0.0000	1.0000	-300.0000
K(Lac)2-	0.0000	0.0000	0.9160	-300.0000
Adipate	0.0000	0.0000	0.7026	-300.0000
2-Heptanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexyne(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
K(But)2-	0.0000	0.0000	0.9160	-300.0000
Ca(Pent)+	0.0000	0.0000	0.9160	-300.0000
2-Butanone(aq)	0.0000	0.0000	1.0000	-300.0000
Hexanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Hexanoate	0.0000	0.0000	0.9160	-300.0000
Ca(Lac)2(aq)	0.0000	0.0000	1.0000	-300.0000
Hexanal(aq)	0.0000	0.0000	1.0000	-300.0000
Heptanoic_acid(a	0.0000	0.0000	1.0000	-300.0000
Heptanoate	0.0000	0.0000	0.9160	-300.0000
p-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Heptanal(aq)	0.0000	0.0000	1.0000	-300.0000
p-Toluate	0.0000	0.0000	0.9160	-300.0000
o-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
o-Toluate	0.0000	0.0000	0.9160	-300.0000
o-Phthalate	0.0000	0.0000	0.7026	-300.0000
1-Hexene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Butyne(aq)	0.0000	0.0000	1.0000	-300.0000
n-Pentylbenzene(	0.0000	0.0000	1.0000	-300.0000
n-Pentane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Octylbenzene(a	0.0000	0.0000	1.0000	-300.0000
n-Hexylbenzene(a	0.0000	0.0000	1.0000	-300.0000
n-Hexane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Heptylbenzene(	0.0000	0.0000	1.0000	-300.0000
2-Pentanone(aq)	0.0000	0.0000	1.0000	-300.0000
n-Butylbenzene(a	0.0000	0.0000	1.0000	-300.0000

n-Butane(aq)	0.0000	0.0000	1.0000	-300.0000
m-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Undecanoic_acid(	0.0000	0.0000	1.0000	-300.0000
Undecanoate	0.0000	0.0000	0.9160	-300.0000
Ca(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Octanone(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxypentano	0.0000	0.0000	1.0000	-300.0000
H-Suberate	0.0000	0.0000	0.9160	-300.0000
H-Sebacate	0.0000	0.0000	0.9160	-300.0000
H-Pimelate	0.0000	0.0000	0.9160	-300.0000
2-Hydroxypentano	0.0000	0.0000	0.9160	-300.0000
1-Hexanol(aq)	0.0000	0.0000	1.0000	-300.0000
H-Azelate	0.0000	0.0000	0.9160	-300.0000
H-Adipate	0.0000	0.0000	0.9160	-300.0000
2-Hydroxyoctanoi	0.0000	0.0000	1.0000	-300.0000
Toluene(aq)	0.0000	0.0000	1.0000	-300.0000
Suberic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Suberate	0.0000	0.0000	0.7026	-300.0000
m-Toluate	0.0000	0.0000	0.9160	-300.0000
Benzoic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyoctanoa	0.0000	0.0000	0.9160	-300.0000
1-Pentyne(aq)	0.0000	0.0000	1.0000	-300.0000
n-Heptane(aq)	0.0000	0.0000	1.0000	-300.0000
Sebacic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Sebacate	0.0000	0.0000	0.7026	-300.0000
Benzoate	0.0000	0.0000	0.9199	-300.0000
n-Octane(aq)	0.0000	0.0000	1.0000	-300.0000
S5--	0.0000	0.0000	0.7026	-300.0000
Benzene(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxynonanoi	0.0000	0.0000	1.0000	-300.0000
n-Propylbenzene(	0.0000	0.0000	1.0000	-300.0000
S4--	0.0000	0.0000	0.7026	-300.0000
Ethylbenzene(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxynonanoa	0.0000	0.0000	0.9160	-300.0000
1-Pentene(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptyne(aq)	0.0000	0.0000	1.0000	-300.0000
1-Butene(aq)	0.0000	0.0000	1.0000	-300.0000

Mineral saturation states

	log Q/K		log Q/K
Witherite	2.0534s/sat	UO2SO4:2.5H2O	-17.6267
Quartz	0.6298s/sat	UO2SO4:3H2O	-17.7038
Barite	0.4980s/sat	Dicalcium_silica	-17.9168
Dolomite-ord	0.4931s/sat	NaUO3	-17.9812
Dolomite	0.4930s/sat	Anthophyllite	-18.3401
Tridymite	0.4295s/sat	UO2F2:3H2O	-18.6222
Chalcedony	0.3445s/sat	Akermanite	-18.6315
Calcite	0.0480s/sat	UO2F2	-18.9482
Cristobalite(alp	0.0451s/sat	CuCl2	-19.2559
Tenorite	0.0429s/sat	Larnite	-19.2965
Ice	-0.0831	MgCl2:4H2O	-19.3904
Aragonite	-0.0971	UO2SO4	-21.4904
Coesite	-0.2197	Lime	-21.8870
Malachite	-0.3882	Na2UO4(alpha)	-22.0171
Cristobalite(bet	-0.4413	UO2(NO3)2:6H2O	-23.0428
Monohydrocalcite	-0.7516	Hydrophilite	-23.4414
SiO2(am)	-0.7799	UO2.3333(beta)	-23.4549
Dolomite-dis	-1.1629	Rankinite	-24.6372
Magnesite	-1.2770	UO2(NO3)2:3H2O	-24.7023
Dioptase	-1.7122	UOFOH:.5H2O	-24.8044
Talc	-1.9364	UO2Cl	-25.1909
Gypsum	-2.0304	MgCl2:2H2O	-25.2366

Anhydrite	-2.3526	UOFOH	-25.3152
Brochantite	-2.7568	Tobermorite-14A	-25.7389
Bassanite	-3.0021	UO2(NO3)2:2H2O	-26.0724
CaSO4:0.5H2O(bet	-3.1893	K2UO4	-27.3583
Fluorite	-3.4288	Tobermorite-11A	-27.9904
Enstatite	-4.0046	UOF2:H2O	-28.1991
Nesquehonite	-4.3929	MgCl2:H2O	-28.8244
CaUO4	-4.5015	UOF2	-28.8530
Sellaite	-5.0154	UO2Cl2:3H2O	-29.2379
UO3:2H2O	-5.1147	UO2(NO3)2:H2O	-29.9148
Schoepite	-5.1148	Foshagite	-30.3973
Chrysotile	-5.2194	Merwinite	-30.6608
UO2(OH)2(beta)	-5.2817	Tobermorite-9A	-31.8398
Diopside	-5.3227	Ba2SiO4	-31.9514
Schoepite-dehy(.	-5.3424	UO2Cl2:H2O	-32.2008
UO3:.9H2O(alpha)	-5.3496	Afwillite	-32.9119
Nahcolite	-5.3592	UO2(NO3)2	-33.6054
Schoepite-dehy(.	-5.4351	KMgCl3:2H2O	-34.0336
Schoepite-dehy(1	-5.4519	Chloromagnesite	-34.9231
Huntite	-5.4630	UO2Cl2	-36.3164
Okenite	-5.4635	UO2SO3	-37.3609
Brucite	-5.5692	UF4:2.5H2O	-39.0437
Wollastonite	-5.6731	BaSiF6	-39.5187
Atacamite	-5.7339	BaO	-41.0286
Pseudowollastoni	-5.9393	KMgCl3	-41.8165
Niter	-6.0451	UF4	-43.5967
Azurite	-6.0656	Hatrurite	-43.6729
UO2CO3	-6.1975	Xonotlite	-43.7243
Rutherfordine	-6.2109	U(SO4)2:8H2O	-46.2827
Schoepite-dehy(.	-6.6256	U(SO4)2:4H2O	-47.6144
Sepiolite	-6.9297	U(SO4)2	-47.8773
Cuprite	-7.0265	Ba2U2O7	-47.8784
Schoepite-dehy(.	-7.1768	C	-49.1926
Artinite	-7.6853	U(CO3)2	-50.3008
Mirabilite	-7.7511	UOCl2	-50.6764
Sanbornite	-7.8617	UClF3	-54.4591
Chalcanthite	-8.0182	UOF4	-57.8305
UO3(gamma)	-8.2611	Na4SiO4	-58.4929
Sylvite	-8.4051	Na3UO4	-58.6604
Halite	-8.5299	Na	-58.9220
UO3(beta)	-8.8963	Na2O	-61.2262
Arcanite	-9.0054	U5O12Cl	-62.1767
Nitrobarite	-9.0125	UOCl3	-62.4290
Nantokite	-9.1361	(UO2)2Cl3	-62.7097
UO3(alpha)	-9.2512	K	-63.3755
Thenardite	-9.2538	UF3	-65.9835
Gyrolite	-9.7760	UF5(beta)	-66.1695
Forsterite	-9.9137	UF5(alpha)	-66.5756
BaUO4	-10.0062	UCl2F2	-67.6359
Natron	-10.0984	Antigorite	-68.9036
UO2FOH:2H2O	-10.3916	UOCl	-69.4584
Mg1.25SO4(OH)0.5	-10.4107	Ba3UO6	-71.6243
Tremolite	-10.6614	S	-74.3666
Na2CO3:7H2O	-10.6626	Covellite	-75.3824
Cu	-10.7378	U2O3F6	-76.9268
Monticellite	-10.8371	Chalcocite	-79.9986
UO2FOH:H2O	-10.8505	K2O	-80.0044
Periclase	-10.9572	UCl3F	-80.6284
Portlandite	-11.2761	Na6Si2O7	-85.0470
UO2FOH	-11.3786	U(SO3)2	-90.7931
Mg1.5SO4(OH)	-11.7302	UCl4	-91.4600
Thermonatrite	-12.1371	UCl3	-95.6084
Na2CO3	-12.4651	UF6	-97.7257

UO2.25	-12.7179	Mg	-103.1465
UO2.25(beta)	-12.7866	U3O5F8	-103.2144
MgUO4	-12.8880	U2F9	-106.4670
MgSO4	-12.9041	UCl5	-111.8288
UO2SO4:H2O	-13.0997	U2O2Cl5	-114.3955
UO2ClOH:2H2O	-14.1266	BaS	-115.2994
BaU2O7	-14.1467	Ca	-120.4510
BaCl2:2H2O	-14.2263	Ba	-125.0194
Chalcocyanite	-14.2533	UCl6	-130.9834
Na2U2O7	-14.3911	Si	-131.5851
BaCl2:H2O	-14.9627	U	-181.0049
Ba(OH)2:8H2O	-15.8132	U4F17	-192.7485
Hydromagnesite	-16.1727	US	-196.2116
UO2.6667	-16.3275	UC	-211.9779
Uraninite	-16.4380	UH3(beta)	-213.7985
BaCl2	-16.5162	US1.9	-228.4001
Natrosilite	-16.5418	US2	-234.0294
Coffinite	-16.6493	UC1.94(alpha)	-260.3479
Ba2Si3O8	-16.7335	US3	-305.0657
MgOHCl	-16.9336	U2S3	-422.9679
Na2SiO3	-17.2617	o-Phthalic_acid	-428.4317
Hillebrandite	-17.4350	U2C3	-474.7483
UO2SO4:3.5H2O	-17.5636	U3S5	-652.1820

Gases	fugacity	log fug.
H2O(g)	0.01025	-1.989
CO2(g)	0.002470	-2.607
NO2(g)	4.631e-013	-12.334
HF(g)	2.007e-015	-14.697
HCl(g)	2.134e-019	-18.671
O2(g)	8.152e-027	-26.089
H2(g)	7.670e-032	-31.115
CO(g)	6.332e-038	-37.198
SiF4(g)	1.386e-041	-40.858
Cl2(g)	5.082e-042	-41.294
SO2(g)	6.926e-046	-45.159
UO2F2(g)	2.572e-064	-63.590
Cu(g)	1.109e-066	-65.955
Na(g)	4.189e-074	-73.378
UO2Cl2(g)	2.403e-075	-74.619
K(g)	1.675e-075	-74.776
UO3(g)	4.240e-076	-75.373
UOF4(g)	9.665e-080	-79.015
UF5(g)	4.998e-088	-87.301
UF4(g)	5.652e-091	-90.248
UF6(g)	9.998e-100	-99.000
H2S(g)	3.847e-100	-99.415
F2(g)	1.819e-100	-99.740
CH4(g)	1.387e-102	-101.858
UCl4(g)	1.943e-118	-117.711
UO2(g)	3.458e-119	-118.461
Mg(g)	6.551e-125	-124.184
UCl5(g)	3.363e-131	-130.473
UF3(g)	1.972e-137	-136.705
UCl6(g)	2.538e-138	-137.596
UCl3(g)	6.131e-145	-144.212
Ca(g)	5.213e-148	-147.283
U2F10(g)	1.902e-148	-147.721
S2(g)	1.603e-164	-163.795
C2H4(g)	9.370e-174	-173.028
C(g)	4.957e-174	-173.305
UF2(g)	1.640e-180	-179.785

UCl2(g)	1.487e-189	-188.828
UO(g)	2.213e-195	-194.655
Si(g)	1.914e-207	-206.718
UF(g)	8.846e-217	-216.053
U2Cl8(g)	1.007e-224	-223.997
UCl(g)	1.277e-231	-230.894
U2Cl10(g)	1.590e-233	-232.799
U(g)	3.754e-272	-271.426

		In fluid		Sorbed		Kd
Original basis	total moles	moles	mg/kg	moles	mg/kg	L/kg
Ba++	9.61e-007	9.61e-007	0.132			
Ca++	0.00166	0.00166	66.5			
Cl-	0.000110	0.000110	3.91			
Cu++	1.08e-007	1.08e-007	0.00684			
F-	5.15e-006	5.15e-006	0.0977			
H+	0.000121	0.000121	0.122			
H2O	55.5	55.5	1.00e+006			
HCO3-	0.00271	0.00271	165.			
K+	0.000200	0.000200	7.82			
Mg++	0.000322	0.000322	7.82			
NO3-	0.00154	0.00154	95.6			
Na+	0.00111	0.00111	25.4			
O2(aq)	-5.21e-009	-5.21e-009	-0.000167			
SO4--	0.000417	0.000417	40.1			
SiO2(aq)	0.000190	0.000190	11.4			
UO2++	2.05e-009	2.05e-009	0.000554			

		In fluid		Sorbed	
Elemental composition	total moles	moles	mg/kg	moles	mg/kg
Barium	9.613e-007	9.613e-007	0.1320		
Calcium	0.001659	0.001659	66.47		
Carbon	0.002708	0.002708	32.52		
Chlorine	0.0001103	0.0001103	3.910		
Copper	1.077e-007	1.077e-007	0.006842		
Fluorine	5.147e-006	5.147e-006	0.09775		
Hydrogen	111.0	111.0	1.118e+005		
Magnesium	0.0003219	0.0003219	7.820		
Nitrogen	0.001543	0.001543	21.60		
Oxygen	55.52	55.52	8.880e+005		
Potassium	0.0002001	0.0002001	7.820		
Silicon	0.0001904	0.0001904	5.346		
Sodium	0.001106	0.001106	25.41		
Sulfur	0.0004174	0.0004174	13.38		
Uranium	2.054e-009	2.054e-009	0.0004887		

```
Temperature =  10.2 C    Pressure =  1.013 bars
pH =  7.600              log fO2 =  -32.704
Eh =   0.3450 volts      pe =   6.1367
Ionic strength      =    0.007230
Charge imbalance    =    0.000233 eq/kg (4.652% error)
Activity of water   =    0.999996
Solvent mass        =    1.000000 kg
Solution mass       =    1.000427 kg
Solution density    =    1.023    g/cm3
Chlorinity          =    0.000110 molal
Dissolved solids    =         427 mg/kg sol'n
Hardness            =      198.18 mg/kg sol'n as CaCO3
  carbonate         =      122.62 mg/kg sol'n as CaCO3
  non-carbonate     =       75.55 mg/kg sol'n as CaCO3
Rock mass           =    0.000000 kg
Carbonate alkalinity=      122.62 mg/kg sol'n as CaCO3
Water type          =    Ca-HCO3
```

Nernst redox couples	Eh (volts)	pe
e- + .25*O2(aq) + H+ = .5*H2O	0.3450	6.1367
8*e- + 9*H+ + NO3- = 3*H2O + NH3(aq)	0.5698	10.1349

No minerals in system.

Aqueous species	molality	mg/kg sol'n	act. coef.	log act.
HCO3-	0.002399	146.3	0.9163	-2.6580
NO3-	0.001711	106.0	0.9142	-2.8057
Ca++	0.001591	63.73	0.7155	-2.9438
Na+	0.001059	24.34	0.9163	-3.0130
SO4--	0.0003256	31.26	0.7036	-3.6400
Mg++	0.0003063	7.440	0.7265	-3.6527
K+	0.0002247	8.781	0.9142	-3.6874
SiO2(aq)	0.0001801	10.81	1.0000	-3.7446
CO2(aq)	0.0001618	7.120	1.0000	-3.7909
Cl-	0.0001103	3.907	0.9142	-3.9965
CaHCO3+	3.164e-005	3.197	0.9163	-4.5377
CaSO4(aq)	3.144e-005	4.278	1.0000	-4.5026
N2(aq)	2.846e-005	0.7971	1.0000	-4.5457
MgSO4(aq)	9.020e-006	1.085	1.0000	-5.0448
MgHCO3+	5.996e-006	0.5114	0.9163	-5.2601
CaCO3(aq)	5.138e-006	0.5140	1.0000	-5.2892
F-	5.094e-006	0.09673	0.9153	-5.3314
NaHCO3(aq)	4.077e-006	0.3423	1.0000	-5.3897
CO3--	4.015e-006	0.2408	0.7067	-5.5471
Ba++	1.060e-006	0.1455	0.7097	-6.1236
HSiO3-	5.379e-007	0.04145	0.9163	-6.3073
MgCO3(aq)	5.220e-007	0.04399	1.0000	-6.2824
KSO4-	3.859e-007	0.05214	0.9163	-6.4514
Cu++	1.692e-007	0.01075	0.7155	-6.9169
OH-	1.286e-007	0.002186	0.9153	-6.9292
NaHSiO3(aq)	2.978e-008	0.002979	1.0000	-7.5261
H+	2.715e-008	2.735e-005	0.9253	-7.6000
CaF+	2.627e-008	0.001551	0.9163	-7.6185
MgF+	2.607e-008	0.001128	0.9163	-7.6218
Cd++	2.574e-008	0.002893	0.7097	-7.7383
CaCl+	2.548e-008	0.001924	0.9163	-7.6317
MgCl+	1.958e-008	0.001170	0.9163	-7.7461
NaCl(aq)	1.512e-008	0.0008832	1.0000	-7.8205
NaCO3-	1.486e-008	0.001233	0.9163	-7.8660
UO2(CO3)3----	1.139e-009	0.0005126	0.2446	-9.5549

UO2(CO3)2--	8.981e-010	0.0003502	0.7036	-9.1993
BaCO3(aq)	6.917e-010	0.0001364	1.0000	-9.1601
KCl(aq)	4.961e-010	3.697e-005	1.0000	-9.3044
HSO4-	4.152e-010	4.029e-005	0.9163	-9.4197
NaF(aq)	4.033e-010	1.693e-005	1.0000	-9.3944
HF(aq)	1.334e-010	2.668e-006	1.0000	-9.8747
Cu+	3.075e-011	1.953e-006	0.9163	-10.5500
BaCl+	2.170e-011	3.748e-006	0.9163	-10.7015
NaOH(aq)	2.013e-011	8.048e-007	1.0000	-10.6962
UO2CO3(aq)	1.625e-011	5.361e-006	1.0000	-10.7891
CdSO4(aq)	4.228e-012	8.811e-007	1.0000	-11.3738
CaCl2(aq)	3.265e-012	3.622e-007	1.0000	-11.4861
BaF+	2.176e-012	3.400e-007	0.9163	-11.7003
HNO3(aq)	1.418e-012	8.934e-008	1.0000	-11.8482
HCl(aq)	5.383e-013	1.962e-008	1.0000	-12.2689
CdCl2(aq)	3.700e-013	6.779e-008	1.0000	-12.4318
UO2OH+	1.346e-013	3.861e-008	0.9163	-12.9090
KHSO4(aq)	4.519e-015	6.151e-010	1.0000	-14.3449
UO2++	1.787e-015	4.823e-010	0.7067	-14.8987
UO2F+	7.147e-016	2.065e-010	0.9163	-15.1838
UO2SO4(aq)	2.345e-016	8.580e-011	1.0000	-15.6299
HF2-	1.391e-016	5.422e-012	0.9163	-15.8948
UO2F2(aq)	9.611e-018	2.959e-012	1.0000	-17.0172
CdCl3-	7.772e-018	1.700e-012	0.9163	-17.1474
UO2(SO4)2--	4.682e-019	2.163e-013	0.7036	-18.4822
UO2Cl+	1.730e-019	5.282e-014	0.9163	-18.7999
UO2+	2.311e-020	6.237e-015	0.9163	-19.6742
UO2F3-	8.388e-021	2.742e-015	0.9163	-20.1143
(UO2)2(OH)2++	3.613e-021	2.073e-015	0.7067	-20.5929
(UO2)3(CO3)6(6-)	1.167e-022	1.365e-016	0.0420	-23.3094
U(OH)4(aq)	3.906e-023	1.195e-017	1.0000	-22.4082
(UO2)3(OH)5+	6.709e-024	6.003e-018	0.9163	-23.2113
UO2Cl2(aq)	7.137e-025	2.432e-019	1.0000	-24.1465
UO2F4--	3.139e-025	1.086e-019	0.7036	-24.6559
Formate	8.728e-031	3.927e-026	0.9153	-30.0975
H2(aq)	1.304e-031	2.628e-028	1.0000	-30.8846
Ca(For)+	2.978e-032	2.533e-027	0.9163	-31.5641
Mg(For)+	7.067e-033	4.897e-028	0.9163	-32.1887
Na(For)(aq)	9.210e-034	6.261e-029	1.0000	-33.0357
NO2-	7.481e-034	3.440e-029	0.9142	-33.1650
K(For)(aq)	1.691e-034	1.421e-029	1.0000	-33.7720
Formic_acid(aq)	1.183e-034	5.441e-030	1.0000	-33.9271
Ba(For)+	1.490e-035	2.716e-030	0.9163	-34.8647
SO3--	1.466e-035	1.173e-030	0.7067	-34.9847
Cu(For)+	1.320e-035	1.433e-030	0.9163	-34.9172
NH4+	1.269e-035	2.287e-031	0.9132	-34.9361
HSO3-	4.024e-036	3.261e-031	0.9163	-35.4333
O2(aq)	3.378e-036	1.080e-031	1.0000	-35.4713
Cd(For)+	1.349e-036	2.123e-031	0.9163	-35.9080
CO(aq)	1.927e-037	5.396e-033	1.0000	-36.7151
NH3(aq)	8.861e-038	1.509e-033	1.0000	-37.0525
Oxalate	4.842e-038	4.260e-033	0.7036	-37.4676
HNO2(aq)	4.147e-038	1.949e-033	1.0000	-37.3822
ClO-	3.814e-038	1.962e-033	0.9163	-37.4566
SiF6--	1.141e-039	1.620e-034	0.7036	-39.0956
HO2-	2.296e-040	7.574e-036	0.9163	-39.6771
U(CO3)5(6-)	2.111e-040	1.135e-034	0.0420	-41.0519
UOH+++	2.555e-041	6.514e-036	0.4619	-40.9281
H-Oxalate	1.540e-041	1.370e-036	0.9163	-40.8505
SO2(aq)	4.985e-042	3.192e-037	1.0000	-41.3024
UF2++	1.414e-042	3.902e-037	0.7067	-42.0003
UF3+	1.026e-042	3.026e-037	0.9163	-42.0267
UF+++	5.810e-044	1.493e-038	0.4619	-43.5713

UF4(aq)	4.625e-044	1.452e-038	1.0000	-43.3349
USO4++	2.629e-045	8.778e-040	0.7067	-44.7311
U(SO4)2(aq)	1.836e-045	7.893e-040	1.0000	-44.7362
U++++	1.112e-047	2.647e-042	0.2574	-47.5431
Oxalic_acid(aq)	6.434e-048	5.790e-043	1.0000	-47.1915
HSO5-	3.293e-048	3.722e-043	0.9163	-47.5204
UCl+++	4.892e-050	1.337e-044	0.4619	-49.6460
S2O6--	5.803e-060	9.288e-055	0.7036	-59.3890
Ca(For)2(aq)	1.935e-061	2.517e-056	1.0000	-60.7132
Mg(For)2(aq)	5.730e-062	6.549e-057	1.0000	-61.2418
Na(For)2-	5.813e-064	6.567e-059	0.9163	-63.2736
Cu(For)2(aq)	2.856e-064	4.384e-059	1.0000	-63.5443
ClO2-	2.527e-064	1.704e-059	0.9163	-63.6354
U+++	1.531e-064	3.642e-059	0.4619	-64.1505
Cd(For)2(aq)	1.429e-064	2.891e-059	1.0000	-63.8451
K(For)2-	8.924e-065	1.152e-059	0.9163	-64.0874
Ba(For)2(aq)	7.297e-065	1.658e-059	1.0000	-64.1369
S2O8--	4.888e-065	9.387e-060	0.7036	-64.4636
Formaldehyde(aq)	5.951e-067	1.786e-062	1.0000	-66.2254
N3-	9.159e-073	3.847e-068	0.9163	-72.0761
Cu(NH3)2++	9.655e-074	9.420e-069	0.7067	-73.1660
HN3(aq)	1.500e-075	6.453e-071	1.0000	-74.8238
ClO3-	6.307e-076	5.261e-071	0.9153	-75.2386
S2O5--	3.094e-076	4.458e-071	0.7036	-75.6621
Cd(NH3)2++	2.678e-077	3.921e-072	0.7067	-76.7230
Urea(aq)	4.169e-078	2.503e-073	1.0000	-77.3799
HCN(aq)	7.657e-080	2.068e-075	1.0000	-79.1160
CN-	7.176e-082	1.866e-077	0.9142	-81.1831
Methanol(aq)	3.532e-082	1.131e-077	1.0000	-81.4519
HS-	3.163e-087	1.046e-082	0.9153	-86.5383
H2S(aq)	1.216e-087	4.142e-083	1.0000	-86.9151
Glycolate	4.197e-088	3.148e-083	0.9163	-87.4150
Ca(Glyc)+	2.498e-089	2.875e-084	0.9163	-88.6403
UO2ClO3+	2.717e-090	9.599e-085	0.9163	-89.6039
Mg(Glyc)+	2.263e-090	2.247e-085	0.9163	-89.6833
Na(Glyc)(aq)	4.534e-091	4.443e-086	1.0000	-90.3435
K(Glyc)(aq)	8.323e-092	9.496e-087	1.0000	-91.0797
Glycolic_acid(aq	6.913e-092	5.255e-087	1.0000	-91.1604
ClO4-	6.060e-092	6.024e-087	0.9153	-91.2560
Cu(Glyc)+	5.904e-092	8.178e-087	0.9163	-91.2668
Methane(aq)	4.747e-092	7.612e-088	1.0000	-91.3236
S--	6.716e-093	2.153e-088	0.7097	-92.3218
Ba(Glyc)+	3.334e-093	7.077e-088	0.9163	-92.5150
S2O3--	1.929e-093	2.162e-088	0.7036	-92.8673
Cd(Glyc)+	7.144e-094	1.339e-088	0.9163	-93.1840
S2O4--	3.101e-095	3.971e-090	0.7097	-94.6575
Acetate	2.389e-097	1.410e-092	0.9173	-96.6592
CaCH3COO+	2.452e-099	2.429e-094	0.9163	-98.6485
MgCH3COO+	1.318e-099	1.098e-094	0.9163	-98.9180
Acetic_acid(aq)	3.204e-100	1.923e-095	1.0000	-99.4943
NaCH3COO(aq)	1.783e-100	1.462e-095	1.0000	-99.7489
KCH3COO(aq)	2.323e-101	2.279e-096	1.0000	-100.6339
CuCH3COO+	6.817e-102	8.354e-097	0.9163	-101.2043
BaCH3COO+	1.619e-102	3.177e-097	0.9163	-101.8288
CdCH3COO+	4.679e-103	8.019e-098	0.9163	-102.3678
Malonate	5.470e-106	5.580e-101	0.7036	-105.4147
CuCH3COO(aq)	1.534e-107	1.880e-102	1.0000	-106.8142
Cu(NH3)3++	8.886e-108	1.018e-102	0.7067	-107.2021
H-Malonate	4.943e-108	5.092e-103	0.9163	-107.3440
Malonic_acid(aq)	8.376e-113	8.712e-108	1.0000	-112.0770
Methanamine(aq)	1.256e-116	3.901e-112	1.0000	-115.9009
Glycine(aq)	3.974e-119	2.982e-114	1.0000	-118.4007
Cu(Gly)+	9.063e-120	1.247e-114	0.9163	-119.0807

Mg(Gly)+	8.674e-122	8.529e-117	0.9163	-121.0997
Ca(Gly)+	2.252e-123	2.569e-118	0.9163	-122.6854
Cd(Gly)+	1.252e-124	2.333e-119	0.9163	-123.9404
S3O6--	8.433e-126	1.620e-120	0.7036	-125.2267
Ba(Gly)+	1.785e-126	3.771e-121	0.9163	-125.7864
Acetaldehyde(aq)	2.541e-131	1.119e-126	1.0000	-130.5950
SCN-	1.397e-131	8.112e-127	0.9153	-130.8932
NH4CH3COO(aq)	4.155e-132	3.202e-127	1.0000	-131.3814
Acetamide(aq)	3.424e-132	2.021e-127	1.0000	-131.4655
UO2SCN+	4.306e-145	1.412e-139	0.9163	-144.4039
Cd(NH3)4++	8.306e-149	1.499e-143	0.7067	-148.2314
Ethanol(aq)	3.267e-151	1.505e-146	1.0000	-150.4858
Ethyne(aq)	1.395e-153	3.632e-149	1.0000	-152.8553
Ethylene(aq)	5.197e-156	1.457e-151	1.0000	-155.2843
Lactate	4.225e-157	3.762e-152	0.9163	-156.4121
Ca(Lac)+	1.478e-158	1.908e-153	0.9163	-157.8682
Mg(Lac)+	2.290e-159	2.595e-154	0.9163	-158.6781
Na(Lac)(aq)	4.662e-160	5.222e-155	1.0000	-159.3315
K(Lac)(aq)	8.558e-161	1.096e-155	1.0000	-160.0676
Lactic_acid(aq)	7.297e-161	6.571e-156	1.0000	-160.1368
Cu(Lac)+	2.724e-161	4.156e-156	0.9163	-160.6027
Ba(Lac)+	1.385e-162	3.133e-157	0.9163	-161.8966
Cd(Lac)+	4.864e-163	9.796e-158	0.9163	-162.3510
Ethane(aq)	1.892e-165	5.688e-161	1.0000	-164.7230
Propanoate	1.521e-168	1.111e-163	0.9163	-167.8557
Ca(Prop)+	8.697e-171	9.836e-166	0.9163	-170.0986
Propanoic_acid(a	2.740e-171	2.029e-166	1.0000	-170.5622
Mg(Prop)+	2.272e-171	2.211e-166	0.9163	-170.6816
Na(Prop)(aq)	1.655e-171	1.590e-166	1.0000	-170.7811
K(Prop)(aq)	3.039e-172	3.407e-167	1.0000	-171.5173
Cu(Prop)+	4.251e-173	5.805e-168	0.9163	-172.4095
Cd(Prop)+	2.736e-174	5.073e-169	0.9163	-173.6008
Ba(Prop)+	1.360e-174	2.859e-169	0.9163	-173.9046
S4O6--	3.508e-175	7.863e-170	0.7036	-174.6076
Ca(Glyc)2(aq)	1.928e-175	3.664e-170	1.0000	-174.7150
Succinate	1.435e-175	1.665e-170	0.7036	-174.9959
USCN+++	1.365e-175	4.039e-170	0.4619	-175.2004
Mg(Glyc)2(aq)	1.070e-176	1.865e-171	1.0000	-175.9708
Cu(Glyc)2(aq)	1.837e-177	3.922e-172	1.0000	-176.7359
H-Succinate	1.234e-177	1.445e-172	0.9163	-176.9465
Na(Glyc)2-	2.152e-178	3.722e-173	0.9163	-177.7052
K(Glyc)2-	3.391e-179	6.413e-174	0.9163	-178.5076
Serine(aq)	1.890e-179	1.985e-174	1.0000	-178.7236
Cd(Glyc)2(aq)	8.971e-180	2.354e-174	1.0000	-179.0472
Ba(Glyc)2(aq)	6.015e-180	1.728e-174	1.0000	-179.2208
Succinic_acid(aq	5.028e-181	5.935e-176	1.0000	-180.2986
Ethanamine(aq)	1.291e-187	5.818e-183	1.0000	-186.8891
Alanine(aq)	5.444e-189	4.848e-184	1.0000	-188.2641
Cu(Ala)+	2.810e-190	4.260e-185	0.9163	-189.5892
Mg(Ala)+	8.022e-194	9.012e-189	0.9163	-193.1337
Ca(Ala)+	5.906e-194	7.566e-189	0.9163	-193.2667
Ca(CH3COO)2(aq)	1.024e-194	1.618e-189	1.0000	-193.9899
Cd(Ala)+	9.651e-195	1.934e-189	0.9163	-194.0534
Mg(CH3COO)2(aq)	2.346e-195	3.339e-190	1.0000	-194.6296
Cu(CH3COO)2(aq)	5.171e-197	9.388e-192	1.0000	-196.2864
Na(CH3COO)2-	2.469e-197	3.481e-192	0.9163	-196.6455
Ba(Ala)+	1.731e-197	3.901e-192	0.9163	-196.7996
Acetone(aq)	1.497e-197	8.689e-193	1.0000	-196.8249
Cd(CH3COO)2(aq)	2.179e-198	5.021e-193	1.0000	-197.6617
K(CH3COO)2-	2.109e-198	3.314e-193	0.9163	-197.7138
Ba(CH3COO)2(aq)	1.064e-198	2.717e-193	1.0000	-197.9729
Aspartic_acid(aq	2.511e-199	3.341e-194	1.0000	-198.6001
Propanal(aq)	5.993e-202	3.479e-197	1.0000	-201.2223

Cu(CH3COO)2-	5.235e-204	9.505e-199	0.9163	-203.3190
S3--	2.047e-219	1.968e-214	0.7036	-218.8417
1-Propyne(aq)	1.523e-220	6.098e-216	1.0000	-219.8174
1-Propanol(aq)	2.376e-222	1.427e-217	1.0000	-221.6242
1-Propene(aq)	6.811e-225	2.865e-220	1.0000	-224.1668
2-Hydroxybutanoa	1.099e-228	1.132e-223	0.9163	-227.9971
NH4(CH3COO)2-	9.550e-229	1.299e-223	0.9163	-228.0580
Asparagine(aq)	3.189e-231	4.211e-226	1.0000	-230.4964
2-Hydroxybutanoi	1.679e-232	1.748e-227	1.0000	-231.7749
Cu(Gly)2(aq)	3.139e-233	6.642e-228	1.0000	-232.5031
Propane(aq)	5.495e-237	2.422e-232	1.0000	-236.2601
Mg(Gly)2(aq)	1.132e-239	1.951e-234	1.0000	-238.9462
Diglycine(aq)	3.516e-240	4.643e-235	1.0000	-239.4540
Butanoate	3.125e-240	2.721e-235	0.9163	-239.5431
Cd(Gly)2(aq)	8.012e-242	2.086e-236	1.0000	-241.0963
Diketopiperazine	1.347e-242	1.536e-237	1.0000	-241.8707
Ca(But)+	1.224e-242	1.557e-237	0.9163	-241.9500
Butanoic_acid(aq	4.501e-243	3.964e-238	1.0000	-242.3467
Na(But)(aq)	3.272e-243	3.601e-238	1.0000	-242.4852
Mg(But)+	3.049e-243	3.395e-238	0.9163	-242.5538
Ca(Gly)2(aq)	1.011e-243	1.901e-238	1.0000	-242.9954
K(But)(aq)	6.007e-244	7.577e-239	1.0000	-243.2214
Cu(But)+	6.911e-245	1.041e-239	0.9163	-244.1984
Glutarate	2.477e-246	3.221e-241	0.7036	-245.7588
Cd(But)+	2.376e-246	4.739e-241	0.9163	-245.6620
Ba(But)+	1.867e-246	4.188e-241	0.9163	-245.7668
Ba(Gly)2(aq)	8.891e-247	2.537e-241	1.0000	-246.0510
H-Glutarate	1.240e-248	1.625e-243	0.9163	-247.9447
Threonine(aq)	3.979e-251	4.737e-246	1.0000	-250.4003
Glutaric_acid(aq	6.397e-252	8.448e-247	1.0000	-251.1940
Ethylacetate(aq)	3.175e-252	2.796e-247	1.0000	-251.4983
S5O6--	2.115e-254	5.418e-249	0.7036	-253.8274
1-Propanamine(aq	3.166e-258	1.871e-253	1.0000	-257.4995
a-Aminobutyric_a	2.412e-260	2.486e-255	1.0000	-259.6177
Glutamic_acid(aq	5.003e-269	7.359e-264	1.0000	-268.3007
Butanal(aq)	4.242e-275	3.057e-270	1.0000	-274.3724
UO2(SCN)2(aq)	2.967e-276	1.145e-270	1.0000	-275.5277
S4--	6.298e-283	8.075e-278	0.7036	-282.3535
Cu(CH3COO)3-	4.498e-292	1.082e-286	0.9163	-291.3850
1-Butyne(aq)	2.941e-292	1.590e-287	1.0000	-291.5315
Cd(CH3COO)3-	1.594e-294	4.614e-289	0.9163	-293.8354
1-Butanol(aq)	9.202e-295	6.818e-290	1.0000	-294.0361
1-Butene(aq)	8.438e-297	4.732e-292	1.0000	-296.0738
2-Hydroxypentano	4.298e-300	5.032e-295	0.9163	-299.4047
Glutamine(aq)	7.293e-303	1.065e-297	1.0000	-300.0000
2-Hydroxypentano	3.865e-304	4.564e-299	1.0000	-300.0000
U(SCN)2++	1.914e-305	6.776e-300	0.7067	-300.0000
n-Butane(aq)	1.392e-308	8.090e-304	1.0000	-300.0000
Alanylglycine(aq	2.416e-310	3.530e-305	1.0000	-300.0000
Pentanoate	7.636e-312	7.718e-307	0.9163	-300.0000
Ca(Lac)2(aq)	7.350e-314	1.603e-308	1.0000	-300.0000
Ca(Pent)+	1.775e-314	2.505e-309	0.9163	-300.0000
Pentanoic_acid(a	1.196e-314	1.221e-309	1.0000	-300.0000
Mg(Lac)2(aq)	1.174e-314	2.377e-309	1.0000	-300.0000
Na(Pent)(aq)	8.492e-315	1.054e-309	1.0000	-300.0000
Mg(Pent)+	4.318e-315	5.414e-310	0.9163	-300.0000
K(Pent)(aq)	1.559e-315	2.185e-310	1.0000	-300.0000
Cu(Lac)2(aq)	5.471e-316	1.322e-310	1.0000	-300.0000
Na(Lac)2-	2.276e-316	4.576e-311	0.9163	-300.0000
Cu(Pent)+	1.710e-316	2.814e-311	0.9163	-300.0000
K(Lac)2-	3.587e-317	7.789e-312	0.9163	-300.0000
Cd(Pent)+	7.484e-318	1.597e-312	0.9163	-300.0000
Cd(Lac)2(aq)	4.441e-318	1.290e-312	1.0000	-300.0000

Ba(Pent)+	2.983e-318	7.110e-313	0.9163	-300.0000
Ba(Lac)2(aq)	1.218e-318	3.840e-313	1.0000	-300.0000
Adipate	1.539e-319	2.217e-314	0.7036	-300.0000
H-Adipate	7.559e-322	1.097e-316	0.9163	-300.0000
Leucylglycine(aq	0.0000	0.0000	1.0000	-300.0000
Leucine(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
K(Prop)2-	0.0000	0.0000	0.9163	-300.0000
Ba(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
1-Octanamine(aq)	0.0000	0.0000	1.0000	-300.0000
K(Pent)2-	0.0000	0.0000	0.9163	-300.0000
Cd(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cd(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Azelate	0.0000	0.0000	0.7036	-300.0000
2-Hexanone(aq)	0.0000	0.0000	1.0000	-300.0000
K(But)2-	0.0000	0.0000	0.9163	-300.0000
Isoleucine(aq)	0.0000	0.0000	1.0000	-300.0000
Azelaic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Hexanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Hexanoate	0.0000	0.0000	0.9163	-300.0000
Hexanal(aq)	0.0000	0.0000	1.0000	-300.0000
Heptanoic_acid(a	0.0000	0.0000	1.0000	-300.0000
2-Heptanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexyne(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptanamine(aq	0.0000	0.0000	1.0000	-300.0000
Heptanoate	0.0000	0.0000	0.9163	-300.0000
Heptanal(aq)	0.0000	0.0000	1.0000	-300.0000
2-Butanone(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Adipic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexene(aq)	0.0000	0.0000	1.0000	-300.0000
p-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
p-Toluate	0.0000	0.0000	0.9163	-300.0000
o-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
o-Phthalate	0.0000	0.0000	0.7036	-300.0000
n-Propylbenzene(	0.0000	0.0000	1.0000	-300.0000
n-Pentylbenzene(	0.0000	0.0000	1.0000	-300.0000
H-Suberate	0.0000	0.0000	0.9163	-300.0000
H-Sebacate	0.0000	0.0000	0.9163	-300.0000
n-Hexylbenzene(a	0.0000	0.0000	1.0000	-300.0000
H-Pimelate	0.0000	0.0000	0.9163	-300.0000
n-Hexane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Heptylbenzene(	0.0000	0.0000	1.0000	-300.0000
n-Heptane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Butylbenzene(a	0.0000	0.0000	1.0000	-300.0000
m-Toluic_acid(aq	0.0000	0.0000	1.0000	-300.0000
m-Toluate	0.0000	0.0000	0.9163	-300.0000
H-Azelate	0.0000	0.0000	0.9163	-300.0000
Valine(aq)	0.0000	0.0000	1.0000	-300.0000
Undecanoic_acid(	0.0000	0.0000	1.0000	-300.0000
Undecanoate	0.0000	0.0000	0.9163	-300.0000
1-Hexanol(aq)	0.0000	0.0000	1.0000	-300.0000
1-Butanamine(aq)	0.0000	0.0000	1.0000	-300.0000
Ca(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
UO2(SCN)3-	0.0000	0.0000	0.9163	-300.0000
Ca(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ethylbenzene(aq)	0.0000	0.0000	1.0000	-300.0000
2-Pentanone(aq)	0.0000	0.0000	1.0000	-300.0000
Tryptophan(aq)	0.0000	0.0000	1.0000	-300.0000
Toluene(aq)	0.0000	0.0000	1.0000	-300.0000
Dodecanoic_acid(	0.0000	0.0000	1.0000	-300.0000
Suberic_acid(aq)	0.0000	0.0000	1.0000	-300.0000

Suberate	0.0000	0.0000	0.7036	-300.0000
Dodecanoate	0.0000	0.0000	0.9163	-300.0000
2-Octanone(aq)	0.0000	0.0000	1.0000	-300.0000
1-Pentyne(aq)	0.0000	0.0000	1.0000	-300.0000
1-Hexanamine(aq)	0.0000	0.0000	1.0000	-300.0000
Sebacic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Sebacate	0.0000	0.0000	0.7036	-300.0000
Decanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Tyrosine(aq)	0.0000	0.0000	1.0000	-300.0000
Decanoate	0.0000	0.0000	0.9163	-300.0000
Decanal(aq)	0.0000	0.0000	1.0000	-300.0000
S5--	0.0000	0.0000	0.7036	-300.0000
1-Pentene(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Benzoic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Cu(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Benzoate	0.0000	0.0000	0.9202	-300.0000
2-Hydroxyoctanoi	0.0000	0.0000	1.0000	-300.0000
Pimelic_acid(aq)	0.0000	0.0000	1.0000	-300.0000
Pimelate	0.0000	0.0000	0.7036	-300.0000
Phenylalanine(aq	0.0000	0.0000	1.0000	-300.0000
Benzene(aq)	0.0000	0.0000	1.0000	-300.0000
Phenol(aq)	0.0000	0.0000	1.0000	-300.0000
Pentanal(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyoctanoa	0.0000	0.0000	0.9163	-300.0000
1-Pentanol(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptyne(aq)	0.0000	0.0000	1.0000	-300.0000
Octanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
Octanoate	0.0000	0.0000	0.9163	-300.0000
Octanal(aq)	0.0000	0.0000	1.0000	-300.0000
Nonanoic_acid(aq	0.0000	0.0000	1.0000	-300.0000
2-Hydroxynonanoi	0.0000	0.0000	1.0000	-300.0000
Nonanoate	0.0000	0.0000	0.9163	-300.0000
Nonanal(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxynonanoa	0.0000	0.0000	0.9163	-300.0000
1-Pentanamine(aq	0.0000	0.0000	1.0000	-300.0000
Na(Prop)2-	0.0000	0.0000	0.9163	-300.0000
Ba(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Na(Pent)2-	0.0000	0.0000	0.9163	-300.0000
Cu(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyhexanoi	0.0000	0.0000	1.0000	-300.0000
Cu(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
Ba(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Na(But)2-	0.0000	0.0000	0.9163	-300.0000
2-Hydroxyhexanoa	0.0000	0.0000	0.9163	-300.0000
1-Octyne(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptene(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyheptano	0.0000	0.0000	1.0000	-300.0000
Mg(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxyheptano	0.0000	0.0000	0.9163	-300.0000
1-Octene(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cd(Prop)2(aq)	0.0000	0.0000	1.0000	-300.0000
Cd(Pent)2(aq)	0.0000	0.0000	1.0000	-300.0000
n-Octane(aq)	0.0000	0.0000	1.0000	-300.0000
n-Octylbenzene(a	0.0000	0.0000	1.0000	-300.0000
n-Pentane(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxydecanoi	0.0000	0.0000	1.0000	-300.0000
Mg(But)2(aq)	0.0000	0.0000	1.0000	-300.0000
Mg(Ala)2(aq)	0.0000	0.0000	1.0000	-300.0000
o-Toluate	0.0000	0.0000	0.9163	-300.0000
Methionine(aq)	0.0000	0.0000	1.0000	-300.0000
2-Hydroxydecanoa	0.0000	0.0000	0.9163	-300.0000

1-Octanol(aq)	0.0000	0.0000	1.0000	-300.0000
1-Heptanol(aq)	0.0000	0.0000	1.0000	-300.0000

Mineral saturation states

	log Q/K		log Q/K
Witherite	1.9775s/sat	UO2SO4:3H2O	-17.4476
Quartz	0.6102s/sat	Na2SiO3	-17.5240
Barite	0.4876s/sat	CdF2	-17.6531
Tridymite	0.4099s/sat	Hillebrandite	-17.8680
Chalcedony	0.3248s/sat	UO2F2:3H2O	-18.3079
Dolomite-ord	0.2524s/sat	Dicalcium_silica	-18.3509
Dolomite	0.2523s/sat	UO2F2	-18.6354
Tenorite	0.0346s/sat	UO2.3333(beta)	-18.8393
Cristobalite(alp	0.0252s/sat	CuCl2	-19.0624
Calcite	-0.0722	Akermanite	-19.2905
Ice	-0.0827	MgCl2:4H2O	-19.3906
Aragonite	-0.2173	Larnite	-19.7313
Coesite	-0.2397	Anthophyllite	-19.9357
Malachite	-0.3214	UO2SO4	-21.2376
Cristobalite(bet	-0.4615	UOFOH:.5H2O	-21.2975
SiO2(am)	-0.8006	UOFOH	-21.8087
Monohydrocalcite	-0.8715	Lime	-22.0995
Magnesite	-1.3983	Na2UO4(alpha)	-22.1492
Dolomite-dis	-1.4046	UO2(NO3)2:6H2O	-22.6359
Dioptase	-1.7397	UO2Cl	-23.3338
Gypsum	-2.0840	Hydrophilite	-23.4446
Anhydrite	-2.4074	UO2(NO3)2:3H2O	-24.2975
Talc	-2.6284	UOF2:H2O	-24.5892
Brochantite	-2.6390	MgCl2:2H2O	-25.2404
Bassanite	-3.0570	UOF2	-25.2440
CaSO4:0.5H2O(bet	-3.2443	Rankinite	-25.2976
Fluorite	-3.4249	UO2(NO3)2:2H2O	-25.6689
Cuprite	-3.7462	Tobermorite-14A	-26.8782
CdSiO3	-4.2212	K2UO4	-27.3542
Enstatite	-4.2305	MgCl2:H2O	-28.8303
Nesquehonite	-4.5159	UO2Cl2:3H2O	-28.9261
CaUO4	-4.5941	Tobermorite-11A	-29.1336
UO3:2H2O	-5.0035	UO2(NO3)2:H2O	-29.5137
Schoepite	-5.0037	Foshagite	-31.2820
Sellaite	-5.0130	Merwinite	-31.5283
UO2(OH)2(beta)	-5.1710	UO2Cl2:H2O	-31.8914
Schoepite-dehy(.	-5.2316	Ba2SiO4	-32.3050
UO3:.9H2O(alpha)	-5.2390	Tobermorite-9A	-32.9862
Schoepite-dehy(.	-5.3246	UO2(NO3)2	-33.2063
Schoepite-dehy(1	-5.3414	Afwillite	-33.5735
Nahcolite	-5.3954	UO2SO3	-33.8147
Atacamite	-5.5572	KMgCl3:2H2O	-33.9848
Okenite	-5.7072	Cd	-34.6667
Diopside	-5.7722	Chloromagnesite	-34.9320
Brucite	-5.7751	UF4:2.5H2O	-35.2289
Chrysotile	-5.8724	UO2Cl2	-36.0092
Wollastonite	-5.8988	BaSiF6	-39.0882
Azurite	-5.9263	UF4	-39.7851
Niter	-5.9458	BaO	-41.2060
Huntite	-5.9480	KMgCl3	-41.7718
UO2CO3	-6.0046	C	-42.5290
Rutherfordine	-6.0179	U(SO4)2:8H2O	-42.5860
Pseudowollastoni	-6.1651	U(SO4)2:4H2O	-43.9201
Schoepite-dehy(.	-6.5158	U(SO4)2	-44.1850
Schoepite-dehy(.	-7.0672	Hatrurite	-44.3213
Cd(OH)2	-7.0824	Ba2U2O7	-44.6938
Nantokite	-7.3936	Xonotlite	-45.0809

Cu	-7.4503	U(CO3)2	-46.7436
Mirabilite	-7.8355	UOCl2	-47.0748
Sepiolite	-7.8642	UClF3	-50.6519
Chalcanthite	-7.8773	U5O12Cl	-53.2856
Cd(OH)Cl	-7.9491	Na3UO4	-57.2754
Artinite	-8.0106	UOF4	-57.3260
Sanbornite	-8.0650	Na	-57.4147
UO3(gamma)	-8.1522	Na4SiO4	-59.0080
Sylvite	-8.3521	UOCl3	-60.3774
Halite	-8.5462	(UO2)2Cl3	-60.5461
Monteponite	-8.5856	UF3	-60.6354
UO3(beta)	-8.7877	Na2O	-61.4872
Nitrobarite	-8.8753	K	-61.8009
Arcanite	-8.9567	Covellite	-62.0718
UO3(alpha)	-9.1428	Chalcocite	-63.3984
Thenardite	-9.3436	UCl2F2	-63.8329
CdSO4:2.667H2O	-9.7347	UF5(beta)	-63.9134
CdSO4:H2O	-9.9938	UOCl	-64.3196
BaUO4	-10.0580	UF5(alpha)	-64.3202
UO2.25	-10.1356	S	-64.3475
UO2FOH:2H2O	-10.1782	CdS	-70.1181
UO2.25(beta)	-10.2044	Ba3UO6	-72.0229
Gyrolite	-10.2442	U2O3F6	-76.1096
Natron	-10.2492	UCl3F	-76.8296
Forsterite	-10.3463	Antigorite	-79.3871
Mg1.25SO4(OH)0.5	-10.5207	K2O	-80.1347
UO2FOH:H2O	-10.6378	CdCl2(NH3)2	-80.4583
Na2CO3:7H2O	-10.8156	U(SO3)2	-80.5183
Periclase	-11.1661	Na6Si2O7	-85.8292
UO2FOH	-11.1666	UCl4	-87.6655
Monticellite	-11.2692	UCl3	-90.2705
Portlandite	-11.4836	UF6	-97.0293
CdSO4	-11.7224	Mg	-100.0942
Mg1.5SO4(OH)	-11.8916	U2F9	-100.3980
Tremolite	-12.2517	U3O5F8	-102.0872
Thermonatrite	-12.2937	BaS	-102.1571
Na2CO3	-12.6226	UN1.73(alpha)	-106.7039
UO2SO4:H2O	-12.8435	U2O2Cl5	-108.7434
MgSO4	-12.9642	UN1.59(alpha)	-109.5019
MgUO4	-12.9855	UCl5	-109.5882
Uraninite	-13.0321	Ca	-117.4049
Coffinite	-13.2634	Ba	-121.9319
UO2.6667	-13.9099	UN	-122.8450
UO2ClOH:2H2O	-13.9140	Si	-125.0598
BaU2O7	-14.0885	UCl6	-130.2961
CdCl2:H2O	-14.1067	CdCl2(NH3)4	-156.3925
Chalcocyanite	-14.1182	U	-171.0676
BaCl2:2H2O	-14.1810	US	-176.2301
Na2U2O7	-14.4080	U4F17	-179.0560
BaCl2:H2O	-14.9183	UC	-195.3693
CdCl2	-15.2298	UH3(beta)	-198.9233
Ba(OH)2:8H2O	-15.9748	US1.9	-199.3869
NaUO3	-16.3441	US2	-204.0135
BaCl2	-16.4731	CdCl2(NH3)6	-232.4220
Natrosilite	-16.8240	UC1.94(alpha)	-237.4766
Hydromagnesite	-16.8649	US3	-265.0291
MgOHCl	-17.0397	U2S3	-372.9677
Ba2Si3O8	-17.1204	o-Phthalic_acid	-378.4368
UO2SO4:3.5H2O	-17.3069	U2C3	-434.8687
UO2SO4:2.5H2O	-17.3706	U3S5	-572.1633

Gases	fugacity	log fug.

N2(g)	0.03354	-1.474
H2O(g)	0.01017	-1.993
CO2(g)	0.002960	-2.529
NO2(g)	2.886e-011	-10.540
HF(g)	2.500e-015	-14.602
HCl(g)	2.652e-019	-18.576
H2(g)	1.480e-028	-27.830
O2(g)	1.976e-033	-32.704
NO(g)	1.008e-033	-32.997
CO(g)	1.465e-034	-33.834
NH3(g)	6.640e-040	-39.178
SiF4(g)	3.298e-041	-40.482
SO2(g)	1.850e-042	-41.733
Cl2(g)	3.935e-045	-44.405
Cd(g)	6.028e-050	-49.220
Cu(g)	2.023e-063	-62.694
UO2F2(g)	5.009e-064	-63.300
Na(g)	1.321e-072	-71.879
K(g)	6.189e-074	-73.208
UO2Cl2(g)	4.644e-075	-74.333
UO3(g)	5.051e-076	-75.297
UOF4(g)	3.000e-079	-78.523
UF5(g)	8.738e-086	-85.059
H2S(g)	7.787e-087	-86.109
UF4(g)	3.463e-087	-86.461
CH4(g)	2.414e-089	-88.617
UF6(g)	4.926e-099	-98.307
F2(g)	1.326e-103	-102.878
UCl4(g)	1.168e-114	-113.933
UO2(g)	7.899e-116	-115.102
Mg(g)	7.193e-122	-121.143
UCl5(g)	5.691e-129	-128.245
UF3(g)	4.057e-132	-131.392
UCl6(g)	1.218e-137	-136.914
UCl3(g)	1.259e-139	-138.900
U2F10(g)	6.028e-144	-143.220
S2(g)	1.711e-144	-143.767
Ca(g)	5.610e-145	-144.251
C2H4(g)	7.345e-154	-153.134
C(g)	2.009e-167	-166.697
UF2(g)	1.138e-173	-172.944
UCl2(g)	1.026e-182	-181.989
UO(g)	9.378e-189	-188.028
Si(g)	5.918e-201	-200.228
UF(g)	2.087e-208	-207.680
U2Cl8(g)	3.711e-217	-216.430
UCl(g)	2.976e-223	-222.526
U2Cl10(g)	4.722e-229	-228.326
U(g)	2.955e-262	-261.529

		In fluid		Sorbed		Kd
Original basis	total moles	moles	mg/kg	moles	mg/kg	L/kg
Ba++	1.06e-006	1.06e-006	0.146			
Ca++	0.00166	0.00166	66.5			
Cd++	2.57e-008	2.57e-008	0.00289			
Cl-	0.000110	0.000110	3.91			
Cu++	1.69e-007	1.69e-007	0.0108			
F-	5.15e-006	5.15e-006	0.0977			
H+	0.000151	0.000151	0.152			
H2O	55.5	55.5	1.00e+006			
HCO3-	0.00261	0.00261	159.			
K+	0.000225	0.000225	8.80			

Mg++	0.000322	0.000322	7.82
NH3(aq)	5.69e-005	5.69e-005	0.969
NO3-	0.00171	0.00171	106.
Na+	0.00106	0.00106	24.4
O2(aq)	4.25e-005	4.25e-005	1.36
SO4--	0.000366	0.000366	35.2
SiO2(aq)	0.000181	0.000181	10.8
UO2++	2.05e-009	2.05e-009	0.000554

Elemental composition		In fluid		Sorbed	
	total moles	moles	mg/kg	moles	mg/kg
Barium	1.061e-006	1.061e-006	0.1456		
Cadmium	2.575e-008	2.575e-008	0.002893		
Calcium	0.001659	0.001659	66.46		
Carbon	0.002612	0.002612	31.36		
Chlorine	0.0001103	0.0001103	3.909		
Copper	1.693e-007	1.693e-007	0.01075		
Fluorine	5.147e-006	5.147e-006	0.09774		
Hydrogen	111.0	111.0	1.118e+005		
Magnesium	0.0003218	0.0003218	7.819		
Nitrogen	0.001768	0.001768	24.75		
Oxygen	55.52	55.52	8.880e+005		
Potassium	0.0002251	0.0002251	8.796		
Silicon	0.0001806	0.0001806	5.071		
Sodium	0.001063	0.001063	24.43		
Sulfur	0.0003664	0.0003664	11.74		
Uranium	2.054e-009	2.054e-009	0.0004887		

Appendix J
Long-Term Water Quality Monitoring Plan

Troy Mine
Long-Term Water Quality Monitoring Plan
January 17, 2012

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Section 1
INTRODUCTION

This proposed template for the Troy Mine Long-Term Water Quality Monitoring Plan is prepared to accompany the Environmental Impact Statement (EIS) being prepared for reclamation of the Troy Mine. Its purpose is to clarify what water quality monitoring is expected to be performed at the mine after the mine is closed, and to detail the expected locations of surface and groundwater stations and wells as well as the parameters to be sampled and the expected sampling frequency. At the time of closure, the Department of Environmental Quality and the USDA Forest Service expect that a final Long-Term Water Quality Monitoring Plan, prepared by the mine and approved by the Agencies, will reflect knowledge of the site current at that time and it may, therefore, differ from this document. It is also expected that the final document will contain additional detail such as standard operating procedures, quality assurance procedures, data reporting requirements, data validation procedures, and analytical methods.

The long-term water quality monitoring identified in this document is derived from the current operational monitoring procedures at the Troy Mine, including additional requirements which are detailed in the Agency Mitigated Alternative of the Troy Mine Revised Reclamation Plan EIS, and Monitored Natural Attenuation (MNA). Sampling locations are shown on attached maps and monitoring frequency and parameter lists are presented in the text. The extent of water quality monitoring includes surface water, groundwater, and seeps and springs. Provision is also made in this plan to expand the seeps and springs monitoring should additional springs or seeps be discovered post-closure.

MNA is included in this monitoring plan to evaluate the effectiveness of the geologic materials beneath the decant ponds for attenuation of metals and nutrients in the mine discharge water. Procedures for monitoring natural attenuation are taken from EPA guidance (EPA 2007). The MNA program accounts for site heterogeneity and variations in seasonal mine water discharge, groundwater levels, and biological activity. Five wells in the area of the decant ponds as well as the decant ponds will be monitored three times per year for additional parameters that allow complete assessment of natural attenuation mechanisms. In addition to monitoring of water chemistry, the MNA program would include monitoring of the rate of accumulation of sediment and organic material within the decant ponds, initially at an annual frequency. Redox conditions within this sediment would also be documented.

Section 2
Surface Water Monitoring

Surface water monitoring of Lake Creek has been conducted since 1979 and monitoring of Stanley and Fairway creeks has been conducted since 1986. The program included bioassay testing, macroinvertebrate monitoring, and water quality and flow monitoring three times per year (Genesis 2006, Appendix F, page 5). Water quality monitoring is described in this plan, whereas bioassay testing and macroinvertebrate testing are described in the *Comprehensive Water Quality Monitoring Program for Streams Adjacent to Asarco's Troy*, *Montana*, *Unit* (Parametrix 2000a, 2000b).

The Proposed Action detailed that all three sites at SC-15 (SC-15A, SC-15B, and SC15-C) be sampled bringing the total number of surface water sites to be sampled to nine. The water quality monitoring stations listed in **Table 2-1** would continue to be sampled post-reclamation for flow and water quality three times per year for at least five years after discharge of mine water commences. Monitoring would continue until the Agencies agree that monitoring is no longer necessary (Genesis 2006, Appendix F, pages 5-6). Sampling locations are shown on **Figure 2-1**.

Table 2-1. Surface Water Monitoring Sites and Schedule

Monitoring Site	Monitoring Parameters	Monitoring Frequency
Lake Creek		
LC-1	Quality and flow	Spring, summer, fall
LC-2	Quality and flow	Spring, summer, fall
LC-4	Quality and flow	Spring, summer, fall
Fairway Creek		
FC-1	Quality	Spring, summer, fall
Stanley Creek		
SC-2	Quality and flow	Spring, summer, fall
SC-15A	Quality and flow	Spring, summer, fall
SC-15B	Quality and flow	Spring, summer, fall
SC-15C	Quality and flow	Spring, summer, fall
SC-17A	Quality and flow	Spring, summer, fall

Analytical parameters for all water samples collected at the Troy Mine site are listed in **Table 2-2**.

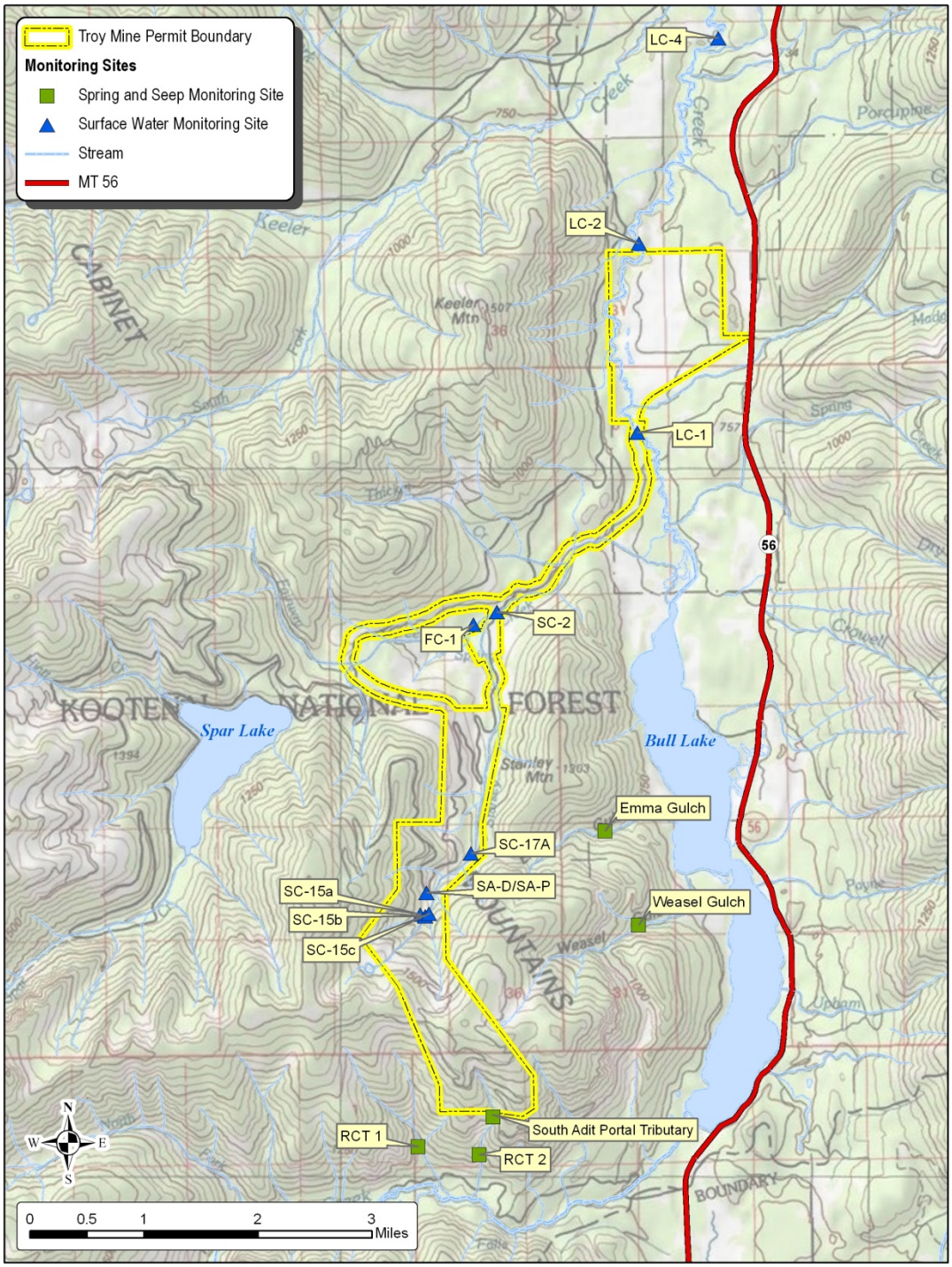

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Figure 2-1. Surface water, spring, and seep monitoring site locations.

Table 2-2. Analytical Parameters for Water Samples.

Common Ions	***Field Parameters***
Sulfate	Temperature (°C)
Chloride	
Carbonate	***Miscellaneous Parameters***
Bicarbonate	pH
Total Alkalinity as $CaCO_3$	Total Suspended Solids (TSS)
Sodium	Total Dissolved Solids (TDS)
Magnesium	
Potassium	***Trace Metals***
Total Hardness as $CaCO_3$	Antimony (Sb) (0.003 mg/L)
	Arsenic (As) (0.003 mg/L)
Nutrients	Cadmium (Cd) (0.00008 mg/L)
Ammonia (0.05 mg/L)	Copper (Cu) (0.001 mg/L)
Nitrate + Nitrite (0.01 mg/L)	Iron (Fe) (0.05 mg/L)
Total Phosphorus as P (0.001 mg/L)	Lead (Pb) (0.0005 mg/L)
	Manganese (Mn) (0.005 mg/L)
	Zinc (Zn) (0.01 mg/L)

Notes: 1. DEQ Water Quality Bureau Circular DEQ-7 (August 2010) Required Reporting Value (RRV) for trace metals are shown in parentheses. All metal analyses must meet the current effective DEQ-7 RRVs.

2. Metals in surface water samples are analyzed for dissolved and total recoverable constituents. Metals in groundwater samples are analyzed for dissolved constituents.

Section 3
Groundwater Monitoring

Groundwater has been monitored during operations at wells and surface expressions primarily in the vicinity of the tailings pond. These same locations would be monitored after mine discharge begins for a minimum of five years. Monitoring would continue until the Agencies agree that monitoring is no longer necessary (Genesis 2006, Appendix F, pages 5-6). **Table 3-1** lists the mine site monitoring locations and the frequency of sampling for locations in the vicinity of the tailings pond. **Figure 3-1** shows the location of these sampling points. Sampling parameters for these locations are listed in **Table 2-2**.

Table 3-1. Groundwater Monitoring Sites and Schedule.

Monitoring Site	Monitoring Parameter	Monitoring Frequency
MW-1	Water level and quality	Annually
MW-2	Water level and quality	Annually
MW-3	Water level and quality	Annually
MW-4	Water level and quality	Annually
IW-1	Water level and quality (MNA)	Annually
Toe Pond 2	Water level and quality	Quarterly
Toe Pond 3	Water level and quality	Quarterly
Toe Pond 4	Water level and quality	Quarterly
Decant Ponds	Water level and quality (MNA)	Quarterly
EP-1	Water level and quality	Quarterly
MW-95-4	Water level and quality	Spring, summer, fall
MW-95-7	Water level and quality (MNA)	Spring, summer, fall
MW-95-8	Water level and quality (MNA)	Spring, summer, fall
MW-97-12	Water level and quality	Spring, summer, fall
MW-97-14	Water level and quality	Spring, summer, fall
MW-01-15	Water level and quality (MNA)	Spring, summer, fall
MW-01-16	Water level and quality (MNA)	Spring, summer, fall
MW-2010-1	Water level and quality	Spring, summer, fall
MW-2010-2	Water level and quality	Spring, summer, fall

Note: (MNA) - Monitoring for parameters in Table 3-2 required in addition to Table 2-2 parameters.

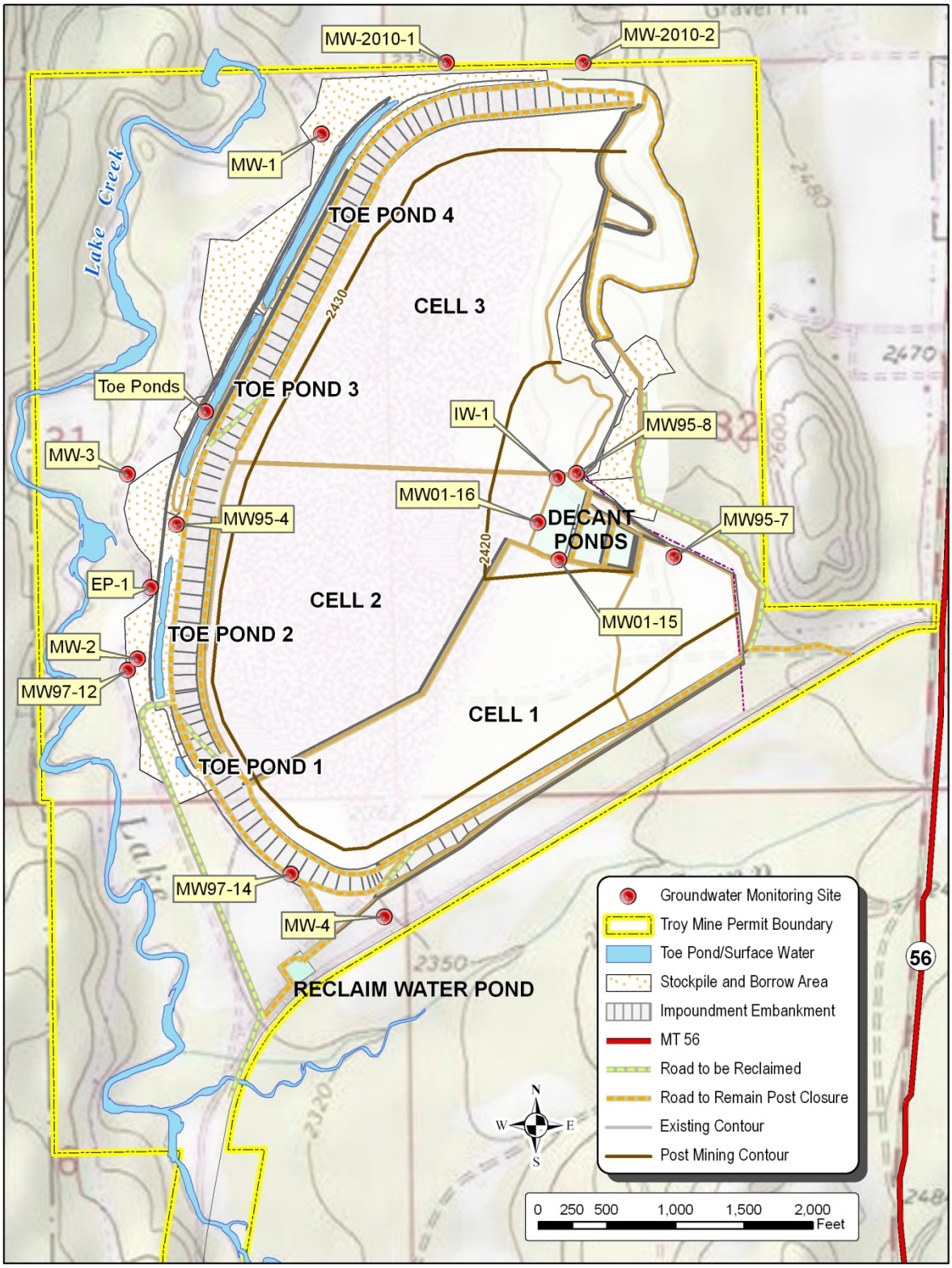

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Figure 3-1. Groundwater monitoring locations.

Most groundwater monitoring sites in the vicinity of the tailings pond are monitoring wells although there is one irrigation well (IW-1) that is sampled. Four toe ponds were installed in 1983 on the downgradient side of the tailings embankment to contain storm water runoff (Genesis 2006, page 7-10) and also capture seepage from the tailings impoundment. The three northern toe ponds usually contain standing water, but the southernmost toe pond is typically dry. A sump and pumping system is currently used to capture groundwater that emerges downhill from the toe ponds. During operations, water is continuously pumped from the sump (site EP-1) to toe pond #2 to prevent downgradient migration of nitrate. The decant ponds will continue to be used for disposal of mine water after mine closure. Sampling of the decant ponds will provide information on the quality of mine discharge before treatment.

The parameter list for five wells and the decant ponds has been expanded to included parameters critical to evaluation of MNA. The five wells and the decant ponds will be monitored for the additional parameters listed in **Table 3-2** as well as those in **Table 2-2**.

Table 3-2. Analytical Parameters for Monitored Natural Attenuation (MNA).

Field Parameters	*Laboratory Parameters*
pH	Ferrous/Ferric Iron
Eh/ORP	Dissolved Silica
Dissolved Oxygen	Dissolved Organic Carbon

ORP = Oxidation Reduction Potential

Section 4
Spring and Seep Monitoring

The farthest upgradient expressions of groundwater are in drainages around the mine and were chosen to monitor changes in the quality of groundwater discharging to these drainages (Genesis 2006, Appendix F, page 2). In coordination with the Agencies, Troy Mine has also monitored groundwater in a tributary below the South Adit portal to evaluate effects on groundwater seepage as the mine floods. These monitoring sites would continue to be evaluated to determine potential mine water influence on surface and groundwater. Post-closure water quality monitoring of seeps and springs would verify whether state water quality standards are met. The monitoring schedule for springs and seeps is presented in **Table 4-1**, and the monitoring parameters are the same as for surface water (**Table 2-2**). The sampling locations are shown in **Figure 2-1.**

Table 4-1. Seep and Spring Monitoring Sites and Schedule.

Monitoring Site	Monitoring Parameter	Monitoring Frequency
Ross Ck RCT 1	Quality and flow	Annually – during low flow
Ross Ck RCT 2	Quality and flow	Annually – during low flow
South Adit Portal tributary	Quality and flow	Annually – during low flow
Emma Gulch	Quality and flow	Annually – during low flow
Weasel Gulch	Quality and flow	Annually – during low flow

Section 5
References

Environmental Protection Agency. 2007. Monitored Natural Attenuation of Inorganic Contaminants in Ground Water, Volume 1 – Technical Basis for Assessment. EPA/600/R-07/139, October 2007. http://www.epa.gov/nrmrl/pubs/600R07139/600R07139.pdf.

Genesis, Inc. 2006. Genesis Incorporated Troy Mine Revised Reclamation Plan. March 2006.

Parametrix, 2000a. Final Draft Annual Report – Year Fifteen. Comprehensive Water Quality Monitoring Program for Streams Adjacent to Asarco's Troy, Montana, Unit. October, 2000.

Parametrix, 2000b. Recommendations to Modify the Surface Water Quality Monitoring Program for Streams Adjacent to Genesis' Troy, Montana, Unit. September 2000.

Appendix K
Draft EIS Comment Summary and Responses

Due to the volume of comments received on the Draft EIS, comments are summarized below. The following tables identify each commenter and which topic areas the comments address. The general topic or resource area is identified across the top and the sub comment is identified within the table. The comment responses are organized in the same manner. For example, under the column heading General comments "A", subcomment "5" would be found in the first section of the comment responses under Comment A5. Table 1 lists agency and elected official comments and the official comments of organizations. Table 2 lists individual comments.

Table 1. Agency, elected official, organization comments

First Name	Last Name	Organization	Comment File Name	A: General	B: Alternatives Definition	C: Air Quality	D: Fish Habitat	E: Hydrology	F: Recreation	G: Socio-economics	H: Reclamation Materials	I: Transportation	J: Vegetation	K: Wildlife
Robert	Stewart	Department of the Interior	2011-06-24 StewartR_DOI											
Julia	DalSoglio	Environmental Protection Agency	2011-06-29 DalsoglioJ_EPA		A-EPA 1			A-EPA #1-21				A-EPA 1		A-EPA 1
James	Mayo	Lincoln County Port Authority	2011-08-01 JMayoLincolnCoPortAuthority		1	4		1, 2, 3			1, 2	1		
Marianne	Roose	Lincoln County Commissioners	2011-08-03 LincolnCoCommissioners		1, 2			1, 2, 3			1, 2, 3	1		
Tonya	Chilton Radandt	Montana Fish Wildlife and Parks	2011-08-04 Chilton-Radandt_FWP											A-FWP-CR #1-4
Chas	Vincent	Lincoln County Delegation	2011-08-05 BennetG_CuffeM_and_VincentC		A-LCD 1			A-LCD #1-2	A-LCD 1		A-LCD 1	A-LCD 1		A-LCD 1
T.O.	Smith	Montana Fish, Wildlife & Parks	2011-08-05 SmithTO_FWP				A-FWP-							

First Name	Last Name	Organization	Comment File Name	A: General	B: Alternatives Definition	C: Air Quality	D: Fish Habitat	E: Hydrology	F: Recreation	G: Socio-economics	H: Reclamation Materials	I: Transportation	J: Vegetation	K: Wildlife
							S #1-3							
Howard	Bakke	Cabinet Resource Group	2011-08-05 BakkeH_and_MartinB_CRG		CRG 1-3			CRG 1-11			CRG 1	CRG 1		
Douglas	Miller	Troy Mine, Inc.	2011-07-26 TroyMineRevettCommentsDEIS	TMI 1-3	TMI 1-6	TMI 1		TMI 1-6			TMI 1-2	TMI 1		

Table 2. Individual Comments

First Name	Last Name	Comment File Name	A: General	B: Alternatives Definition	C: Air Quality	D: Fish Habitat	E: Hydrology	F: Recreation	G: Socio-economics	H: Reclamation Materials	I: Transportation	J: Vegetation	K: Wildlife
Bob	Bernhart	2011-06-07 BernhartB					1			3			1
Issac	Erickson	2011-06-07 EricksonI					1, 2, 7		3				2
Earlene	Jellesed	2011-06-07 JellesedE					1			1			1
Steve	Lloyd	2011-06-08 LloydS		1			1			1, 3	1		
Howard	Morkert	2011-06-08 MorkertH							2				
Jill	Blomdahl	2011-06-09 BlomdahlJ							3	2			
Soraya	Garcia	2011-06-09 GarciaS					2						

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Cary	Brus	2011-06-12 BrusC	5	3			2, 4, 6, 9	1	1	1, 3, 4	1	1	
Tim	Brus	2011-06-12 BrusT					1, 7						
Hank	Bailey	2011-06-13 BaileyH	5				2, 4, 6, 9	1	1	1, 3, 4	1	1	
Howard	Bakke	2011-06-13 BakkeH_CRG	1										
Kim	DeVore	2011-06-13 DeVoreK_a					1		3				
Kim	DeVore	2011-06-13 DeVoreK_b	5	3			2, 4, 6, 9	1	1	1, 3, 4	1	1	
Debbie	Lyman	2011-06-13 LymanDe	1										
Bill	Thompson	2011-06-13 ThompsonB	5	3			2, 4, 6, 9	1	1	1, 3, 4	1	1	
Tom	Swanson	2011-06-14 SwansonT	5						1, 2				
Ron	Waeckerlin	2011-06-14 WaekerlinR	5										
Dave	Lyman	2011-06-15 LymanDa	1										
Dave	Ballard	2011-06-16 BallardD	5						2				
Phil	Hough	2011-06-17 HoughP_FSPW	1										
Larry	Coryell	2011-06-21 CoryellL		1, 5			5			5	1		
Sam	Ziegler	2011-06-22 ZieglerS					1, 2, 7		3				
Patti	Vincent	2011-06-23 VincentP					1, 2, 7		3				
George	Byers	2011-06-24 ByersG					1, 7		1, 3				
Cort	Freeman	2011-06-24 FreemanC					1, 3				1		
Martin	Johnson	2011-06-24 JohnsonM					1, 7						
Nancy	Schlepp	2011-06-24 SchleppN								1, 2			1
Barry	Stang	2011-06-24 StangB					1, 7						
Eric	Williams	2011-06-24 WilliamsE		1			1			1	1		
Holly	Harper	2011-06-25 HarperH								1, 2			1

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Steve	McCall	2011-06-25 McCallS					1			1			1
Dave	Shorten	2011-06-25 ShortenD	5				1				1		
Timothy	Ware	2011-06-25 WareT					1, 2, 7		3				
Ralph	Yant	2011-06-25 YantR							3	2			
Frank	Blair	2011-06-27 BlairF					1						
Clint	Chapman	2011-06-27 ChapmanC							3	2			
Mark	Compton	2011-06-27 ComptonM					1		3				
Joseph	Dillon	2011-06-27 DillonJ	5										
James	Ebisch	2011-06-27 EbischJ					1, 2			1			1
Tom	Harrington	2011-06-27 HarringtonT_JLDC		1			1			2	1		
Paul	Kaplan	2011-06-27 KaplanP											
Keith	Larsen	2011-06-27 LarsenK		2			1, 7						
Jerry	Laughery	2011-06-27 LaugheryJ					1, 2, 7		3				
Tom	Lewis	2011-06-27 LewisT					1, 2, 7		3				
Kevin	McClelland	2011-06-27 McClellandK					1						
Scott	Mendenhall	2011-06-27 MendenhallS		1, 2			1, 2			1, 2, 3			1
Michael	Mullaney	2011-06-27 MullaneyM					1, 2, 7			2			1
Patricia	Nelson	2011-06-27 NelsonP					1, 7						
James	Rasmussen	2011-06-27 RasmussenJ					1		3				
Tracy	Stevenson	2011-06-27 StevensonT					7		1, 3				
Gail	Stevers	2011-06-27 SteversG					1, 2, 7			2			1
Scott	Viegut	2011-06-27 ViegutS					1		3				
Taylor	Walt	2011-06-27 WaltT					7		1, 3				

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David	Watson	2011-06-27 WatsonDa					1, 2, 7		3				
Douglas	Watson	2011-06-27 WatsonDo		1	4		2, 3			1, 2	1		
John	Welsh	2011-06-27 WelshJ											
David	Axe	2011-06-28 AxeD				1	7		3				1
Arlyne	Beito	2011-06-28 BeitoA		1			1			3	1		1
Josh	Brothers	2011-06-28 BrothersJ					7		1, 3				
Doris	Brown	2011-06-28 BrownD					7		1, 3				
William	Cohan	2011-06-28 CohanW		2			1, 7						
Steve & Ruth	Endicott	2011-06-28 EndicottSandR							2				
Dennis	Facer	2011-06-28 FacerD					1			3			1
Louis	Hill	2011-06-28 HillL		1			1			1	1		
Stephen	Langedyke	2011-06-28 LangdykeS					1, 2, 7		3				
Tara	Mastel	2011-06-28 MastelT_JLDC											
Roberta	McCanse	2011-06-28 McCanseR		1			6, 8, 10			2, 3	3	2	
Dwight	Morris	2011-06-28 MorrisD					1, 2, 7			2			1
Bert	Nicholl	2011-06-28 NichollB								1, 2			1
Lenny	Pauley	2011-06-28 PauleyL					1		1	3			1
Carol	Perry	2011-06-28 PerryC								1, 2			1
Charles	Pickering	2011-06-28 PickeringC							1, 3	2			
Nicholas	Ross	2011-06-28 RossN					1, 2, 7		3				
Brady	Selle	2011-06-28 SelleB		1									
Reinnis	Sipols	2011-06-28 SipolsR					1		3				
Jim	Stoor	2011-06-28 StoorJ	5				1, 2, 7		3				
Chester	Stryker	2011-06-28 StrykerC					1, 2, 7		3				

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Jon	Weisenbach	2011-06-28 WeisenbachJ					1			1			1
Ken	Ahern	2011-06-29 AhearnK	5				1				1		
Lori	Bowe	2011-06-29 BoweL		1			2				1		
Jim	Hammons	2011-06-29 HammonsJ					1						
Hank	Hartung	2011-06-29 HartungH					7		1, 3				
Karyn	Holcomb	2011-06-29 HolcombK	5				1				1		
Jay	Matthews	2011-06-29 MatthewsJ	5				1				1		
Bob	Moore	2011-06-29 MooreB								1, 2			1
Fred	Watson	2011-06-29 WatsonF					1, 2, 7		3				2
Brian	Wilkins	2011-06-29 WilkinsB					1			3			1
Larry	Bowman	2011-06-30 BowmanL							1				
Mark	Briggs	2011-06-30 BriggsM		1			1			1	1		
Bud	Chewning	2011-06-30 ChewningB					1, 7						
George	Clements	2011-06-30 ClementsG					1, 2, 7			2			1
Robert	Clough	2011-06-30 CloughR					2				1, 2		
Stanley	Davis	2011-06-30 DavisS	1										
Al	Dibble	2011-06-30 DibbleA	5				1		1		1		
Tim	Dimock	2011-06-30 DimockT					2				1, 2		
Lavada	Erickson	2011-06-30 EricksonL		1			1			1	1		
Rick	Henderson	2011-06-30 HendersonR					1, 2, 7		3				
Bernard	Hurd	2011-06-30 HurdB											
Sheri	Keehn	2011-06-30 KeehnS					2				1, 2		
Julie	Kendall	2011-06-30 KendallJ					1, 7						
Rudy	Ketchum	2011-06-30 KetchumR	5				1				1		
Vanessa	Lanz	2011-06-30 LanzV					1						

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Sharon	Lingel	2011-06-30 LingelS					1			1			1
Harry	Moe	2011-06-30 MoeH							3	2			
Mike	Moodry	2011-06-30 MoodryM					1			3			1
Clint	Mortensen	2011-06-30 MortensenC		1			1			1	1		
Carol	Oedewaldt	2011-06-30 OedewaldtC					7		1, 3				
Michael	Owens	2011-06-30 OwensM_and_AndersonM											
Tom	Phillips	2011-06-30 PhillipsT					1				1, 2		
Steve	Rebo	2011-06-30 ReboS							3	2			
Darrell	Scharf	2011-06-30 ScharfD					7		3				
Judy	Seeman	2011-06-30 SeemanJ	5				1				1		
Frank	Sholey	2011-06-30 SholeyF					1						
Seth	Slatter	2011-06-30 SlatterS					1, 2, 7		3				2
Kelly	Stolp	2011-06-30 StolpK	5				1				1		
Mark	Thompson	2011-06-30 ThompsonM		1			1			1	1		
Ron	Tuohimaa	2011-06-30 TuohimaaR							3				
Fred	Wesley	2011-06-30 WesleyF	5				1				1		
Steven	Erickson	2011-07-01 EricksonS	5				1				1		
Lacie	Farmer	2011-07-01 FarmerL					1				1		
Dan	Freebury	2011-07-01 FreeburyD					7		1, 3				
Milo	Haugen	2011-07-01 HaugenM		1			1			1	1		
Ralph	Heinert	2011-07-01 HeinertR		1			7		3				
James	McGlasson	2011-07-01 McGlassonJ											
Laura	McGlasson	2011-07-01 McGlassonL											

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Joe	Nicholls	2011-07-01 NicholllsJ					2				1, 2		
Timothy	Oman	2011-07-01 OmanT								1, 2			1
Steve	Schwab	2011-07-01 SchwabS					1, 2, 7			2			1
Kerry	Weightman	2011-07-01 WeightmanK					1, 7						
Donald	Bennett	2011-07-02 BennettD								1, 2			1
Garman	Guthrie	2011-07-02 GuthrieG					7		1, 3				
E. Dianne	Habeck	2011-07-02 HabeckD		1			1			1	1		
Connor	James	2011-07-02 JamesC					1, 7						
John	McMenamin	2011-07-02 McMenaminJ								1, 2			1
Chuck	Riley	2011-07-02 RileyC					1, 2, 7		3				
Colleen	Snyder	2011-07-02 SnyderC							3	2			
Dan	Snyder	2011-07-02 SnyderD					1			1			1
JoAnn	Spell	2011-07-02 SpellJ	5				1				1		
Ronald	Spell	2011-07-02 SpellR					1, 7						
Nancee	Tallmadge	2011-07-02 TallmadgeN					1			3			1
Chris	Hesse	2011-07-03 HesseC											
Barry	Bruland	2011-07-04 BrulandB	5	1			1		3		1		
Renee	Guisewite	2011-07-04 GuisewiteR					1, 2, 7		3				
Rusty & Joan	Maynard	2011-07-04 MaynardRandJ					1, 2, 7		3				
Sharon	Rice	2011-07-04 RIceS					1, 2, 7		3				
Tammy	Anderson	2011-07-05 AndersonT	5	1			7		3				
Monty	Carson	2011-07-05 CarsonM					1, 2, 7		3				2
Lawrence	Dolezal	2011-07-05 DolezalL		1			1, 7			1, 2	1		1
Owen	Erickson	2011-07-05 EricksonO		2			1, 2			1, 2, 3	1		
Ed	Hammersch	2011-07-05											

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	midt	HammerschmidtEandL											
Rich	Johnson	2011-07-05 JohnsonR	5				1				1		
Tom	Jones	2011-07-05 JonesT		2			1, 7						
Dan	Kneller	2011-07-05 KnellerD		2			1, 7						
James	Regh	2011-07-05 ReghJ					1, 2, 7		3				2
Edwina	Smith	2011-07-05 SmithE					1			1	1		
Andrew	Foote	2011-07-06 FooteA							3				
Chris	Hesse	2011-07-06 HesseC											
Elvie	Miller	2011-07-06 MillerE							3	2			
Sharel	Uphus	2011-07-08 UphusS		1			1			1	1		
Marc	McGill	2011-07-12 McGillM				1	7		3				1
Jon	Bennion	2011-07-15 BennionJ_MCC					1, 2, 3, 7		3	1, 2	1		1
Pat	McLeod	2011-07-22 McLeodP		1			12	1		1, 3			
Peter	Lopushok	2011-07-24 LopushokP		1			12, 13	2		1	1, 2		
Randy	Gariglietti	2011-07-26 GariglietiR		1			12, 13			1, 2, 3	1, 2		
Cole	Anderson	2011-07-28 AndersonC					1						
Justin	Beard	2011-07-28 BeardJ					1, 7						
Mark	Boswell	2011-07-28 BoswellM					1, 7						
Derek	Bricker	2011-07-28 BrickerD					1			3			1
Levi	Carlberg	2011-07-28 CarlbergL					1, 2, 7		3				
Ron	Caudill	2011-07-28 CaudillR					1			1			1
Roland	Chambers	2011-07-28 ChambersR					7		1, 3				
Ben	Colgan	2011-07-28 ColganB					1			3			1
Denise	Conner	2011-07-28 ConnerD					1, 7		3				

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Paul	Coon	2011-07-28 CoonP					1, 2, 7		3				
Kirk	Jaynes	2011-07-28 JaynesK		2			1, 7						
Ross	Julson	2011-07-28 JulsonR					2				1, 2		
Kyle	Keller	2011-07-28 KellerK					1			1			1
Cody	Lamey	2011-07-28 LameyC								1, 2			1
Tom	Lampshire	2011-07-28 LampshireT					1		3				
Randy	Leir	2011-07-28 LeirR	5				1				1		
Ole & Rusti	Leivestad	2011-07-28 LeivestadRO	5				13					3	
Kurt	Leverette	2011-07-28 LeveretteK					1, 2, 7		3				2
Dave	Lyman	2011-07-28 LymanDa		1			11, 12, 13			3	1, 2	2	
Debbie	Lyman	2011-07-28 LymanDe		1			11, 12, 13			3	1, 2	2	
Daniel	Mclinden	2011-07-28 McLindenD					1		3				
Ron	Moe	2011-07-28 MoeR					1			1			1
Donald	Pattie	2011-07-28 PattieD					1, 7						
Dean	Petty	2011-07-28 PettyD					1, 2, 7		3				2
Donald	Ratliff	2011-07-28 RatliffD		1			1			1	1		
Joseph	Rose	2011-07-28 RoseJ					1, 7						
Jim	Shaw	2011-07-28 ShawJ					1, 2, 7		3				
Tad	Singbeil	2011-07-28 SingbeilT					1		3				
Rod	Thorstenson	2011-07-28 ThorstensonR					1			1			1
Vaughn	Wallace	2011-07-28 WallaceV					2				1, 2		
Joe	Warner	2011-07-28 WarnerJ					1, 2, 7		3				
Austin	Wilson	2011-07-28 WilsonA					1, 2, 7		3				2
Ben	Wurz	2011-07-28 WurzB					1			3			1

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Gary	Zajanc	2011-07-28 ZajancG					1						
Mitchell	Benson	2011-07-29 BensonM							3	2			
Darby	Boespflug	2011-07-29 BoespflugD				1	7		3				1
Nate	Boespflug	2011-07-29 BoespflugN				1	7		3				1
Justin	Brown	2011-07-29 BrownJ					1, 7						
Matt	Brown	2011-07-29 BrownM	5				1				1		
John	Byrd	2011-07-29 ByrdJ					1, 2, 7		3				
Ward	Davis	2011-07-29 DavisW	5				1				1		
Mark	Dolan	2011-07-29 DolanM				1	7						1
Owen	Erickson	2011-07-29 EricksonO					7		1, 3				
Cory	Farmer	2011-07-29 FarmerC					7		1, 3				
Chris	Foote	2011-07-29 FooteC					1, 2, 7		3				
Stephanie	Fredin	2011-07-29 FredinS		2			1, 7		1				
Chris	Hawthorne	2011-07-29 HawthorneC							3	2			
Mike	Higareda	2011-07-29 HigaredaM					2				1, 2		
Mike	Holcomb	2011-07-29 HolcombM		2			1, 7						
Jeff	Holder	2011-07-29 HolderJ					1		3				
Clint	Jensen	2011-07-29 JensenC	5				1				1		
Matt	Jungst	2011-07-29 JungstM					1, 2, 7		3				2
Kent	Kanzler	2011-07-29 KanzlerK					1			1			1
Kasie	Kim	2011-07-29 KimK					1, 2, 7		3				2
Dan	Koch	2011-07-29 KochD								1, 2			1
Jon	Kyriss	2011-07-29 KyrissJ	5				1				1		
Rod	Lautt	2011-07-29 LauttR	5				1				1		
Charla	Lucibello	2011-07-29 LucibelloC					1		3				

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Margaret	Mack	2011-07-29 MackM		2			1, 7						
Judy	Matott	2011-07-29 MatottJ		1			1		1	1	1		
Ryan	Medlinger	2011-07-29 MedlingerR					1		3				
Johnny	Peek	2011-07-29 PeekJ					1			1			1
Joe	Pepiot	2011-07-29 PepiotJ					7		1, 3				
Kim	Posselt	2011-07-29 PosseltK					1						
Scott	Savage	2011-07-29 SavageS					1, 7						
Michael	Scott	2011-07-29 ScottM	5				1				1		
John	Shaw	2011-07-29 ShawJ	5				1				1		
Michael	Shea	2011-07-29 SheaM											
Danny	Stindt	2011-07-29 StindtD					1		3				
Timothy	Thompson	2011-07-29 ThompsonT		2			1, 7						
Echo	Venn	2011-07-29 VennE					1, 7						
Justin	Venn	2011-07-29 VennJ		2			1, 7						
Brandon	Vincent	2011-07-29 VincentB		1			1			1	1		
Scott	Vincent	2011-07-29 VincentS					1		3				
Vance	Vincent	2011-07-29 VincentV		2			1, 7						
George	Williams	2011-07-29 WilliamsG							3	2			
Patty	Coe	2011-07-30 CoeP					1, 2, 7		3				
Mike	Cuffe	2011-07-30 CuffeM		1			1			1, 2	1		
Diane	Mosley	2011-07-30 MosleyD		1			12, 13			3	1		
Milton	Mosley	2011-07-30 MosleyM		1			12, 13			3	1		
Brian	Sharp	2011-07-30 SharpB								1, 2			1
Ken	Farmer	2011-07-31 FarmerK					1, 2		3				2
Susan	Farmer	2011-07-31 FarmerS					1		3				
Ted	Antonioli	2011-08-01 AntonioliT					1						

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Betti	Hill	2011-08-01 HillB											
Doug	Kary	2011-08-01 KaryD					1, 7						
Steve	Mangold	2011-08-01 MangoldS											
Jeff	Coleman	2011-08-02 ColemanJ				1	7		3				1
Ronald & Kathleen	Cotten	2011-08-02 CottenR_andK		4	2, 3, 5		1, 2, 12, 13			1, 2, 3			
Greg	Garwood	2011-08-02 GarwoodG		2			1, 7						
Donna	Heikkinen	2011-08-02 HeikkinenD					7		1, 3				
William	Inabnit	2011-08-02 InabnitW					7		1, 3				
Mark	Mihelich	2011-08-02 MihelichM					1, 2, 7			2			1
Joe	Moodry	2011-08-02 MoodryJ					7		1, 3				
Harold	Sant	2011-08-02 SantH		2			1, 7						
Bob & Rita	Windom	2011-08-02 WindomB_and_R		2			1, 7						
Bruce	Clark	2011-08-03 ClarkB	TMI 1-3	TMI 2-6	TMI 1		TMI 1-6			TMI 1-2	TMI 1		
Darren	Coldwell	2011-08-03 ColdwellD					1, 7						
Larry	Erickson	2011-08-03 EricksonL		1			1			1, 2	1, 4		1
Derek	Feeback	2011-08-03 FeebackD					1, 4, 7			1	1		
Glenn	Knodle	2011-08-03 KnodleG					1, 4, 7			1	1		
Nancy	Oyer	2011-08-03 OyerN					2				1, 2		
Grace	Rantala	2011-08-03 RantalaG							3	2			
Jennifer	Shearer	2011-08-03 ShearerJ								1, 2			1
Margeaux	Zwang	2011-08-03 ZwangM								1, 2			1
Don	Allen	2011-08-04 AllenD_WETA					7		2				

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Doug	Ferrell	2011-08-04 FerrellD		1			1				1		
Ernest	Scherzer	2011-08-04 ScherzerE		1			1, 2, 12, 13			1, 2, 3	1		
Dave	Skinner	2011-08-04 SkinnerD		1			1, 2			1, 3			
Mike	Banks	2011-08-05 BanksM					1						
Paul	Glader	2011-08-05 GladerP_Hecla		1, 2			1			1, 2, 3		2	
Cesar	Hernandez	2011-08-05 HernandezC					13						
Phil	Hough	2011-08-05 HoughP_FSPW	3	1			1, 2				1	2, 4	
Robert & Sara Lou	Springer	2011-08-05 SpringerRAndSL	5				13						
		2011-08-18 Nhpkki.pdf											
Colleen	Hinds	2011-08-25 HindsC		1			12, 13			3	1, 2		
Max	Schrader	20110608 Transcript of Testimony								2			
Chas	Vincent	20110608 Transcript of Testimony		2	4		1, 2, 7			1, 2	1		1
Steve	Lloyd	20110608 Transcript of Testimony					1						
Bruce	Vincent	20110608 Transcript of Testimony					1, 2			3, 5			1

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A. General Comments:

Comment A1: Many commenters asked for an extension of the public review and comment period.

Response A1: The Agencies extended the comment period 30 days in response to requests. The ending date for public comment was extended from July 5th to August 5th 2011.

Comment A2: Overall, the need for a new pipeline, reclamation material amendments, or removal of the demolition debris from the site is not supported by the analysis in the Draft EIS.

Response A2: With respect to the need for a new pipeline, please see the response to Comment E1.

With respect to the need for reclamation material amendments, please see the response to Comment H3 and Comment H-TMI-1.

With respect to the need to remove demolition materials from the site, please see the response to Comment B1.

Comment A3: Long-term monitoring for vegetation, noxious weeds, and water quality is needed to address impacts.

*Response A3: For a description of the long-term monitoring plan for vegetation and noxious weeds, please see **Section 2.4.3.2** of the Final EIS.*

*For a description of the long-term monitoring plan for water quality, please see **Section 2.4.3.1** of the Final EIS – Surface Water Quality and Long-Term Monitoring of Water Quality and the response to Comment E-A-EPA 6.*

Comment A4: The disturbance of vegetation, soil, and habitats will be greater under the Agency-Mitigated Alternative than under the Proposed Action (e.g. removal of paving on road, use of toe pond soil stockpile, burying pipeline, etc.).

Response A4: *The Agencies agree that the short-term impacts will be greater, but they believe the overall long-term impacts will be less under the Agency-Mitigated Alternative. The rationale for removing the pavement from the roads is addressed in the response to Comment E-A-LCD 2. The rationale for using the toe pond soil stockpile is addressed in the response to Comment H3 and Comment H-TMI-1 below. The preferred treatment of the pipeline has been revised and is addressed in comment E1. In addition, the Final EIS has been revised to reflect this change.*

Comment A5: Reclamation bond should be sized appropriately. Some commenters suggested the reclamation bond should be large enough to cover the "worst case" scenario while others suggested the reclamation bond should be small enough as not to affect the continued operation of the mine.

Response A5: *The reclamation bond may not be less than the estimated cost to the Forest Service or the DEQ to ensure compliance with the respective federal and state reclamation requirements. The federal reclamation requirements include compliance with 36 CFR 228, Subpart A. The bond amount is the Agencies' estimated cost to complete site reclamation. The calculation of the reclamation bond is based on what it would cost the Agencies to hire a third party contractor to perform the work described in the reclamation plan if the company is unable or unwilling to do this work themselves. According to 82-4-338(6) MCA the reclamation bond must be based upon reasonably foreseeable activities. Currently, the bond at the Troy Mine is almost all in the form of a surety. Interest gathered on a CD or cash bond is non-obligated and can be returned to the company.*

Comment A-TMI 1: ES3 – Discussion of "patented" land may be confusing, may be better to just use private land and NFSL.

Response A-TMI 1: *There is a difference and a need to distinguish between patented and private land. Please see* ***Section 2.1.1****. Also see definition of patented land in* ***Chapter 7****: "A parcel of land which the federal government sold to a claim holder and whose ownership can be transferred to other private parties. The minerals contained within the land also belong to the claim holder."*

Comment A-TMI 2: 1-11: "*Based on the analyses in this EIS, the Deciding Officers only determine whether the Proposed Action is in compliance with respective state and federal laws*."

The statement does not seem to be correct. The Deciding Officers prepare a Record of Decision (ROD) that determines what if any stipulations may be required to mitigate any impacts. The further discussion that indicates the ROD can only select from one of the alternatives is also incorrect. The ROD may select or modify any alternative including the preferred alternative to address a variety of issues.

Response A-TMI 2: *The Agencies agree that this statement needs to be corrected. Based on the analyses in this EIS, the KNF Supervisor and the DEQ Director will make an informed decision on the Proposed Action. Each Deciding Officer's decision will be documented in their respective Record of Decision. Federal and state agency decision making is governed by*

regulations. Each agency's regulations provide the conditions the project must meet to obtain the necessary permit, approvals, or licenses and provide the conditions under which the agency could deny necessary permits or approvals. Please refer to ***Section 1.8*** *Decision Framework of the Final EIS that states the decision objective of the Agencies is to select an action that meets both the purpose and need for the project and respects the legal rights of Troy Mine, Inc., but still protects the environment in compliance with applicable laws, regulations, and policies.*

<u>Comment A-TMI 3</u>: 3-26: "*requiring lands disturbed by mining…be reclaimed to comparable stability and utility.*"

36CFR 228.8(g) is not the USFS's responsibility in this case to interpret DEQ's regulations. In fact 228.8(h) indicates that "certification or approval" by state agencies can be taken as acceptance of compliance with parallel regulations. The State and Federal responsibilities and authorities should be accurately described and kept separate from each other.

<u>Response A-TMI 3:</u> *Thank you for your comment. The text has been updated to read:*

> *The Montana Metal Mine Reclamation Act (MMRA) sets forth reclamation standards for lands disturbed by mining. The basic objective is to establish, on a continuing basis, the vegetative cover, soil stability, water condition, and safety condition appropriate to any subsequent use of the area (Section 82-4-302(2), MCA). Generally, lands disturbed by mining must be reclaimed to comparable stability and utility as that of adjacent areas (Section 82-4-336(9)(a), MCA). The reclamation standards apply to all lands disturbed by mining, whether they are federal, state, or private.*

USFS enforces several laws and regulations related to the impacts of mining on NFSL. The Organic Act authorizes the Secretary of Agriculture to issue rules and regulations for the use and occupancy of the National Forests and to protect them from unnecessary environmental impacts. The Multiple Use Mining Act of 1955 authorizes the Forest Service to restrict mining operations on National Forest System lands to only those uses reasonably incident to mining and in a manner that minimizes adverse environmental impacts. It is the purpose of the 36 CFR 228, Subpart A regulations to set forth rules and procedures through which use of the surface of National Forest System lands in connection with operations authorized by the United States mining laws shall be conducted so as to minimize the adverse environmental impacts on National Forest System resources. Forest Service Manual 2840 provides guidance for mining reclamation on NFSL.

USFS is required by regulation (36 CFR Part 228, Subpart 228.8) to ensure all operations are reclaimed. Forest Service manual direction for reclamation of mineral activities (FSM 2840) directs that mineral activities must be managed to minimize impacts and disturbed lands must be returned to a use consistent with long-term forest land and resource management plans. Reclamation is further defined as the actions to shape, stabilize, revegetate, or otherwise treat the affected lands in order to achieve a safe and ecologically stable

condition. The direction includes that all Plans of Operations with reclamation requirements must contain measurable performance standards that specify the revegetation of disturbed areas with measures for timing, kind, and amount.

B. Alternatives Definition:

Comment B1: Alternative locations for disposal of mine buildings and foundations were suggested. Commenters suggested the building materials and foundations should be buried in the mine, left in place and covered with pit run debris, or recycled with the debris removed to an approved landfill site. The Montana Solid Waste Management Act does not prohibit on-site disposal of inert building material. Commenters noted the inconsistencies in requiring inert building materials to be removed from the site when DEQ had allowed asbestos contaminated soil to be disposed at the Troy landfill and the annual allowance of iron released to the tailings impoundment, but not allowing steel rebar to be buried or placed in the mine.

Response B1: The mine office and mill buildings are situated on NFSL. It is Forest Service policy (FSM 2100) to discourage the disposal of solid waste on NFSL unless such use is the highest and best use of the land (USFS 1990). The Forest Service agrees that reinforced concrete foundation material may be buried on NFSL under the following conditions:

- *The concrete must be free from contaminants, such as petroleum products.*
- *Contaminated sections of concrete must be removed and disposed of at a proper waste facility off NFSL.*
- *The concrete must be cut or broken into sections no larger than four feet square and buried in a manner that will not create large voids which could lead to future settling of the materials. This may involve mixing glacial borrow material from east of the impoundment with the concrete sections during backfill operations. The rebar can remain in the concrete provided it is cut flush with the individual sections.*
- *The concrete must be buried with a minimum of four feet of glacial borrow material from east of the impoundment which must be graded in a manner that will not concentrate surface water runoff or allow water to pond.*
- *At time of mine reclamation, if new federal regulations prohibit burying of any materials, then all materials must be hauled off-site.*

The Montana Solid Waste Act defines "solid waste" to exclude mining wastes regulated under the mining and reclamation laws administered by DEQ. Thus, mining wastes are not regulated under the Montana Solid Waste Act. Under the MMRA, a reclamation plan must provide sufficient measures to prevent pollution of air or water and the degradation of adjacent lands. Burial of building demolition materials on site containing potential pollutants such as petroleum products, lead-based paints, etc. could potentially pollute ground and surface waters in violation of the MMRA. ***Section 2.4.3.2*** *of the Final EIS has been revised accordingly.*

The materials disposed of at the Troy Landfill are outside the scope of this EIS. The iron in the Troy tailings is a result of the milling process and disposal is allowed under the MMRA.

Comment B2: The Draft EIS needs to more completely document the potential risk to water quality from burying inert materials as a justification for alternatives that require building materials to be buried off site. Commenters argued that there would be no difference in impacts from burying inert building materials such as concrete versus burying natural materials. Commenters also argued that man-made materials such as concrete bridge abutments and metal culverts have already been placed on site and are exposed to the elements. If on-site burial would create water quality risks, the Draft EIS should document potential risks to water quality at potential off site locations as well.

Response B2: Please see the response to Comment B1.

Comment B3: Although some commenters noted that the adit closure measures described in the Agency-Mitigated Alternative, such as emergency overflow, are needed to protect the environment, others noted that the additional 100 feet of rock to close the South Adit does not address any specific impact and is, therefore, not necessary.

Response B3: There is a large amount of overburden located near the entrance to the South Adit. The adit must be backfilled 100 feet in order to reach the competent rock, which is located further back inside the adit. Backfilling deeper into the adit will prevent the adit entrance from sloughing.

Comment B4: Commenters addressed the timing of reclamation activities. Some noted that the tailings impoundment area should be reclaimed as soon as its capacity is exceeded which may be before mine operation ceases and that reclamation should be completed within 2 years of the start of reclamation (including removal of infrastructure, placement of growth media, revegetation, etc.).

Response B4: According to 82-4-336(3) MCA reclamation activities must be completed not more than two years after completion or abandonment of the operation on that portion of the complex. Since the reclamation bond is calculated on what it would cost the Agencies to hire a third party contractor to perform the work described in the reclamation plan, it is to the benefit of the company to complete reclamation as soon as possible in order to maintain or even reduce the bond amount during the life of mine.

If the mining company wants to enlarge the impoundment, it would have to file for either a revision or an amendment to its operating permit to increase the impoundment capacity. If permitted, reclamation could be delayed again until completion of the mine or until the impoundment reaches its new permitted capacity.

Comment B5: A commenter suggested that one acre of the tailings ponds should be left un-reclaimed in case the community wants to use the material for building blocks.

Response B5: According to 82-4-336(9)(a) MCA, the company can propose leaving mine related facilities in place if there is a reasonable post-mining use. The Agencies would have to agree with this post-mining use. It would be up to the company to propose such a post-mining land use, which the Agencies would then review.

Comment B-TMI 1: TMI disagrees that burial of concrete foundations and steel at the mill site pose any risk to water quality. On-site burial of demolition waste is an accepted practice during mill site reclamation. The unnecessary handling and haulage of inert materials to an offsite disposal area would increase risk to air and water quality.

TMI's Proposed Action is as follows:

1. Equipment from the mill, shops, office and associated facilities will be salvaged or disposed of offsite. Buildings will be removed and salvaged or demolished. The mill site materials which will be buried on site are primarily concrete, but also may include some metal, glass, plastic and wood. All of these materials will be buried on site with a minimum of three feet of cover material.

2-15: The agency alternative includes: *"All demolition materials, whether originating above or below ground, would be disposed of off NFSL in appropriate disposal areas to comply with the Montana Solid Waste Act."*

The need or benefit of this unnecessary action is not provided anywhere in the document.

3-75: There is no evidence, documentation or reason that "buried demolition debris could contaminate surface water." This rational for requiring the removal of concrete foundation materials and structural steel from the mill site area is not based on fact and should be corrected in the FEIS.

3-82: There is no documentation of any "risk" to water quality from burial of building and foundation materials. Concrete and steel would not result in leaching of problematic constituents in the oxidizing conditions of shallow burial. In fact, the increased alkalinity and iron potentially available from these materials are documented in the metals fate and transport discussions, at the tailing impoundment, provides a beneficial effect on metals of concern.

Response B-TMI 1: The Agencies have developed the alternatives to comply with USFS policy and the MMRA. Please see response to Comment B1.

Comment B-TMI 2: ES6/ES7 – The No Action description of groundwater monitoring is inaccurate and misleading by implying there are only two groundwater monitoring wells. Currently TMI samples 15 monitoring wells, two of which are at the Libby Load-out Facility. TMI also samples the Service Adit ditch, Service Adit pipe and the EP-1 pump-back station.

Response B-TMI 2: Text in the Executive Summary has been revised to clarify the current groundwater monitoring program. Text was edited as follows:

> *As part of the baseline sampling program, two test wells were drilled in July of 1976, and monitoring of two sites along Lake Creek began in 1979. Several additional monitoring sites have been added since that time. Surface water quality has been monitored at seven sites on Stanley, Fairway, and Lake Creeks since 1986. Five additional surface water sites are sampled*

and represent the farthest upgradient expressions of groundwater in drainages around the mine. These sites were chosen to monitor changes in the quality of groundwater discharging to surface drainages. Fifteen wells are currently monitored by TMI. These monitoring wells and sites would continue to be evaluated to determine potential mine water influence on surface and groundwater under the No Action Alternative.

<u>Comment B-TMI 3:</u> 2-25: *"Annual aerial inspections of the mine shadow area would be conducted by Troy Mine, Inc. with agency participation. Surveys would be conducted until bond release, and the subsidence portion of the reclamation bond would be held for a minimum of twenty years after the mine has been decommissioned and the adits have been plugged."*

The requirement for annual aerial inspections for subsidence is not necessarily an accurate method for determining subsidence based on actual site experience. Surface road erosion could appear to be a subsidence event when viewed from the air. Other methods of field inspection should be considered. Twenty years of subsidence inspection before bond release is excessive.

<u>Response B-TMI 3:</u> Subsidence features may take years to develop a surface expression. That is why subsidence monitoring will be required for twenty years after the mine has been decommissioned and the adits have been plugged. The text in the Final EIS has been changed to require once every five year flights with annual field reviews for twenty years.

<u>Comment B-TMI 4:</u> 2-36: This is the No Action and Proposed Action water monitoring plan, which is the one proposed in the Appendix F of the Revised Reclamation Plan with some additions. TMI adds the following Point of clarification: Table 2-2 is the one we proposed in the Revised Reclamation Plan during March 2006. As of 2005, TMI takes samples at 13 monitoring well sites – (two of which are at the Libby Loadout Facility). We also sample the mine's service adit ditch, service adit pipe and the Enviro-pump station and these sites are in the monitoring program. During the summer of 2010, two additional monitoring wells were drilled on the north end of the tailing facility, bringing the total to 15 monitoring wells.

The surface water program includes 16 surface water locations. In all we sample 34 locations including the monitoring wells, surface locations, plus the adit ditch, adit pipe and the spring at the Enviro-pump station.

Lake Creek 1, 2 and 4; Stanley Creek - 2 and Fairway Creek – 1 are the bio-monitoring (macroinvertebrate) sampling locations. As a point of clarification Lake Creek 1 and 2, date back to 1979.

<u>Response B-TMI 4:</u> Thank you for your comment. The Final EIS has been revised to clarify that Table 2-2 is the operational groundwater monitoring schedule that is currently followed. It is relevant to both the No Action Alternative and the Proposed Action. Post-closure monitoring under these alternatives would continue to use the existing operational monitoring plan until the mining company proposes changes approved by the Agencies.

Comment B-TMI 5: 2-57*: "If needed, the domestic water well located southeast of the tailings impoundment would be used for irrigation during the first three growing seasons; after which time, the well would be plugged and abandoned as required by ARM 36.21.810."*

The company objects to abandoning the well at the industrial site and abandoning the irrigation well at the decant pond area, because these private wells will have future uses.

> *Response B-TMI 5: The Agencies concur with the company's comment. The Agencies will stipulate that the wells will be left for post mine land use. If the wells are no longer needed, they should be plugged and abandoned as required by ARM 36.21.810.*

Comment B-TMI 6: 2- 59: 6th bullet; "*The East Impoundment, North East Impoundment, and Cell 3 borrow areas would be planted with lower elevation forest type vegetation."*

The references to an East impoundment and NE impoundment should be East Borrow and North East Borrow.

> *Response B-TMI 6: Thank you for your comment. The text in **Section 2.5** has been changed accordingly.*

Comment B-CRG 1: Under the Proposed Action, the proposed fill material for the adits is composed of large-sized development rock and a 12 "layer of growth medium; is this sufficient to preclude groundwater seepage from the adits?

> *Response B-CRG 1: The closure plan proposal to backfill adits with coarse fill applies only to adits at higher elevations on Mount Vernon above the level to which the underground workings will flood; therefore, groundwater would not seep from these adits. Please refer to Table 2-1 for a comparison of closure plans under each alternative for both the high elevation dry adits and lower draining adits. Seepage may discharge from the Service and Conveyor adits if the underground intake structures that feed the gravity flow pipelines fail over time. The Agencies would bond for regular inspections and for repair of the structure if needed over time as part of the long-term water management plan.*

Comment B-CRG 2: Why aren't the design details for the proposed non-hydraulic plugs and partial concrete dams or bulkhead in the Service and Conveyor adits included under the Proposed Action?

> *Response B-CRG 2: In **Section 3.8.5.2:** Under the Proposed Action, reclamation activities on the Troy Mine Permit Area would follow the specifications of the revised plan (Genesis 2006) (Table 2-1). Development rock would be used to backfill from portals 30 feet into the adit and would be placed as tightly as possible against the roof. Two concrete, non-hydraulic plugs are proposed for the Service and Conveyor adits. Conceptual designs for the plugs are outlined in Appendix J of the 2006 Revised Reclamation Plan and were not added to the text in the Draft EIS. Also, for the Agency-Mitigated Alternative, a conceptual design was provided in Draft EIS Appendix G, Page 4, Figure 1. TMI will be required to submit a detailed design to the Agencies for review and approval within one year of the ROD.*

Comment B-CRG 3: Why was subsidence not addressed as part of the Proposed Action? Given the history of subsidence at the Troy Mine, the potential impacts from this should be analyzed. Surveys should be conducted to ascertain the structural stability of the mine and potential areas for future subsidence.

> *Response B-CRG 3: The issue of subsidence was addressed for all three alternatives. In* ***Section 3.8.5.2****, the Agencies stated that the effects of subsidence under the Proposed Action would be the same as those under the No-Action Alternative. Studies were submitted to address subsidence impacts during operations and the Agencies bonded for future events. In the Agency-Mitigated Alternative in* ***Section 3.8.5.3****, additional subsidence monitoring and mitigations are listed. If the Proposed Action is selected by the decision makers, they can select the proposed monitoring and mitigation plans listed in the Agency-Mitigated Alternative.*

Comment B-A-EPA 1: Thank you for including clear descriptions of the alternatives, including identification of the differences between No Action, the Proposed Action and the Agency-Mitigated Alternative, and Table 2-1 (pages 2-19 to 2-35) comparing features of the alternatives in relation to the major issues (i.e., Water Management, Adit Closure and Mine Water Distribution, Water Treatment and Disposal, Groundwater Quality, Surface Water Quality, Long-Term Monitoring of Water Quality, Reclamation, Reclamation Materials, Subsidence, Revegetation, Infrastructure, and Topography). This information improves project understanding and assists in providing a basis of choice among alternatives for both the decision maker and the public in accordance with the Council on Environmental Quality (CEQ) rules for implementing NEPA (40 CFR Part 1500). We also appreciate the inclusion of a clear watershed map in Figure 3-2 (page 3-46) showing locations of waterbodies in the project area in relation to mine facilities. Understanding of the location of waterbodies in relation to mine facilities is critical for environmental impact assessment.

> *Response B-A-EPA 1: Thank you for your comment.*

Comment B-A-LCD 1: Requiring the concrete and rebar to be dug up, broke up, and moved to another location to be buried doesn't make any sense either. Why not allow the non-hazardous material that is inert to be buried and covered with appropriate fill and then revegetated? There is no environmental benefit in burying these material in another location, the time and resources put into doing so have more of an impact to the environment. This proposed action is unwarranted and does nothing but increase costs.

> *Response B-A-LCD 1: Please see the response to Comment B1. The proposal to bury materials on site is part of the Proposed Action. The Agency-Mitigated Alternative addresses the need to comply with the MMRA as well as the USFS regulations and policy.*

C. Air Quality:

<u>Comment C1:</u> Removing the pavement from the main road will create more dust and air quality impacts.

<u>Response C1:</u> Please see response to Comment E-CRG-1.

<u>Comment C2:</u> Past air quality issues have been resolved, but future management changes may allow them to re-occur. The Agency-Mitigated Alternative would prevent future air quality problems, while the Proposed Action and No Action Alternative are not sufficient to prevent potential future issues.

<u>Response C2:</u> Regardless of the Alternative selected, Troy Mine, Inc. would continue to be required to meet opacity standards, apply water or chemical dust suppressant to maintain reasonable precautions, and follow the ambient monitoring network requirements in Attachment I and Attachment II of Troy Mine, Inc.'s Montana Air Quality Permit (MAQP). Attachment I of the MAQP is specific to ambient air monitoring required after closure of the mine and during reclamation of the tailings pond.

Troy Mine Inc. would be required to install, operate and maintain two air quality monitoring sites in the vicinity of their tailings pond. Additionally, Troy Mine, Inc. would be required to begin monitoring within one month after the closure of the mine and would continue monitoring until mine reclamation has been completed. DEQ would continue to monitor compliance with dust, opacity and ambient monitoring requirements.

<u>Comment C3:</u> Air quality should be monitored throughout the reclamation period and until it is fully demonstrated that revegetation efforts have successfully minimized air quality impacts.

<u>Response C3:</u> The Montana Air Quality Permit (MAQP) specifically requires that Troy Mine, Inc. install, operate and maintain two air quality monitoring sites in the vicinity of their tailings pond after closure of the mine and during reclamation of the tailings pond. Troy Mine, Inc. would be required to begin monitoring within one month after the closure of the mine and would continue monitoring until mine reclamation has been completed. Additionally, DEQ would continue to monitor Troy Mine, Inc.'s compliance with dust, opacity, and ambient monitoring requirements.

All air monitoring data would continue to be reviewed by the DEQ and the DEQ will determine if continued monitoring or additional monitoring is warranted. The DEQ may require continued air monitoring to track long-term impacts of emissions for the facility or require additional ambient air monitoring or analyses if any changes take place in regard to quality and/or quantity of emissions or the area of impact from the emissions.

<u>Comment C4:</u> Reclamation materials should come from the borrow area rather than the toe pond soil stockpile to limit the amount of disturbance that would create new dust problems.

<u>Response C4:</u> Please see response to Comment H1.

Comment C5: Growth media should be amended with organic materials to ensure rapid growth to minimize dust impacts.

Response C5: Thank you for your comment. The Agencies are requiring organic amendments in the Agency-Mitigated Alternative. Dust impacts will be mitigated as described in the response to Comment H1.

Comment C-TMI 1: [3-8: (section 3.4.5.1)] "*The Libby loadout facility is not addressed in the No Action Alternative*."

This is not correct. The Libby Load-out is currently permitted, bonded and has a reclamation plan. TMI submitted a "Minor Revision" to our Operating Permit for the New Libby Load-out facility on February 7, 2011. We received Approval for the Minor Revision from the MT DEQ on February 16, 2011. TMI started using the new load-out during March 2011.

*Response C-TMI 1: The Agencies agree and the text in **Section 3.4.5.1** has been revised as follows:*

> *The Libby loadout is currently permitted, bonded, and has a reclamation plan. The Libby loadout facility is located in the Kootenai business park.*

D. Fish Habitat:

Comment D1: Commenters noted that fisheries have had no negative impacts from the impoundment and the attenuation study done while the mine was shutdown clearly illustrates what to expect when this operation is decommissioned.

Response D1: The results of the shutdown period support a determination of minimal effect to aquatic resources as a result of closing the mine. However, the shutdown represents a brief time frame in contrast to that after reclamation. That is reflected in the analysis.

Comment D-A-FWP-S 1: 3.7.4.1 The Fish Population Status - Several species of fish in addition to those noted from the report are in the Lake Creek drainage near, upstream and downstream of the affected area: mountain whitefish (*Prosopium williamsoni*), coarsescale sucker (*Catostomus macrocheilus*), longnose sucker (*Catostomus catostomus*), Northern Pikeminnow (*Ptychocheilus oregonensis*), Northern pike (*Esox lucius*), brown trout (*Salmo trutta*), peamouth chub (*Mylocheilus caurinus*), Smallmouth bass (*Micropterus dolomieu*).

*Response D-A-FWP-S 1: Thank you for your comment. Those species are added to the species list in **Section 3.7.4.1** of the Final EIS.*

Comment D-A-FWP-S 2: 3.7.4.2 Bull trout - There is no evidence that there is not a fluvial bull trout population in Lake Creek. In October 2006, MFWP personnel collected bull trout between 210 – 330 mm in the Lake Creek dam indicating that a fluvial lifestyle is probable.

For any of the actions related to water quality note that, during some time in their lives, 100 percent of the bull trout in the Lake Creek drainage will be influenced by the water quality effects from the proposed alternatives.

Response D-A-FWP-S 2: *KNF based this analysis on data collected by FWP over the years. No evidence of bull trout spawning in Lake Creek has ever been found by FWP or KNF. It is well established that bull trout occupy Lake Creek at different times of the year particularly as a migratory route between Bull Lake and Keeler Creek. It is also well documented that large adfluvial fish spend a minimal amount of time in Keeler Creek spawning, thus it is likely those were the fish captured in October 2006. For that reason, water quality and its potential effects to bull trout were considered in this analysis.*

Comment D-A-FWP-S 3: Page 3-23 Paragraph 3: Note: Instream activities proposed in the Lake Creek drainage between Bull Lake and Keeler Creek should be accomplished between July 15 and September 1, unless there are approved mitigation plans.

Response D-A-FWP-S 3: *All instream activities would require a 124 permit which is issued by FWP prior to the commencement of instream activities. This process has facilitated close coordination between KNF and FWP. The suggested timing restriction is a standard condition of the 124 permit.*

E. Hydrology:

Comment E1: Many commenters noted concerns about the proposal to bury the pipeline to carry mine water to the tailings impoundment area. These concerns include the construction impacts of removing and then building a new underground pipeline; long-term maintenance requirements of a buried pipeline; the potentially longer reaction time to a leak in an underground pipeline; and the impact of a leak in an underground pipeline. Commenters indicated that the EIS should include the current actual condition of the pipeline, how long it is expected to last, and a stronger discussion of why agencies feel it should be buried because it appears that the existing line is expected to last for several more decades without significant maintenance. The EIS should also discuss the long term impacts of repeatedly burying and unburying line every 40 years (based on a presumed 40 year life span of a pipeline).

Response E1: *The Agency-Mitigated Alternative has been revised with respect to the tailings pipeline.*

The Agencies have reviewed the comments received on the Draft EIS and determined that the existing pipelines could continue to be used as long as they can be operated with a low risk of failure. At the time of mine closure, the existing tailings lines and return water line would be evaluated by a qualified engineer to determine their remaining service life as a water conveyance line. If their condition is suitable, they would be retrofitted to enhance existing leak detection systems and to improve their integrity if that is determined to be necessary (for example, inner sleeves can be inserted into the pipelines to reduce the risk of leaks developing). The bond would also be held for the future installation of a replacement

pipeline. At this time, the Agencies anticipate that the replacement line would follow the route of the existing tailings lines, and would remain on the surface in locations where the existing lines are on the surface, and would be buried where the existing lines are buried.

The current condition of the pipelines is under review by the Agencies, and will be addressed via the mine's operating plan. A pipeline rupture occurred in October 2009, resulting in release of tailings into Thicket Creek. Another spill occurred in October 2011; however, this spill was not caused by wear of the pipeline, but rather through human error during maintenance of the pipelines and installation of a leak detection system. Because it is not known how long the mine will continue to operate, it cannot be determined in advance what the condition of the existing tailings lines will be at the time of mine closure. Consequently, a review of the pipeline condition at the time of closure will be necessary to determine how much pipeline maintenance and upgrades would be appropriate at that time. Transport of mine water via the tailings pipelines is expected to result in less wear than transport of tailings slurry. Consequently, the probability of pipeline leaks developing is expected to be lower than at present. Routine inspection and maintenance of the pipelines would continue for as long as they are in use. Please refer to Appendix G for the Conceptual Design of the New Water Line for Transport of Mine Water after Closure.

<u>Comment E2:</u> Many commenters made note of the current above-ground pipeline and commented that the above-ground pipeline does not result in impacts or unusual maintenance concerns. Some noted that leak sensors could be installed in an above-ground line to allow for response to leaks in the same manner as with an underground pipeline. Many commenters felt that it would be easier to monitor an above-ground line and that leaks in an above-ground pipeline would be easier to detect and repair with less disturbance to surrounding resources. Several commenters noted that no vandalism has occurred on the existing pipeline and that the concern expressed in the Draft EIS is not supported by past experience. Additionally, some commenters noted that an above ground pipeline does not have a visual or aesthetic impact.

<u>Response E2:</u> Please see response to Comment E1 above.

<u>Comment E3:</u> Commenters noted that if the pipeline will be carrying water that meets drinking water standards upon mine closure, there would be no need to change or remove the existing line. Similarly, some commenters questioned what the impact of a leak, containing water that meets drinking water quality standards, would be on surrounding resources.

<u>Response E3:</u> Water draining from the Troy Mine currently does not meet drinking water quality standards for nitrate and antimony. Nitrate concentrations are expected to decline to within drinking water standards rapidly following closure of the mine; however, elevated dissolved antimony is expected to persist in the mine drainage. It is important to note that aquatic life standards for metals are often significantly more stringent than human health standards for the same metals. For example, the drinking water standard for copper is 1.3 parts per million, while the aquatic life standard for copper in Stanley Creek is 2.85 parts per billion or approximately 1/500th of the drinking water standard. Dissolved copper in mine water after closure of the mine is expected to remain in the 60 parts per billion range (see

Final EIS Table 3-7), about 20 times the chronic aquatic life standard. In the event of pipeline failure, water would flow from the rupture point into Stanley, Thicket, and/or Lake Creeks. Although the water would likely meet drinking water criteria for everything but antimony, it would likely exceed aquatic life criteria for copper and possibly cadmium, lead, and/or other metals. If a major pipeline leak occurred and was not quickly repaired, the probable impacts of discharge of the mine water to surface waters could potentially include: mortality of aquatic life, including fish; migration of individual fish; and temporary loss of fish habitat in the affected streams.

Comment E4: Draft EIS should more accurately describe the current condition of the pipeline, including the secondary containment currently being installed at creek crossings in the analysis of existing conditions.

Response E4: The current condition of the pipeline is unknown. Several pipeline leaks have occurred since the mine restarted operations in 2004. A contributing factor to these leaks has been failure of the adhesive that holds the liner in place. Secondary containment boxes with leak detection sensors are being installed at stream crossings. The Agencies are currently reviewing whether additional operational pipeline upgrades are warranted under the Operating Plan.

Comment E5: A seven-mile long pipeline is a fatal flaw of the preferred alternative; if, in fact, mine water doesn't need treatment, then it should be discharged to the nearest channel.

*Response E5: The discharge of mine water directly to Stanley Creek was envisioned when the mine was originally permitted and is analyzed in the No Action Alternative (**Section 3.9.5.1** – Water Quality). Mine water does not meet state water quality standards for discharge to Stanley or Lake creeks. Mine water would require treatment before discharge to surface water near the mine site, but would not require treatment if conveyed to the tailings impoundment for infiltration into the underlying groundwater. Fish and aquatic life are very sensitive to some metals, including copper. Consequently, while the concentration of copper in post-closure mine water is expected to be only about 1/20th the human health standard, it would exceed criteria protective of aquatic life by a factor of about 20 times.*

Comment E6: In regard to the drainage channel, some commenters noted that waste rock is native to the area and therefore there would be no need to import rock; while other commenters noted that it is important to use non-mineralized rock to line the drainage channel.

Response E6: The Agencies would require non-mineralized rock be used for drainage channels in order to eliminate the possibility that mineralized rock might elevate heavy metal concentrations in the streams. The Agencies assumed all the waste rock in the area is potentially mineralized. If TMI provides testing (leachate and net neutralizing potential) that demonstrates it has a source of non-mineralized rock, the Agencies would consider using that source. The potential source rock that would be used for construction of drainage channels has not yet been identified, but would likely be from a commercial or off-site quarry that could be approved at closure by the Agencies as non-mineralized riprap.

Comment E7: Commenters noted that there is good data from the shutdown period and the past 30 years to support the conclusion that there has been no impact to water quality from the mine operations.

Response E7: There have been impacts to water quality from the Troy Mine, most notably due to tailings pipeline ruptures and erosion of sediment from the mill site area. The data show that mine water exceeds aquatic life criteria for copper and other metals and therefore cannot be discharged to surface waters. Please see response to Comment E5.

Comment E8: Commenters had questions and comments regarding the decant ponds. Some commenters asked how long it would take to remediate nitrogen and copper in the decant ponds.

Response E8: Nitrate and nitrite ("nitrates") nitrogen (N) in mine water from mine development blasting operations is a short-term pollutant. Mine waters during operations average 4.88 milligrams per liter (mg/L) as N. This is well below the human health-based groundwater standard of 10 mg/L. Based on data collected in 1993 after mine shutdown, with the cessation of blasting, the nitrogen level in the water will drop to less than 1 mg/L within a few months. By the time the water level in the mine void rises to the adit overflow and begins discharging, water routed to the decant ponds is predicted to average less than 1 mg/L as N.

Copper will be removed in the upper one foot of geologic material beneath the decant ponds. In addition, further study has shown that any copper that did not precipitate in the surface layer would be precipitated as a result of mixing with ambient groundwater that contains dissolved iron.

The decant ponds will constitute an in situ treatment system.

The decant ponds will be bermed to prevent rain water and snowmelt from flowing into the ponds.

The water management analysis (Appendix C) indicates that precipitation and evaporation are insignificant compared to future discharges from the underground workings. The decant ponds will be oversized to allow for increased mine discharge and/or slower than expected infiltration from the ponds.

Comment E9: Sufficient justification for one new surface water monitoring site and four new monitoring wells was not provided in the Draft EIS.

Response E9: No new monitoring wells were proposed under any alternative in the Draft EIS. Monitoring of some new surface water locations is proposed under the Agency-Mitigated Alternative as described in ***Section 2.4.3.1*** *– Surface Water Quality and Long-Term Monitoring of Water Quality. These new sites would generally be high elevation springs and stream channels where groundwater first reaches the ground surface, providing baseflow to the streams. These sites are considered to be the most likely areas where water from the*

flooded underground mine may first reach the ground surface. New monitoring sites are needed because existing site locations are not in the areas most vulnerable to effects from underground mine water.

Comment E10: Draft EIS should demonstrate that the toe pond runoff is safe for irrigation before it is used for that purpose and the Draft EIS should identify the proposed sources for irrigation water.

*Response E10: Under the Proposed Action, irrigation is proposed, if needed, during the first and second growing seasons after reclamation to establish vegetation and prevent wind erosion (**Section 2.4.2.2** - Revegetation). The source of irrigation water proposed is the domestic water well (one season only, **Table 2.1**) and snowmelt and runoff from the toe ponds (**Section 2.4.2.1** – Water Treatment and Disposal). Under the Agency-Mitigated Alternative, water from the domestic water well (**Section 2.4.3.2** - Infrastructure) or the decant ponds would be used to establish vegetation and prevent wind erosion if needed during the first three growing seasons.*

Irrigation water under both the Proposed Action and Agency-Mitigated Alternative meet EPA's criteria for irrigation water quality.

The Agencies reviewed the available water quality data for water in the toe ponds (pH, ammonia, nitrate+nitrite, total phosphorus, arsenic, copper, lead, iron, manganese, and zinc) from the Troy database (2005 to 2009). The water quality data were compared with EPA's recommended irrigation limits for constituents in irrigation water (US EPA 2004, Guidelines for Water Reuse EPA/625/R-04/108). EPA's guidance document provided limits on several trace elements, nutrients, and salinity for waters used for both short- and long-term irrigation. The Agencies compared the toe pond water quality to the recommended irrigation water limits for pH, ammonia, nitrate+nitrite, total phosphorus, arsenic, copper, iron, manganese, lead, and zinc. Ammonia, nitrate+nitrite, and total phosphorus are considered nutrients for irrigation waters. The concentrations of arsenic, copper, iron, manganese, lead, and zinc in toe pond waters were below the recommended concentrations for both short- and long-term irrigation water quality. The EPA guidance did not provide data for acceptable limits for antimony or silver in irrigation water; however, both silver and antimony are at non-detectable concentrations in the toe pond water. The quality of the toe pond water meets criteria for the short- and long-term irrigation of reclaimed areas, if needed during closure.

The decant pond water quality (Table 3-7 of the Draft EIS) was compared with EPA's recommended irrigation limits for constituents in irrigation water. The quality of decant water meets irrigation water quality criteria for copper, zinc, ammonia, nitrate+nitrite, and total dissolved solids. The EPA guidance did not provide data for acceptable limits for antimony in irrigation water. The decant pond water quality would be suitable for short- and long-term irrigation water quality.

The domestic water well is located upgradient of the tailings impoundment and would be consistent with background water quality. Background groundwater quality would meet EPA's criteria for both short- and long-term irrigation water quality.

<u>*Comment E11:*</u> The Draft EIS should identify all water resources affected by operation and potentially affected by reclamation.

<u>*Response E11:*</u> *This EIS is for mine closure and reclamation and does not address current mine operations. Effects from operations were addressed under the original EIS on the mine operation. Effects to water resources from the proposed reclamation alternatives are discussed in detail in* ***Section 3.9.5****.*

<u>*Comment E12:*</u> Some commenters noted that the Draft EIS should account for used/spilled solvents, grease, and lube oils. The Draft EIS should also disclose the Toxic Release Log of all spills and include any impacted sites in the reclamation plan. Some commenters also asked that the Draft EIS consider long-term monitoring and recording for any signs of harmful material.

<u>*Response E12:*</u> *This EIS addresses reclamation of the mine after its closure, and does not address operational issues. Spills are cleaned up when they occur; these activities are not deferred until reclamation.*

<u>*Comment E13:*</u> The location, contents, and impacts of the barrels buried in the tailings embankment should be disclosed in the Draft EIS and appropriate reclamation measures included in the plan.

<u>*Response E13:*</u> *This was dismissed in issues considered but not evaluated further in* ***Section 2.3.2*** *item 4. In addition, from January 30 to February 2, 2012, TMI conducted an excavation in the tailings impoundment at the site of Anomaly #5 as noted in the 2004 geophysical survey of the impoundment. An excavator and bulldozer removed tailings until the source of the anomaly was identified as a large rusty metal screen. The excavation was then deepened to the original ground surface without uncovering any other metallic debris. Representatives of TMI, the original geophysical contractor, DEQ, and Cabinet Resource Group were all present during this activity."*

<u>*Comment E-CRG 1:*</u> DEIS pg: 3-23:

"*The Agency-Mitigated Alternative would reduce sediment loading both by implementing reclamation actions and by treating mining road-related sediment sources. Thus, sediment levels in Stanley and Lake Creeks would be expected to decline over time*."

There is nothing in the DEIS supporting the claim that removing the asphalt surface of the mine road would reduce the risk of dust and sedimentation to nearby streams. Road 4626 is currently used heavily to access Spur Lake. Converting the industrial grade asphalt road to a gravel surface will defeat the original required mitigation of a blacktop road. The mine road from the Hwy 200 junction to the Spar Lake Road junction should be left in place.

<u>Response E-CRG 1:</u> Under the Agency-Mitigated Alternative there is more potential for sediment delivery in the short term from NFSR 4626 by converting it to gravel where it is under Forest Service jurisdiction from MP 2.33 to the mill site. The exception would be at the Stanley Creek bridge crossing where the approaches would be paved for 300 feet in both directions. In the long term, the effect would be the same because the Forest Service cannot afford to maintain an asphalt surface and would have to eventually convert it to gravel. Sediment would be minimized by implementing BMPs including constructing drain dips and placing sediment barriers along the outside shoulder where the road is immediately adjacent to the stream.

<u>Comment E-CRG 2:</u> The major issue of difference between the Proposed Action and the Agency-Mitigated Alternative is the replacement the two above ground pipelines with a buried one. There are good arguments for both. Would the construction project cause environmental damage through loss of natural vegetation and siltation at stream crossings? However, the current pipeline has had incidents of failure, and with closure of the mine the opportunity for vandalism greatly increases. Also, the concrete support piers are not "natural" and would extend the amount of time needed to return the area to its natural state. With the exception of the prohibition of burying demolition debris (see the following comment regarding mill site demolition) CRG supports the Agency-Mitigated Alternative as it applies to the pipelines.

<u>Response E-CRG 2:</u> Thank you for your comment. Please see the response to Comment E1.

<u>Comment E-CRG 3:</u> The agency alternative includes:

"*All demolition materials, whether originating above or below ground, would be disposed* of off *NFSL in appropriate disposal areas to comply with the Montana Solid Waste Act*".

There is no justification for this requirement; there is no documentation of risk to water quality. Concrete and steel debris possibly buried in the mine, in the driest possible location, would not result in leaching of problematic constituents. In fact, the additional handling and transport of these materials increases the chance of impacting air and water quality.

<u>Response E-CRG 3:</u> The Agency-Mitigated Alternative was designed to comply with the MMRA and USFS regulations and policy. Please see the response to Comment B1.

<u>Comment E-CRG 4:</u> The issue of barrels in the tailings is an issue of great concern to CRG, one the DEQ has avoided since it was first brought to the agency's attention in 1996. The rationale for dismissing this "potential" issue as beyond the scope of this DEIS is disingenuous.

CRG has not claimed to know the contents of the barrels. We have provided the DEQ with a list of possibilities –"solvents, waste oil, and grease"—that are known to have entered the mine, for which there is no record, as required by law, of disposal (Refers to CRG letter of Dec.27, 2007, Appendices, Appendix A, Scoping Report, Appendix F, pgs 53-83). The DEIS states that "the allegations" (which we did not make) "were never substantiated, and….the U S. District Court dismissed the case without prejudice."

The only way to know what is in the barrels is to look inside them, an increasingly expensive proposition. This poses two questions: is there sufficient evidence to warrant further investigation, and if so, who is to pay for it?

Several years after the DEQ did not so much as acknowledge receipt of a citizen complaint alleging late night burials of 55 gallon drums in the tailings, CRG learned of it, and began to investigate. We found corroborating witnesses. We sued ASARCO to gain access to the tailings impoundment for a consulting firm of our hire to do a preliminary ground penetrating radar search for barrels. The U.S. Circuit Court let us do so. Anomalies consistent with barrels were located in places barrels were said to be buried.

ASARCO denied any such thing had ever happened, and vilified CRG with asperity. After over a year of such denials, a former mine manager, being deposed under oath, admitted that barrels had been buried. Until then, it was reasonable for the DEQ to take no action, as the allegations might have just been disgruntled ex-employees trying to cause trouble. After this admission however, that was no longer the case.

Our lawsuit against ASARCO was dismissed without prejudice at our request. At the expenditure of great effort and considerable expense, we have established that there are several corroborating witnesses to the initial charge, that ASARCO admitted to burials, after having lied about it, and that there are targets that could be barrels where barrels are said to be buried. We feel we have done our part as citizens, and it is not CRG that should bear the expense and responsibility of pursuing this matter further, but rather this is the responsibility of the agencies that ostensibly exist to look out for the public's interests. For the agencies to blithely accept ASARCO's word that no contaminants were buried after it vehemently denied it had buried anything at all, for them to sweep this under the rug and make no inquiry into what was buried and why, why was it done at night and why it was lied about, would be unconscionable

We do not propose that the tailing impoundment be dug up to find every barrel in it, yet a more thorough look at areas that testimony has indicated as burial sites is by no mean unreasonable. Barrels will rust, and their unknown, possibly toxic contents, likely unmonitored for, will release into the groundwater, threatening yet another post-mining problem and expense for the people of Montana. This issue must no longer be ignored.

Response E-CRG 4: *This issue is outside the scope of the Draft EIS. Please see the response to Comment E13 and* ***Section 2.3.2*** *of the Final EIS.*

Comment E-CRG 5: What is the predicted attenuation rate for nitrogen and copper compounds to reach acceptable background quality?

Response E-CRG 5: *Background quality is not the criterion used in this case; standards for human health and aquatic life are the criteria. Nitrogen and copper compounds have been discharged to the tailings decant ponds for 30 years, but monitoring of groundwater between the tailings impoundment and Lake Creek, and of Lake Creek itself, does not show increases in the concentrations of these parameters which indicates that attenuation processes beneath the tailings impoundment adequately remove these compounds. After*

cessation of blasting underground, there will be no further source of added nitrogen and nitrate levels in mine water are expected to decline to less than 1 mg/L within a few months. Copper is expected to remain elevated in mine water. Monitoring of groundwater adjacent to the decant ponds indicates that this copper precipitates or is adsorbed to material beneath the decant ponds and reaches acceptable aquatic life criteria within a short distance from the decant ponds.

<u>Comment E-CRG 6:</u> How much water is anticipated to dissipate into fracture zones from the mine pool?

<u>Response E-CRG 6:</u> *The quantity of water that may drain from the flooded mine workings via fractures has not been determined; consequently, long-term post-closure monitoring of springs, seeps, and surface waters surrounding the mine would be required to document the effects, if any, of such seepage, and for purposes of implementing remedial actions, if necessary. Limited monitoring during the 1993-2004 interim shutdown, during which the mine void was temporarily flooded nearly to the maximum level, did not indicate impacts to surface waters surrounding the mine.*

<u>Comment E-CRG 7:</u> How would the monitoring plan be modified to account for groundwater seepage from the mine? What mitigation measures would be implemented to address groundwater seepage from the mine?

<u>Response E-CRG 7:</u> *Please refer to Appendix J of the Final EIS. Mitigation measures, if any, would be dependent on the location, quality, and quantity of seepage. For example, if a seep develops that results in sufficient loading of copper to downgradient surface water to result in exceedance of aquatic life criteria, the seep could be intercepted by a collection trench or drill hole, then piped to a location suitable for passive treatment (e.g. a location where a thick sedimentary deposit of sufficient distance from surface waters could attenuate copper from the seepage via precipitation within the sediments; alternatively a treatment cell could be constructed to perform that function if the natural soils are not sufficient).*

<u>Comment E-CRG 8:</u> Surface water quality monitoring should be collected at designated locations more frequently in order to promptly address any degradation to water quality. Remote monitoring systems that automatically upload to a website accessible by the public should be considered.

<u>Response E-CRG 8:</u> *Remote monitoring systems of the type described in this comment would not provide useful data for the parameters of concern. Automated monitoring systems can test for parameters such as pH, conductivity, or dissolved oxygen. For the data to be of value in detecting degradation from the Troy Mine, the remote monitoring systems would be required to detect copper at very low levels. Please see Appendix J of the Final EIS. Developing and maintaining reliable remote monitoring systems is difficult given the limited access, environmental conditions, and potential for vandalism. It would be more economical and reliable in this case to physically visit and collect samples on a periodic basis.*

Comment E-CRG 9: What mitigation measure would be employed if the Agencies determined that water quality was not improving?

> *Response E-CRG 9: Water quality is not predicted to improve, but the attenuation processes which remove metals from water in the decant ponds are predicted to continue to be effective. The proposed mitigation measure is to retain a bond or trust fund sufficient to maintain the pipelines from the mine to the decant ponds.*

Comment E-CRG 10: The long term groundwater monitoring does not address how potential seeps or springs would be treated if water quality did not meet Agency standards.

> *Response E-CRG 10: Please see response to Comment E-CRG 7.*

Comment E-CRG 11: Under the Agency-Mitigated Alternative, what manner of "additional": monitoring would be required to ensure water quality at seeps and springs is met?

> *Response E-CRG 11: Please see Appendix J and* ***Section 2.4.3.1*** *of the Final EIS - Surface Water Quality and Long-Term Monitoring of Water Quality.*

Comment E-TMI 1: The DEIS concludes that the existing dual 8" urethane lined steel pipelines that carry tailing slurry during operations need to be replaced with a new buried line at closure. TMI disagrees that the lines need to be replaced and there is little rational in the DEIS to justify this suggested replacement. The main reasons TMI disagrees with the installation of a new buried line are:

1. The existing two surface tailing lines and the existing buried pipeline have more than enough capacity and useful life to transport the mine water to the tailing facility as verified in discussions with the pipeline manufacturer;
2. The installation of a new buried line at closure would create significant new ground disturbance that will require additional reclamation;
3. There are areas in the pipeline and road corridor that are impractical for burial due to proximity of live streams (Stanley Creek and Lake Creek); and
4. TMI is installing additional secondary containment for monitoring and leak detection near stream crossings, on the existing tailing lines, that will allow better monitoring and the surface lines will be easier to repair if necessary.

It is TMI's opinion, based on actual review and testing by the pipeline manufacturer, that these lines currently have significant safe and useful life and should continue to be used following closure. TMI's proposed Closure Operations Manual (see Appendix A) summarized in this section provides a reasonable engineering approach to minimizing risk of a mine water spill during post closure.

The DEIS does not document any particular flaw or problem with the two existing 8" lines, but indicates that they are "old" and that above ground pipelines would be "more susceptible to vandalism". It is further indicated (with no documentation or explanation) that a leak from a buried pipeline would be less likely to cause sediment to reach surface water. The DEIS

incorrectly implies that the current operations does not include secondary containment of the tailing pipelines and that there is no monitoring of possible pipeline leaks. The Closure Operations Manual addresses secondary containment and leak detection monitoring. TMI would like to note that the installation of a new buried line will include a number of stream crossings where the line will either have to be buried under the stream or attached to bridge structures creating new areas of both engineering and installation challenge.

TMI has substantiated that the existing above ground tailing lines will have many years of service left at closure. Based on actual testing conducted in 2004 with the pipeline manufacturer (Irathane), the urethane lining in the existing pipelines is in excellent shape. At the time of the testing each of the slurry lines had a total of sixteen million tons of slurry flow through them, yet the lining was like new. In discussions with the manufacturer, they believe that the lining would last indefinitely with the continuous flow of mine water.

Therefore, TMI considers the addition of a 10 to 18 inch diameter buried pipeline for transporting mine water to the tailing storage facility unnecessary. The life and capacity of the two existing two surface 8 inch pipelines and the existing 10 inch buried pipeline will be every bit as effective as the proposed HDPE pipe and there is no new disturbance required.

TMI believes excavation for burial of the proposed pipeline will cause undue environmental disturbance; increase risk of sedimentation to nearby streams; and not provide any more assurance against discharge to nearby streams nor protect against vandalism. Assuming that the pipe must be buried below the frost line, the 6.1 miles of pipeline will require disturbing a 25 ft width or a minimum additional disturbance of 18.5 acres.

The DEIS documents concern with the tailings lines plugging and an over pressure event occurring which may break the lines. This will not happen for the following reasons:

1. The tailing line design includes a rupture disk installed in each tailings line that will open at 586 psi in the event of a pressure surge with the discharge directed to a containment pond. These rupture disks will prevent a tailing line breakage from an over pressure event from occurring; and
2. The tailings lines have been pressure tested at 1,110 psi. At closure, when running water in the line, the potential maximum pressure will be only 475 psi.

<u>Response E-TMI 1:</u> Refer to response to Comment E1.

<u>Comment E-TMI 2:</u> The surface water program includes 16 surface water locations for a total of 34 sample locations. Lake Creek 1, 2 and 4; Stanley Creek - 2 and Fairway Creek – 1 are the bio-monitoring (macroinvertebrate) sampling locations. As a point of clarification Lake Creek 1 and 2, date back to 1979.

ES10 – *"The surface water quality monitoring sites that would be sampled are the same sites as those identified under the No Action Alternative."*

TMI adds the following points for clarification: As of 2005/2006, the TMI surface water quality monitoring includes 16 locations as follows:

LC-1, LC-2, LC-4

SC-2, SC-15, SC-17A

FC-1

Emma Gulch,

Weasel Lake, Weasel Gulch

Ross Creek 1 and 2

Toe Ponds: 4, 3, 2

Decant Pond

> *Response E-TMI 2:* *Thank you for your comment. The Final EIS will clarify the current surface water monitoring program. See also response to Comment B-TMI-2.*

Comment E-TMI 3: 3-47 1st paragraph: "*along an approximately 200 foot length of a tributary of Ross Creek."*

The FEIS should note the tributary is ephemeral.

> *Response E-TMI 3:* *The text has been clarified as follows:*
>
> > *Development rock from construction of the South Adit was sidecast along an approximately 200 foot length of a tributary of Ross Creek. The sidecast material has forced this ephemeral stream into the opposite bank, resulting in erosion at high flows.*

Comment E-TMI 4: 3-86 1st paragraph: "*In Lake Creek, non-mine sediment sources are somewhat more substantial, but would still be substantially less than the sediment generated by the reclamation*."

The statement is not reasonable. The Proposed Action will not produce sediment to Lake Creek or Stanley-Fairway Creek because the topsoil stockpiles would be left in the current reclaimed condition and FR4628 paved surface would not be removed and replaced with a gravel surface.

Over all the years of monitoring, the numbers of clinger taxa in Stanley Creek have been similar to Fairway Creek and similar between Lake Creek Sites. This metric demonstrates that for both Fairway-Stanley and Lake Creek systems, little sedimentation effects have been noted in any of the streams evaluated. TMI has included the Comprehensive Water Quality Monitoring Programs for Streams adjacent to TMI: Spring 1986 through fall 2009, Year 25 in the Appendix E to this letter.

*<u>Response E-TMI 4:</u> The Agencies agree this sentence is unclear and it has been deleted from the Final EIS. The sentence was in a paragraph that applied to all alternatives, and the alternatives have different effects on sediment delivery which are summarized by alternative (**Section 3.9.5.4**).*

The Draft EIS does not analyze effects of operations on sediment delivery, and the past water quality monitoring results are not applicable to the proposed reclamation activities.

<u>Comment E-TMI 5:</u> 3-86, last paragraph: TMI believes the Proposed Action concrete closure/water capture structures in the service and conveyor adits would not have any more potential to "seep" resulting "*in water quality impacts*" than the agencies concrete water capture and diversion structure. No design was included in the DEIS.

<u>Response E-TMI 5:</u> Based on the design information presented for the Proposed Action it was not apparent how leakage would be controlled. Regardless of the alternative selected, TMI will be required to submit a detailed design to the Agencies for review and approval. A conceptual design for Agency-Mitigated Alternative was provided in the Draft EIS Appendix G, Page 4, Figure 1.

<u>Comment E-TMI 6:</u> 3-90, 1st paragraph*: "Because nitrate concentrations would decrease after blasting ceases, closure and reclamation of the mine would reduce nutrient loading to surface water under all alternatives."*

The analysis and conclusions provided elsewhere in the DEIS indicate there has been no nutrient impact to Stanley or Lake Creeks from the mine. The implication that the mine has caused impairment to Stanley or Lake Creeks or that mine closure will somehow "reduce nutrient loading" to these creeks is not accurate.

<u>Response E-TMI 6:</u> Mine closure will reduce nutrient sources and availability, regardless of whether these sources currently contribute nutrient loading to Stanley or Lake creeks.

<u>Comment E-A-EPA 1:</u> We are particularly concerned regarding the long-term pollutant removal effectiveness associated with the plan to discharge mine water draining from the underground workings to the decant ponds within the tailings impoundment after mine closure.

The DEIS states that mine water would be treated at the decant ponds through "natural attenuation mechanisms" as the water infiltrates, allowing metals concentrations to attenuate within the soils. Mechanisms for attenuating metals (removing them from groundwater) are stated to include dilution, precipitation, adsorption, and co-precipitation. It is further stated that the effectiveness of the natural attenuation mechanisms in treating mine water has been substantiated through monitoring of water at the tailings impoundment for the past 30 years as well as through studies directed at understanding the geochemical processes that occur in the underlying soils and groundwater system, and that the Agency-Mitigated Alternative would comply with the Clean Water Act and the Montana Water Quality Act.

The EPA acknowledges that there is empirical evidence that infiltration of mine water into groundwater beneath the Troy Mine tailings impoundment and decant ponds have apparently not resulted in elevated levels of copper and other metals in groundwater downgradient from the tailings impoundment or in Lake Creek (which is hydrologically connected to the groundwater beneath the impoundment). However, we are concerned that there may be a finite capacity for metals removal and/or immobilization, and/or that geochemical conditions may change over time reducing effectiveness of the removal/immobilization mechanisms, or that metals immobilized as precipitated metal compounds in decant pond sediments and groundwater have potential to become re-mobilized at some point in the future.

DEIS Appendix I states that the longevity of the natural attenuation mechanisms is dependent on the duration of the geochemical conditions conducive to attenuation and to the capacity of the tailing impoundment/aquifer sediments to continue to uptake metals. It concludes that the mineral precipitation and co-precipitation mechanisms are expected to last indefinitely or in perpetuity as long as geochemical conditions remain similar to current conditions. The adsorption mechanisms are conservatively estimated to last a minimum of 600 years.

However, it is also acknowledged that there are limitations and uncertainties regarding the long-term effectiveness of the natural attenuation mechanisms, including:

1. The lack of actual post-closure mine water for evaluation;

2. The lack of the analysis of several metals in some previous investigations;

3. The very low or non-detectable concentrations of some metals;

4. The assumption of chemical equilibria or disequilibria in geochemical modeling;

5. Uncertainties in the thermodynamic data upon which geochemical calculations and modeling is based.

Mine adit flow volumes and decant pond infiltration rates over time also have certain data limitations and uncertainties. Appendix I states that in spite of the uncertainties it is felt that this study is a reliable prediction of post-mine closure water quality and the behavior of metals in the infiltration pond and groundwater system. The reliability of these predictions is bolstered by the empirical evidence of attenuation that has occurred for over thirty years.

The EPA remains concerned, however, about whether the “natural attenuation mechanisms” occurring in impoundment/decant pond sediments and groundwater will continue to function effectively in regard to metals removal or immobilization over the long-term, and/or that at some point immobilized metals may become re-mobilized (i.e., the natural attenuation mechanisms may be reversible). Long-term outcomes with natural attenuation are difficult to predict. What are the Kootenai National Forest’s and Montana DEQ’s contingency plans in the event that elevated levels of metals or other pollutants are found in groundwater downgradient from the impoundment/ decant ponds and/or in Lake Creek at some point in the future after mine closure (e.g., decades into the future)?

<u>Response E-A-EPA 1:</u> Long-term monitoring of groundwater and evaluation of monitoring results will be required to document that discharge to the decant ponds is not resulting in a contaminant plume downgradient of the ponds. Based on geochemical studies and 30 years of monitoring, development of a groundwater plume is not foreseeable and a bond for a wastewater treatment plant is not reasonable. However, the mine will still have an operating permit and yearly reviews as well as five-year bond reviews. In the event that monitoring does show that attenuation mechanisms become less effective over time, it may be necessary to determine the cause of loss of attenuation capacity and re-evaluate water disposal options accordingly. Potential contingency actions include low-cost maintenance options such as: clean-out of sediment and precipitates that have accumulated in the decant ponds, excavation of a new infiltration pond sufficiently distant from the decant ponds that the substrate retains the attenuation capacity that the decant ponds formerly had, modification of the discharge to alter redox conditions, irrigation of the mine water onto the reclaimed tailings impoundment surface, or other actions that may be determined to be appropriate at the time based upon the cause of decreased attenuation capacity.

<u>Comment E-A-EPA 2:</u> It is also not clear to us if long-term water quality monitoring plans are adequate to allow detection of elevated metals levels in groundwater downgradient from the tailings impoundment should that occur in the future. The EPA has published technical guidance documents regarding the use of "Monitored Natural Attenuation" for the remediation of contaminated soil and ground water. EPA uses the term "Monitored Natural Attenuation" to emphasize the need to incorporate adequate monitoring when natural attenuation is relied upon for the remediation of contaminated soil and ground water.

While scientific understanding of natural attenuation processes is increasing, there is still much to be learned regarding the mechanisms governing natural attenuation processes and their ability to address contamination problems, particularly over the long-term. Therefore, while EPA believes monitored natural attenuation may be used where circumstances are appropriate, it should be used with caution commensurate with the uncertainties associated with a particular application. Furthermore, largely due to the uncertainty associated with the potential effectiveness of monitored natural attenuation to meet remediation or treatment objectives that are protective of human health and the environment, EPA expects that long-term performance monitoring must be a fundamental component of any monitored natural attenuation remedy.

<u>Response E-A-EPA 2:</u> The Agencies concur that long-term monitoring of mine water and groundwater near the Troy decant ponds to document the continued effectiveness of attenuation mechanisms is appropriate. Troy Mine, Inc. will be required to submit a long-term monitoring plan based upon EPA's MNA guidance for Agency review and approval.

<u>Comment E-A-EPA 3:</u> There are also uncertainties associated with the engineered design, operation and maintenance of the six mile pipeline from the underground mine to the decant ponds over the long term. Our detailed comments identify uncertainties and information/data needs for the pipeline, and include recommendations to reduce risk of pipeline leaks and spills. We also recommend that the FEIS provide additional information and clearer disclosure

regarding the streams and wetlands that may be crossed by the pipeline, and more complete evaluation and discussion regarding stream and wetland impacts associated with pipeline construction, operation and maintenance.

Response E-A EPA 3: Refer to response to Comment E1.

Comment E-A-EPA 4: It is EPA's understanding that discharge of mine water by infiltration into groundwater beneath the tailings impoundment has been occurring for many years (discharging at up to 1,170 gallons per minute to groundwater hydrologically connected to Lake Creek) without authorization by a Montana Pollutant Discharge Elimination System (MPDES/NPDES permit). Unpermitted discharges are expected to continue post-closure with transport of underground mine water to the decant ponds. While we understand that natural attenuation mechanisms are stated to occur in the decant pond sediments and groundwater that remove and/or immobilize metals, and it does not appear that elevated levels of metals are found in Lake Creek, we recommend that the MDEQ continue to monitor groundwater and Lake Creek, and carefully evaluate whether pollutants may move into Lake Creek via hydrologically connected groundwater in the future, and if so, reconsider the need for a MPDES Permit.

Response E-A-EPA 4: Please see response to Comment E-A-EPA 11 and Appendix J of the Final EIS.

Comment E-A-EPA 5: We want to reiterate and expand upon the discussion included in EPA's transmittal letter relating to our most significant concern regarding the preferred alternative (Agency-Mitigated Alternative), which is the long-term plan to discharge mine water draining from the underground workings to the decant ponds within the tailings impoundment after mine closure (page 2-52, ES-16). The preferred alternative proposes to capture mine water that would collect in the underground mine after closure and transport it via a new buried pipeline to the decant ponds at the tailings impoundment for final treatment and disposal in perpetuity. The DEIS states that mine water would be treated at the decant ponds through "natural attenuation mechanisms" as the water infiltrates, allowing metals concentrations to attenuate within the soils (page 3-77, and Appendices C, D, G, and I), such that the Agency-Mitigated Alternative would comply with the Clean Water Act and the Montana Water Quality Act (page 3-90).

The DEIS states that the effectiveness of the natural attenuation mechanisms in treating mine related water has been substantiated through monitoring of water at the tailings impoundment for the past 30 years as well as studies directed at understanding the geochemical processes that occur in the underlying soils and groundwater system. Table 3-11, "Groundwater Quality Data for Monitoring Wells at Tailings Impoundment 2000 — 2009" (page 3-59) indicates that antimony and copper concentrations downgradient of the tailings impoundment have consistently met groundwater quality standards; Table 3-9, "Surface Water Quality Data for Lake Creek, 2005 — 2009" indicates that antimony and copper water quality standards have been met at the Lake Creek monitoring station downstream of the impoundment (i.e., groundwater discharging to surface water in the vicinity of the impoundment does not compromise water quality in Lake Creek, page 3-53). The DEIS also states that during active operation of the mine

up to 1,170 gpm of the decant pond water seeped through the unlined bottom of the ponds into the underlying aquifer, which is hydraulically connected to Lake Creek, yet elevated levels of metals have not been found in downgradient groundwater or in Lake Creek (pages 3-53, 3-6 1, 3-77).

Mechanisms for attenuating metals (removing them from groundwater) include dilution, precipitation, adsorption, and co-precipitation (page 3-77). DEIS Appendices D and I provide more detailed information regarding the natural attenuation mechanisms. The Appendix D, "Metals Attenuation Study," indicates that copper was attenuated within the upper foot of soil via the precipitation of secondary copper phases (carbonates, silicates, and oxides) as well as adsorption onto organic matter (Appendix D, page 1). Appendix D also states that should the initial removal mechanisms occurring beneath the decant ponds (i.e., precipitation) become less effective over time, there are additional existing geochemical mechanisms (i.e., co-precipitation and adsorption) capable of removing at least 73-98% of the copper, 11-59% of the antimony, and 35-84% of the uranium from groundwater (Appendix D, page 14).

The Appendix I, "Assessment of Natural Attenuation of Metals in a Decant Pond Disposal System," states that concentrations of metal parameters are much lower in the groundwater than in the mine water/decant pond, evidencing that metal parameters are attenuated (removed) in the groundwater system (Appendix I, page viii). Analyses of sediments in the decant pond reveal that metals are enriched in the sediments, supporting the view that metals attenuated/removed from groundwater are retained in the sediments. Geochemical modeling and lab experiments demonstrate that natural attenuation is provided by the precipitation of iron from mixing of mine water and decant pond water with natural ambient groundwater. Copper, iron, lead, and manganese minerals are oversaturated in mine water and are favored to precipitate from mine water. Appendix I states that precipitation of naturally-occurring iron and manganese in groundwater can significantly reduce the concentrations of arsenic, antimony, copper, lead, and uranium in mine water and decant pond water to levels below human health and aquatic life standards during groundwater transport within a short distance (ten to one hundred feet) of the decant ponds. (Appendix I, pages 1-5, 1-6). The geochemical mechanisms responsible for copper attenuation include primarily the formation of copper minerals and secondarily adsorption by organic matter in soils.

The EPA acknowledges that there is empirical evidence that infiltration of mine water into groundwater beneath the Troy Mine tailings impoundment and decant ponds have apparently not resulted in elevated levels of copper and other metals in groundwater downgradient from the impoundment or in Lake Creek. Although it is not fully clear if all metals and metalloids of potential concern have been adequately evaluated. Monitoring should verify that all metals and metalloids that could potentially be present in mine waters are not present at the Troy Mine (at detectable levels), or if present, determine the concentrations at which they have been found (e.g., Ag, As, Bi, Cd, Co, Cr, Cu, Hg, Mn, Mo, Ni, Pb, Sb, Se, Tl, U, V and Zn).

The EPA is concerned about the long-term effectiveness of the "natural attenuation mechanisms," since this treatment and disposal system is proposed to occur in perpetuity. We are concerned that there may be a finite capacity for metals removal and/or immobilization,

and/or that geochemical conditions may change over time reducing effectiveness of the removal/immobilization mechanisms, or that metals immobilized as precipitated metal compounds in decant pond sediments and groundwater, may become re-mobilized at some point in the future (i.e., the natural attenuation mechanisms may be reversible).

Appendix I states that the longevity of the natural attenuation mechanisms is dependent on the duration of the geochemical conditions conducive to attenuation and to the capacity of the tailing impoundment/aquifer sediments to continue to uptake metals (Appendix I, page 9-2). It concludes that the mineral precipitation and co-precipitation mechanisms are expected to last indefinitely or in perpetuity as long as geochemical conditions remain similar to current conditions. The adsorption mechanisms are conservatively estimated to last a minimum of 600 years.

However, it is also acknowledged that there are limitations and uncertainties regarding the long-term effectiveness of the natural attenuation mechanisms, including (Appendix I, page 1-8):

1. The lack of actual post-closure mine water for evaluation;

2. The lack of the analysis of several metals in some previous investigations;

3. The very low or non-detectable concentrations of some metals;

4. The assumption of chemical equilibria or disequilibria in geochemical modeling;

5. Uncertainties in the thermodynamic data upon which geochemical calculations and modeling is based.

Appendix I states that in spite of these uncertainties it is felt that this study is a reliable prediction of post-mine closure water quality and the behavior of metals in the infiltration pond and groundwater system. The reliability of these predictions is bolstered by the empirical evidence of attenuation that has occurred for over thirty years.

The EPA remains concerned, however, about whether the “natural attenuation mechanisms” occurring in impoundment/decant pond sediments and groundwater will continue to function effectively in regard to metals removal or immobilization over the long-term, and/or that at some point immobilized metals may become re-mobilized. What are the Kootenai National Forest’s and Montana DEQ’s contingency plans in the event that elevated levels of metals (or metalloids) are found to develop in groundwater downgradient from the impoundment/decant ponds and/or in Lake Creek at some point in the future after mine closure (e.g., decades into the future)?

It is also not clear to us if long-term water quality monitoring plans are adequate to allow detection of elevated metals levels in groundwater downgradient from the tailings impoundment should that occur in the future. The EPA has published technical guidance documents regarding the use of “monitored natural attenuation” for the remediation of contaminated soil and ground water (EPA, Office of Solid Waste and Emergency Response, Directive 9200.4-17P, April 1999). EPA uses the term “Monitored Natural Attenuation” to

emphasize the need to incorporate adequate monitoring when natural attenuation is relied upon for the remediation of contaminated soil and ground water.

While scientific understanding of natural attenuation processes is increasing, there is still much to be learned regarding the mechanisms governing natural attenuation processes and their ability to address contamination problems, particularly over the long-term. Long-term outcomes are very difficult to predict. Therefore, while EPA believes monitored natural attenuation may be used where circumstances are appropriate, it should be used with caution commensurate with the uncertainties associated with a particular application. Furthermore, largely due to the uncertainty associated with the potential effectiveness of monitored natural attenuation to meet remediation or treatment objectives that are protective of human health and the environment, EPA expects that long-term performance monitoring must be fundamental components of any monitored natural attenuation remedy.

EPA technical guidance regarding monitored natural attenuation that we draw to the lead agencies attention include:

"Monitored Natural Attenuation of Inorganic Contaminants in Ground Water, Volume 1 - Technical Basis for Assessment" (EPA/6001R-07/139, October 2007, http://www.epa.gov/nrmrl/pubs/600R07139/600R07139.pdf);

"Monitored Natural Attenuation of Inorganic Contaminants in Ground Water, Volume 2 Assessment for Non-Radionuclides Including Arsenic, Cadmium, Chromium, Copper, Lead, Nickel, Nitrate, Perchiorate, and Selenium" (EPA/600/R-07/140, October 2007, http://www.epa.gov/nrmrl/pubs/600R07140/600R07140.pdf);

"Metal Attenuation Processes at Mining Sites," ((EPA/6001R-07/092) September 2007, http://www.epa.gov/nrmrl/pubs/600R07092/600R07092.pdt).

See also the EPA website on Monitored Natural Attenuation, http://www.epa.gov/nrmrl/gwerd/gw/mna.html, and note that there is also a publication, "A Citizen's Guide to Monitored Natural Attenuation," EPA 542-F-01-004, April 2001, http://www.clu-in.org/download/citizens/mna.pdf).

These EPA technical guidance documents address long-term attenuation capacity and reversibility issues, and long-term monitoring plans in the context of Tier 3 and Tier 4 analyses.

In Tier 3 analysis EPA recommends that long-term capacity and reversibility be specifically investigated. The DEIS states that mechanisms are expected to last indefinitely as long as geochemical conditions remain similar. This may be reasonable, but this type of broad conclusion typically requires a fairly detailed study of bonding/uptake mechanisms of metals in the solid phase and lab-based extractability assessments. It is not clear if the studies identified in Appendices D and I adequately address EPA Tier 3 analysis requirements. Tier 4 deals with the development of a long-term monitoring plan and the development of a contingency plan in case trends revealed by the monitoring data fail to meet expectations. We are including

additional discussion of long-term water quality monitoring and Tier 4 analysis in our following comment (comment No. 3) [Comment E-A-EPA 6].

The EPA recommends that long-term attenuation capacity and reversibility issues, and long-term monitoring and contingency plans be more comprehensively addressed in the FEIS in a manner consistent with the EPA technical guidance documents referenced above.

<u>Response E-A-EPA 5:</u> Thank you for your comments concerning the long-term effectiveness of natural attenuation mechanisms. The Agencies share these concerns and have required several studies to address this issue. The monitored natural attenuation guidance documents recommended in EPA's letter have been reviewed and provided an excellent framework for the development of a long-term monitoring program. We note that these guidance documents are also referenced in Hydrometrics' October 2010 report "Assessment of Natural Attenuation of Metals in a Decant Pond Disposal System – Troy Mine", which is included in the Draft EIS as Appendix I.

The need to assess attenuation mechanisms was raised in 2000 during discussions with the mining company concerning needed revisions to the mine's reclamation plan. In September 2000, Revett Minerals initiated a multi-phase water fate and transport study. This included a 'groundwater sampling and water quality evaluation' during 2000, groundwater tracer testing during 2001, additional monitoring well installation during 2001 – 2002, and geochemical testing of aquifer materials during 2003. These studies were summarized in the January 2004 report "Assessment of Fate and Transport of Copper in Decant Pond Disposal System – Troy Mine" prepared by Land and Water Consulting, Inc., and submitted as Appendix C of the Troy Mine's October 2005 Revised Reclamation Plan. During the research phase, one of the decant ponds was dewatered and sediment samples from the pond bottom were collected and analyzed for total metals content, mineralogical characterization via electron microprobe analysis, and sequential extraction analysis. The studies concluded that copper minerals are forming in the sediments directly beneath the decant pond. The sampling occurred following ten years of suspension of milling operations during which discharge of mine drainage to the decant ponds continued. Consequently, geochemical conditions in the decant ponds at the time of sample collection should have closely replicated those which will occur after closure of the mine.

The Agencies reviewed the studies and noted that (1) only copper attenuation had been addressed and that further studies should evaluate the fate and transport of other metals present in mine drainage; (2) duration of the natural attenuation mechanisms should be addressed; and (3) the potential for secondary attenuation processes to immobilize metals along the groundwater flow path, should the primary mechanism described in the decant pond sediment study ever fail, should also be evaluated.

As part of the Agencies' review of attenuation studies, recent water quality monitoring data from the Troy Mine's adit discharges and decant ponds were also reviewed. Routine sampling conducted by the mine includes the following metal parameters: aluminum (Al), silver (Ag), arsenic (As), barium (Ba), beryllium (Be), boron (B), cadmium (Cd), chromium (Cr),

copper (Cu), iron (Fe), mercury (Hg), manganese (Mn), nickel (Ni), lead (Pb), antimony (Sb), selenium (Se), silicon (Si), thallium (Tl), uranium (U), and zinc (Zn). These data, as well as data collected by DEQ, were compared with human health standards and with aquatic life standards for Lake Creek. Hardness results for Lake Creek monitoring sites ranged from 27 mg/L up to 40 mg/L. Metals which were present in either mine drainage or process water at levels in excess of the chronic aquatic life criteria at 25 mg/L hardness were recommended for inclusion in further attenuation studies.

In all results of tests for dissolved metals, only antimony exceeded human health standards in samples from either mine drainage or process water. For samples analyzed for total recoverable metals, arsenic and lead also sometimes exceeded human health standards; levels of these metals in the dissolved fraction of water samples were consistently within human health standards.

Concentrations of dissolved copper and cadmium commonly exceeded the chronic aquatic life criteria at 25 mg/L hardness in samples collected from the Troy Mine's decant ponds and adit drainage. Dissolved lead in mine water was sometimes detected at concentrations higher than chronic aquatic life criteria. Silver was sometimes detected at concentrations exceeding aquatic life criteria in the total recoverable fraction of either mine drainage or decant pond water, but was not detected in the dissolved fraction. Mercury was not detected, and uranium was only detected at concentrations much lower than human health standards; however, these metals were recommended for further analysis in the next phase of attenuation studies due to the limited amount of data that had been collected at sufficiently low detection limits.

Based on the review process described above, the following metals were identified for further assessment of attenuation potential: arsenic, antimony, cadmium, copper, iron, lead, manganese, mercury, silver, and uranium. The study included as Appendix I of the Draft EIS further reviews the long term effectiveness of the attenuation mechanisms that occur at the base of the decant ponds and that were previously assessed solely for copper attenuation during the 2000 – 2004 studies. Given that some uncertainty remained concerning the long term effectiveness of the attenuation processes that occur immediately beneath the decant pond, the Agencies also decided that a separate study should be conducted to assess the effects of mine water mixing with groundwater beneath the tailings impoundment without the benefit of the attenuation that occurs within or beneath the decant pond. This study is presented in Appendix D of the Draft EIS, and shows that significant attenuation of metals would also occur as a result of the mixing of mine water with ambient groundwater.

Comparison of previous research with Monitored Natural Attenuation guidance documents:

EPA's guidance documents on Monitored Natural Attenuation were published during 2007. Most of the relevant research at the Troy tailings impoundment site was conducted prior to then, yet was consistent with that guidance. EPA's guidance recommends a four-tiered approach to evaluation of natural attenuation. Tier I involves demonstration that the

groundwater plume is not expanding and that sorption of the contaminant onto aquifer solids is occurring where immobilization is the predominant attenuation process. Characterization of hydrogeologic conditions beneath the Troy tailings impoundment and decant ponds has been occurring for over 30 years. Initially, four deep monitoring wells were installed beyond the impoundment perimeter during the late 1970s. Following baseline data collection, the monitoring program shifted from groundwater characterization to water quality monitoring and macro-invertebrate diversity assessment in Lake Creek. Following suspension of milling operations in 1993, the middle cell of the tailings impoundment was reclaimed, allowing for access to the impoundment surface for the installation of wells to evaluate groundwater conditions beneath the tailings. Consultants representing ASARCO and the Cabinet Resource Group co-operated in the implementation of these studies, which included the drilling of several additional monitoring wells during 1995 and 1997. More detailed studies were conducted between 2000 and 2004, as noted above. Geochemical testing of aquifer materials was planned during 2003; however, groundwater collected from the monitoring wells nearest the decant ponds, installed within 30 to 50 feet of the ponds during 2001, showed background concentrations of copper. Consequently, it was decided that materials collected from these wells would not be expected to be strongly enriched in copper and could not be analyzed to determine the attenuation mechanisms. Instead, soil/sediment samples were collected from shallow pits dug in the bottom of the decant pond during the period when it was dewatered in early 2003 (Land and Water Consulting, Inc., 2004). These studies indicate that there is no groundwater plume associated with the discharge to the decant pond, as copper is precipitated within the sediments comprising the decant pond bottom in the form of several secondary copper minerals including malachite, chrysocolla, copper oxides, copper/iron oxides, and copper iron/copper manganese silicates. Copper was also concentrated in organic matter found on the pond bottom including algae and pine needles. The 2004 study concluded that copper precipitation in the decant pond is driven by chemical changes that occur in mine water after it is discharged to the decant pond. These changes include the increased availability of dissolved oxygen, the increased availability of dissolved silica, and the increased availability of organic and inorganic carbon (Land and Water Consulting, Inc., 2004).

Tier II analyses recommended in EPA's NMA guidance involve determination of the mechanism and rate of the attenuation process. Mine water has been discharged to the Troy tailings impoundment and decant ponds since 1981, either combined with tailings slurry during operations, or during the 1993 – 2004 interim shut-down phase as a direct discharge of mine water to the decant ponds. Monitoring of groundwater near the decant ponds, beneath the tailings impoundment, and between the tailings impoundment and Lake Creek has been occurring since 1995. This monitoring does not show evidence for an expanding plume of metal-contaminated groundwater; consequently it is apparent that the rate at which attenuation processes occur within and immediately beneath the decant ponds has been sufficient to preclude the development and expansion of a plume. Analyses of groundwater chemistry, and of the composition and mineralogy of sediment beneath the decant pond where metal precipitation is occurring, as noted previously and further described in the 2004 report, describe the mechanism of attenuation per Tier II guidance.

Tier III analyses involve determination of the capacity of the aquifer to attenuate the mass of contaminant within the plume and the stability of the immobilized contaminant to resist re-mobilization. The studies described above indicate that the attenuation of metals from Troy mine water occurs primarily within the decant ponds themselves and is not dependent upon interaction with ambient groundwater. Further, interaction with aquifer solids of limited availability does not appear to be a factor that would limit the duration of the attenuation process. Changes in groundwater chemistry that would result in slower rates of attenuation are not anticipated. Attenuation of metals in water discharged to the decant pond has been occurring for 30 years without the development of a groundwater plume. The chemistry of mine water has not changed substantially during that time, nor is it expected to after closure of the mine. Sulfate concentrations in mine water have remained in the 20 to 30 mg/L range, which is low and indicative that acid rock drainage is not developing within the mine workings. Given the record of stable mine water chemistry and rapid precipitation of metallic minerals as mine water seeps out of the decant ponds, it is anticipated that the currently occurring attenuation processes will remain effective for a long time. The Agencies note that EPA's MNA guidance appears to be focused on acid mine drainage sites where pollutant concentrations are generally much higher than at the Troy mine site and physical or chemical changes that may impede long-term attenuation are more likely to develop.

Tier IV involves designing a performance monitoring program based on the mechanistic understanding developed for the attenuation process, and establishing a contingency plan tailored to site-specific characteristics. The Agencies concur that long-term monitoring of mine water and groundwater near the Troy decant ponds to document the continued effectiveness of attenuation mechanisms is appropriate. Troy Mine Inc. will be required to submit a long-term monitoring plan based upon EPA's MNA guidance for Agency review and approval. Should the primary attenuation mechanisms occurring beneath the decant ponds ever fail to adequately remove metals from mine water, a contingency plan was presented in the EIS. As evaluated in the study included as Appendix D of the Draft EIS, secondary attenuation processes resulting from direct mixing of water discharged from the mine via the decant ponds with ambient groundwater within the Lake Creek valley aquifer will result in co-precipitation of mine-derived metals and dissolved iron that is naturally present within the aquifer.

Comment E-A-EPA 6: DEIS Table 2-1 (page 2-23) includes information on long-term monitoring of water quality for each alternative, and brief narrative discussion of monitoring is included for each alternative (pages 2-38, 2-39, 2-45, 2-46, 2-54). The DEIS states that the Agency-Mitigated Alternative includes water quality monitoring of springs in the analysis area to validate the prediction that water quality standards would be met post-closure (page 3-23). However, proposed long-term water quality monitoring is presented in a disjointed manner in the DEIS. The narrative monitoring discussions refer the reader to Table 2-2, "No Action Alternative Groundwater Monitoring Sites and Schedule" (page 2-36, 2-37), Table 2-3, "No Action Alternative Surface Water Monitoring Sites" (page 2-38), and Figure 2-5 "Proposed Surface and Groundwater Monitoring Sites" (page 2-40). The DEIS reader must flip back and forth between

the narrative discussions of monitoring for each alternative and Tables 2-2 and 2-3 and Figure 2-5 in an effort to understand proposed long-term water quality monitoring.

It is not clear to us from Figure 2-5 which groundwater monitoring sites are immediately downgradient from the decant ponds at the tailings impoundment, or if these sites are adequate or appropriate groundwater monitoring sites. It is also not clear which pollutant parameters would be analyzed and which analytical methods would be used at each site. It appears that groundwater samples would be collected three times per year (spring, summer, fall, page 2-37), and that the preferred alternative includes a commitment to monitor water quality post-closure for a minimum of five years after mine water discharge actually commences (page 2-54), and/or until the Agencies agree that monitoring is no longer necessary (page 2-23).

We believe a more detailed, comprehensive long-term water quality monitoring plan for groundwater and surface water, particularly for waters downgradient from the tailings impoundment decant ponds, must be disclosed to assure that adequate long-term performance monitoring is incorporated into the natural attenuation treatment plan. This is necessary to assure that the natural attenuation mechanisms continue to be effective in removing/immobilizing metals over the long-term, and that if metals levels increase for any reason, such increases will be identified and detected so they may be mitigated. A contingency plan in case trends revealed by the monitoring data fail to meet expectations is also needed.

We refer the lead agencies to the EPA monitored natural attenuation guidance documents referenced in our comment above for identification and discussion of factors that should be considered in developing a long-term performance monitoring plan for groundwater downgradient from the decant ponds. In particular we recommend pages 18 to 22 in the document, "Monitored Natural Attenuation of Inorganic Contaminants in Ground Water, Volume 1 - Technical Basis for Assessment," EPA/600/R-07/139, October 2007, http://www.epa.gov/nrmrl/pubs/600R07139/ 600R07139.pdf.

A list of pollutant parameters and proposed analytical methods at each monitoring site along with monitoring frequency should be clearly presented. The monitoring plan should be designed to monitor specific metals of concern. Monitoring parameters that should be considered include metals and metalloids that could be present or of concern in Troy Mine waters (e.g., Ag, As, Bi, Cd, Co, Cr, Cu, Hg, Mn, Mo, Ni, Pb, Sb, Se, Ti, U, V and Zn). Monitoring should also include other parameters that link to the proposed attenuation mechanisms, such as pH, redox conditions, dissolved oxygen, dissolved organic carbon, and concentrations of major cations (Ca, Mg, Na, K) and anions (S04, Cl, HCO3), so that geochemical conditions required for natural attenuation can be tracked. Nitrogen parameters (total nitrogen, nitrite+nitrate nitrogen, kjeldahl nitrogen, ammonia nitrogen) should also monitored to evaluate potential presence of contaminants from mine blasting residues.

Monitoring plans should also include well defined triggers that would initiate the implementation of additional evaluation and/or contingency remedial technologies if natural attenuation processes fail to fulfill expectations. Potential chemical and biological monitoring indicators that will be used to signify that natural attenuation treatment may be failing should

be identified with trigger values defined. Long-term monitoring plans must be adequate to detect if natural attenuation may be failing at some point, and if monitoring triggers indicate potential failure that should result in follow-up monitoring and investigation. A different reclamation treatment approach may need to be implemented in the event of failure of natural attenuation. Such measures should be incorporated into a monitoring and contingency/ corrective action plan. EPA's Monitored Natural Attenuation technical guidance documents for Tier 4 analysis recommends:

- Select monitoring locations and frequency consistent with site heterogeneity
- Select monitoring parameters to assess consistency in hydrology, attenuation efficiency, and attenuation mechanism
- Select monitored conditions that "trigger" re-evaluation of adequacy of monitoring program (frequency, locations, data types)
- Select alternative remedy best suited for site-specific conditions

We believe some level of monitoring will likely need to be conducted in perpetuity to assure that natural attenuation mechanisms remain effective in perpetuity. Although monitoring frequency can be reduced over time if monitoring results do not evidence contamination (e.g., reduce monitoring to twice per year, then annually, then biennially, etc.). However, some minimal level of monitoring will likely need to be conducted over the very long-term to validate continued effectiveness of natural attenuation. Bonding and financial assurances should provide adequate funding for long-term monitoring, and implementation of an alternative treatment reclamation approach in the event of failure of natural attenuation.

<u>Response E-A-EPA 6:</u> The Agencies concur that long-term monitoring of mine water and groundwater near the Troy decant ponds to document the continued effectiveness of attenuation mechanisms is appropriate. Troy Mine, Inc. will be required to submit a long-term monitoring plan based upon EPA's NMA guidance for Agency review and approval.

A conceptual long-term monitoring plan that incorporates the NMA guidance is included in Appendix J of the Final EIS.

<u>Comment E-A-EPA 7:</u> The DEIS states that copper is attenuated within the upper foot of soil of the decant ponds via the precipitation of secondary copper phases (carbonates, silicates, and oxides) as well as adsorption onto organic matter (Appendix D, page 1). It is also stated that the decant ponds would be cleaned out periodically (page 2-2 1). If heavy metals precipitate and accumulate in the upper foot of soil in the decant ponds and ponds are periodically cleaned out, it is not clear to us where the metal laden sediments removed from the decant ponds will be disposed. Disposal of metal laden sediments resulting from the periodic clean out of the decant ponds should be described in the FEIS (i.e., identification of the depository or landfill where metal laden sediments would be taken for final disposal).

Also, is there any potential that the periodic clean out of sediments from the decant ponds will mobilize some pollutants, or over time impair the efficacy of the "natural attenuation mechanisms" and/or pollutant removal efficiency of the decant pond?

<u>Response E-A-EPA 7:</u> The location for disposal of sediment periodically removed from the decant ponds was not specified in the Draft EIS. It is anticipated that the volume of material would be minor and the frequency of clean-out would be low. The Agencies would require that the material removed be tested via TCLP or other appropriate methods to determine whether metals contained within the sediments might become re-mobilized after removal from the pond bottom. If it is determined that metals would not leach from the sediment, it would likely be buried within the tailings impoundment and soil would be re-spread over the material. If metal mobility is a concern, the material could potentially still be disposed within the tailings impoundment if it is then covered with a barrier cover to preclude exposure of the material to water. Alternatively, the material could be transferred to any appropriately designed and licensed landfill that agrees to accept the material. The possibility also exists that the material could be shipped off-site for reprocessing and metal recovery.

The secondary copper minerals are stable under surface conditions; that is why they precipitated in the first place. As long as the water is well-oxygenated and its pH is near neutral, the minerals will remain stable.

There is no apparent mechanism for the cleanout of silt from the decant ponds to remobilize metals in the geologic materials or to impair the efficiency of oxygenated water and an inert solid surface to continue to precipitate minerals.

Under the Agency-Mitigated Alternative, cleanout of the decant ponds will be minimized because a berm will prevent inflow of sediment to the ponds and the mine water discharge is clear. In addition, the depth of the ponds (about 10 feet) will minimize plant growth within the ponds. However, if sediment and debris are removed from the decant ponds, they may be contaminated with metals. If TCLP testing of the excavated material documents that the potential for re-leaching of metals from the sediment is sufficiently low, then these materials will be buried within the tailings impoundment where the same attenuation processes are available in the subsurface to remove any metals that are contained in these materials. Topsoil in the burial area will be removed and replaced after burial, and the disturbed area will be revegetated.

The removal of materials from the ponds may mobilize metals that have been captured through geochemical processes in the uppermost soil at the base of the ponds. If this is the case, the remobilized metals will be attenuated in the remaining natural soils beneath the ponds, which extend for at least 15 vertical feet before encountering regional groundwater.

<u>Comment E-A-EPA 8:</u> The volume calculations for infiltration in the decant ponds appear to be based on an oversimplification of the hydrogeology in the area of the decant pond as demonstrated by the tracer tests described in Appendix C. We are concerned about the data limitations and uncertainties associated with decant pond infiltration rates over the long-term. Contingency planning should address this uncertainty.

<u>Response E-A EPA 8:</u> The decant ponds are documented to have performed their function of water infiltration for many years. Should their ability to continue to infiltrate mine water

become impaired in the future, the Agencies have proposed in the Draft EIS that the ponds would periodically be cleaned out. If this proves to be insufficient to restore their infiltration capacity, the ponds could also be expanded or relocated. If their capacity to infiltrate mine water were to diminish in the future and no actions were taken to restore their function, then the water level in the ponds would rise until the water expanded onto the reclaimed tailings and onto adjacent lands. As the pond surface area increased, infiltration rates would return to a balance with the rate of discharge to the ponds.

As a clarification, the tracer test performed by Hydrometrics in 2001 was not used to derive the infiltration rate; rather, the incidental data on ponds elevations collected with no discharge to the ponds were used to calculate the infiltration rate directly. This infiltration rate (0.4 ft/day) should be a good representation of the infiltration rate at the ponds without further modeling. Another estimate of the infiltration rate was derived from the measured hydraulic conductivity of groundwater beneath the ponds. This infiltration value, which varies from 8.4 to 10.1 ft/day, would allow a 1.6-acre pond 10 feet deep to contain the wettest condition expected in a ten year period. The more conservative estimate of 0.4 ft/day would require a 23-acre pond 10 feet deep to contain the same wet condition. Because the existing 5-acre pond has successfully infiltrated the discharge water for the period of mine operation, it was decided that the existing pond size should be used to infiltrate the mine discharge after closure. The expected discharge rate after mine closure is less than during mine operation, and the discharged water will be clear. These factors plus the depth of the ponds, which limits plant growth, should preserve the historical infiltration rate. If a diminishing rate is observed, the pond bottom can be cleaned to restore the original rate. The contingency plan (if more capacity is needed) is to construct more or larger infiltration ponds.

Comment E-A-EPA 9: The DEIS states that domestic wells in the vicinity of the tailings impoundment would not be affected (page 3-89). The EPA recommends that the FEIS identify the location and proximity of nearby domestic wells to the tailings impoundment (e.g., wells within a mile).

Response E-A-EPA 9: A new figure has been inserted into the Final EIS in ***Section 3.9.5.4****.*

Comment E-A-EPA 10: The DEIS states (page 3-5 8) that if nutrients in shallow groundwater discharge locally to surface water (as they may at the toe ponds) nuisance algal growth could occur, although numeric exceedances for the aquatic life standard for ammonia or for the human health standard for nitrate plus nitrite are not observed in the toe pond water quality data. Nonetheless, the DEIS states that nitrate plus nitrite levels may be high enough at times to promote nuisance algal growth in the toe ponds. Table 3-11 shows ammonia levels as high as 4.2 mg/L in groundwater (MW95-4) and nitrate+ nitrite levels as high as 1.19 mg/l. Table 3 in Appendix F (Appendix F, page 11) shows decant pond water ammonia levels from 4.4 to 11.2 mg/l, Nitrate+nitrite N from 14.5 to 37.6 mg/l; Mine water disused area ammonia levels of 0.39 mg/l and Nitrate+nitrite of 7.4 mg/L; and Adit discharge ammonia levels of 2.33 mg/L and Nitrate+nitrite of 7.99 mg/L. Currently, nitrate concentrations in the tailings decant pond water range between 10 mg/L and 30 mg/L, and concentrations in monitoring wells located close to the

decant ponds are similar. However, monitoring wells and the toe ponds downgradient of the tailings impoundment generally have nitrate concentrations of less than 1 mg/L (Table 3-1 1).

The DEIS states that after cessation of mining, addition of nitrate to the tailings impoundment would cease (page 3-70), and residual nitrate would slowly be rinsed out of the tailings by precipitation and diluted in the groundwater, and concentrations of nitrate in the underlying aquifer would decline. Nitrate concentrations are expected to decline rapidly after mining ends, as was observed during the interim mine shut-down between 1993 and 2004, because nitrate-rich mine water will no longer be discharged in the tailings impoundment.

While we agree that nitrogen levels in mine waters discharged to the decant ponds are likely to decline after mining ends there does appear to be potential for elevated nitrogen levels to occur in groundwater and surface waters hydrologically connected to groundwater. It is important to recognize that recent scientific studies have increased concerns about impact of even low levels of nitrogen in surface waters in regard to stimulation of growth of algae and undesirable aquatic vegetation. The Montana DEQ is developing numeric water quality criteria intended to control excessive nutrient (nitrogen and phosphorus) pollution in Montana's streams, rivers, and lakes to assure a level of water quality that will protect the beneficial uses of these waterbodies, (see DEQ website, http://deq.mt.gov/wginfo/standards/NurnericNutrientCriteria.rncpx).

In 2008, DEQ released the report, "Scientific and Technical Basis of the Numeric Nutrient Criteria for Montana's Wadeable Streams and Rivers" which included draft numeric nutrient criteria that, if achieved, ensure protection of designated uses. The 2008 report proposed a total nitrogen criterion of 0.23 3 mg/l for the Northern Rockies ecoregion as the concentration that would ensure protection of aquatic life and recreational uses. We recommend that the revised reclamation plan take this science into consideration and that the closure and post-closure monitoring include monitoring for nitrogen parameters and growing season chlorophyll in the long-term water quality monitoring plan so that the response of the algal community to nitrogen loading can be identified and mitigated if need be.

> *<u>Response E-A-EPA 10:</u> Thank you for your comment. As EPA notes in this comment, the concentrations of nitrogen compounds in the toe ponds do not exceed and are less than the numeric aquatic criteria for ammonia or the human health standard for nitrate + nitrite. The highest concentrations of nitrogen compounds are expected during mining operation and the operational levels of nitrogen compounds in decant water discharged to the tailings impoundment range up to 37.6 mg/L nitrate + nitrite and 11.2 mg/L ammonia. However, the operational concentrations of nitrogen compounds in groundwater downgradient of the tailings impoundment and in the vicinity of the toe ponds are less than 1 mg/L. When blasting ceases, the input concentrations of nitrogen compounds would decrease further. It is important to note that there is no hydrogeological evidence that water from the tailings impoundment or toe ponds discharge to Lake Creek (Castro 2009).*
>
> *We are aware that DEQ Water Quality Standards Section has prepared a preliminary technical analysis to address total nutrient concentrations that could represent an undesirable biological impact for streams in Montana during the growing season from July 1*

through September 30 (Suplee et al. 2008, Suplee and Suplee 2011a). The analysis is not yet complete and has not been developed sufficiently to begin the rulemaking process. The technical analysis seeks to determine seasonal criteria that would be generally applied on an ecoregion level, but would be further subject to reach-specific factors that affect algal growth. To address the uncertainty regarding the response of area streams to increased nutrients, the Troy Mine performs aquatic monitoring in Lake Creek as part of the Hardrock Operating Permit requirements. More than 25 years of monitoring data (Fairway, Stanley, and Lake Creeks) have been collected and do not indicate the development of nuisance algal growth as a result of mine effluent discharge (Parametrix 2010).

EPA has indicated that both total nitrogen (TN) and total phosphorus (TP) are the minimum acceptable nutrient criteria for evaluating the potential for nuisance algal growth (Suplee et al. 2008). Significant increases in algal growth may not occur in response to increases in TN concentration if TP concentrations are sufficiently low that they limit algal growth when nitrogen is already present in surplus (Allan 1995, Steinman and Mulholland 1996). Further, it has been documented that elevated TN and TP can lead to significant seasonal dissolved oxygen decreases along a stream, which would be harmful to fish (Suplee and Suplee 2011b).

The TN concentration cited in your comment was one of three nutrient concentrations developed in a preliminary technical analysis on an ecoregion basis (Suplee et al. 2008). The Troy Mine is within the Northern Rockies Ecoregion 15q Purcell-Cabinet-North Bitterroot Mountains (NRIS). The preliminary technical analysis indicates that for this ecoregion, a TN concentration of 0.233 mg/L, a nitrate + nitrite concentration of 0.081, and a TP concentration of 0.012 mg/L could be appropriate numeric criteria for the Montana Board of Environmental Review to consider for adoption. These TN, nitrate + nitrite, and TP concentrations are based on maintaining in-stream chlorophyll a concentrations to less than 150 mg/m^2 as identified by MDEQ's nuisance algae public-perception survey. Nuisance algal levels were defined quantitatively in this survey using a benthic algae metric (i.e., chlorophyll a density per unit area of stream bottom; Suplee et al. 2009). Please refer to the table that follows.

Period of Record: 2000-present	***L-1 (upstream of tailings impoundment)***	***L-2 (downstream of tailings impoundment)***	***L-4 (downstream of tailings impoundment)***	***DEQ Preliminary Technical Analysis Nutrient Total Concentration Northern Rockies Ecoregion, (mg/L)***
Ammonia median (mg/L)	*<0.050*	*<0.050*	*<0.050*	*0.081*
$NO_2 + NO_3$ median (mg/L)	*0.062*	*0.060*	*0.110*	*0.233*
Total P median (mg/L)	*0.011*	*0.012*	*0.011*	*0.012*

Allan, J.D. 1995. Nutrient Dynamics. Pp. 283-303. In: J.D. Allan. Stream ecology structure and function of running waters. Chapman and Hall, London, UK.

Castro, James. 2009. Technical memo. Montana Department of Environmental Quality, Helena, MT.

NRIS. Ecoregions of Montana. http://nris.mt.gov/gis/gisdatalib/downloads/ecoreg2002.pdf. Draft 2. Accessed September 2, 2011.

Parametrix. Final annual report – year 25; comprehensive water quality monitoring program for streams adjacent to Genesis, Inc., - Troy Mine: Analysis of spring 1986 through fall 2009 samples. Prepared for Genesis Inc. and Montana Department of Environmental Quality. July. Bellevue, WA.

Steinman, A.D., and P.J. Mulholland. 1996. Phosphorus limitation, uptake, and turnover in stream algae. Pp. 161-189. In: F.R. Hauer and G.A. Lamberti, editors. Methods in Stream Ecology. Academic Press, San Diego, CA.

Suplee, M., V, Watson, A. Varghese, and J. Cleland. 2008. Scientific and technical basis of the numeric nutrient criteria for Montana's wadeable streams and rivers. Montana Department of Environmental Quality, Helena, MT.

Suplee, M.J., V. Watson, M. Teply, and H. McKee. 2009. How green is too green? Public opinion of what constitutes undesirable algae levels in streams. Journal of the American Water Resources Association 45: 123-140.

Suplee, M., and R.S. Suplee. 2011a. Guidance Document: Assessment methodology for determining wadeable stream impairment due to excess nitrogen and phosphorus levels. Draft 6: April 2011. Montana Department of Environmental Quality, Helena, MT.

Suplee, M., and R.S. Suplee. 2011b. Guidance Document: Assessment methodology for determining wadeable stream impairment due to excess nitrogen and phosphorus levels. Appendix B. Draft 6: April 2011. Montana Department of Environmental Quality, Helena, MT.

Comment E-A-EPA 11: The DEIS states that during active operation of the mine, Troy Mine, Inc. typically uses the tailings impoundment and decant ponds to settle out suspended sediment from the tailings slurry, and then clarified tailings/decant pond water is pumped to the mill circuit via a return line (page 3-60). The DEIS also states that up to 1,170 gpm of the decant pond water seeps through the unlined bottom of the ponds into the underlying aquifer (i.e., or approximately 1.7 million gallons per day). The 2001 Hydrometrics report (Appendix H) indicated that, while deep groundwater and the decant ponds system are hydraulically connected, most of the decant pond water is transported downgradient (towards Lake Creek) via the shallow alluvial aquifer (page 3 61); and it is also stated that groundwater beneath the tailings moves in a westerly direction and eventually discharges to Lake Creek (Summit Envirosolutions 1996, page 3-77).

It appears, therefore, that discharge of mine water by infiltration into groundwater beneath the tailings impoundment has been occurring for many years (groundwater hydrologically connected to Lake Creek). Such discharges are also proposed to occur after mine closure when underground mine waters will be piped to the decant ponds as the plan for treatment and disposal of mine waters over the long-term. It also appears that the amount of mine water infiltrating into groundwater may potentially increase after mine closure if the discharge to the decant ponds from the underground mine were to be anything close to the maximum pipeline design flow of 6.9 cfs (3,100 gpm). It is our understanding that existing and proposed discharges of mine water to groundwater hydrologically connected to Lake Creek have been occurring without authorization by an Montana Pollutant Discharge Elimination System (MPDES) permit, and such unpermitted discharges are expected to continue post-closure.

While we understand that natural attenuation mechanisms are stated to occur in the decant pond sediments and groundwater that remove and/or immobilize metals, and it does not appear that elevated levels of metals are found in Lake Creek, we recommend that the MDEQ continue to monitor groundwater and Lake Creek and carefully evaluate whether pollutants may move into Lake Creek via hydrologically groundwater in the future, and if so, reconsider the need for a MPDES Permit.

Response E-A-EPA 11: The Agencies have found no evidence of a direct connection of tailings seepage to surface water.

All of the potassium data from the Asarco/Sterling/Genesis water monitoring reports since 1985 showed no trends in potassium concentrations in Lake Creek above and below the tailings impoundment. Site LC-1 is upstream of the tailings impoundment, LC-2 is at the downstream end (and therefore definitely downstream of the paleochannel of Camp Creek, which is suspected to carry water from the impoundment to Lake Creek), and LC-4 is some distance downstream of the impoundment, past the point where a tributary enters Lake Creek. The only trend that may exist is a higher average potassium concentration at LC-4. Since LC-2 is not trending higher than LC-1, any elevated potassium at LC-4 would have to come from a source other than the mine.

Four reports were generated by consulting companies on the subject of seeps below the Troy tailings between 1990 and 2000.

The first was the Final Report on the ASARCO, Troy Unit Groundwater/Seepage Study submitted by EBASCO in September 1990. In this report, water quality data from the tailings water, the toe ponds, seeps between the tailings impoundment and Lake Creek, another seep on the opposite bank of Lake Creek and two miles downstream, and Lake Creek water sampled at points above and below the tailings impoundment were compared using "Euclidean distances" cluster analysis and analysis of variance.

This study concluded that the water in the seeps below the tailings impoundment did not originate in the tailings. Although the seeps near the tailings impoundment (S1 and S3) contained levels of magnesium, chloride, and sulfate similar to those in the tailings

impoundment water, there were no other similarities. On the other hand, the specific conductance, nitrate/nitrite, ammonia, Kjeldahl nitrogen, copper, and potassium levels in S1 and S3 were very similar to those at the downstream seep (S5), and very different from those in tailings impoundment water.

Since potassium has been regarded as a conservative indicator of tailings water, and since all of the seeps contain much lower potassium levels than those in the tailings, this casts doubt on the hypothesis that the tailings water is having an impact on the creek water via the seeps.

The second report was a re-evaluation, requested by the Department of State Lands, of the data in the first report. Draft Report: Supplemental Analysis of Water Quality Data for Springs and Other Surface Waters in the Vicinity of the Tailing Impoundment, ASARCO Troy Unit was submitted by Parametrix in April 1991. In this study, different statistical techniques were used, including five different cluster analysis methods and multiparametric analysis of variance. The findings in this report confirmed the conclusions of the first report. Again, seeps S1 and S3 were found to be different from tailings water but somewhat similar to the downstream seep S5.

A third study was performed jointly by Summit Envirosolutions, Inc., on behalf of the Cabinet Resource Group and McCulley, Frick, and Gilman, Inc. (MFG) on behalf of ASARCO. The report, Interim Report of Findings, Hydrologic and Hydrogeologic Assessment, ASARCO Troy Mine, Troy, Montana, was completed in June 1996. This study was intended mainly to develop a water monitoring plan for the mine. This study concluded, based on the groundwater and surface water quality data, that no acutely toxic levels of dissolved metals could be found to be mobilized into Lake Creek by groundwater under the tailings impoundment. (Copper above the chronic aquatic life limit was found in Lake Creek, but the levels upstream and downstream of the tailings impoundment were the same, i.e., the copper came from a source other than the tailings.)

The fourth study was performed by Summit Envirosolutions for the Cabinet Resource Group and was reported in Site Instrumentation Status Report, Troy Tailings Impoundment, Lincoln County, Montana, Summit Project No. 0762-002 on December 3, 1999. This report recommended regular sampling of certain monitoring wells but drew no new conclusions about any hydrological connection between the tailings and Lake Creek.

Comment E-A-EPA 12: The discussion of exceedances of copper water quality standards in upper Stanley Creek indicates that the source(s) of these exceedances may be due to several factors, including sediment generated from surface water erosion of naturally copper-bearing soil, groundwater seeping from the mine void, erosion of copper-bearing soil from the portal patios, or groundwater containing naturally-elevated copper concentrations from mineralization in the area (page 3-85). The DEIS states that the occasional low-level naturally-occurring copper exceedances in upper Stanley Creek would be expected to continue through post-closure for all alternatives. There have historically been numerous detections of copper in Fairway Creek despite the Fairway site being upgradient of the mine. The DEIS indicates that the most likely

reason for these detections is that copper occurs naturally in the region and is present in soils and sediment.

The MDEQ's Clean Water Act 303(d) listing website (http://cwaic.mt.gov/query.aspx) lists Stanley Creek as water quality impaired (from headwaters to confluence with Fairway Creek, 4 miles, MT76D002_010) with only partial support for aquatic life and cold water fishery uses with probable causes listed as unknown, copper, nutrients, and biological indicators, and probable sources listed as mine tailings and streambank modifications/destabilization. If natural sources of copper in the Stanley Creek drainage are believed to be causing water quality standards exceedances rather than mine tailings, it would be appropriate to revise the information on the MDEQ 303(d) listing website for Stanley Creek accordingly.

Similarly the disclosure of Lake Creek water quality in Table 3-9 (page 3-53) suggests potential for only low level exceedances of copper water quality criteria. This table does not include identification of cadmium, lead or mercury levels, which are among the listed pollutants causing water quality impairment for Lake Creek on MDEQ's Clean Water Act 303(d) website. Lake Creek is listed as water quality impaired (Bull Lake outlet to mouth, 17.6 miles, MT76D002_070) with only partial support for aquatic life and cold water fishery uses, and no support for drinking water use, due to cadmium copper, lead, mercury and zinc, nitrate/nitrite, and sedimentation from mine tailings, natural sources, and forest roads.

It is also worthy of note that the DEIS states that copper and antimony are the constituents of concern (page 3-50) because they have exceeded water quality standards for surface water in the mine water (i.e., copper concentrations averaged 0.04 1 mg/L and antimony concentrations have averaged 0.0 10 mg/L during mine operations; and during an interim shutdown copper concentrations were somewhat higher, averaging 0.059 mg/L, and antimony concentrations averaged 0.011 mg/L (Table 3-7, page 3-5 1). However, copper, cadmium, lead, mercury, and zinc are listed by MDEQ as the probable causes of Lake Creek water quality impairment, but the MDEQ website does not identify antimony as a probable cause of impairment. Table 3-7 in the DEIS does not identify cadmium, lead and mercury levels in mine waters.

The DEIS discussion of metals levels in Stanley and Lake Creeks appear, therefore, to be disconnected from the MDEQ's water quality impairment listings. It will be important that further evaluation of water quality impairments in Lake Creek and Stanley Creek and their magnitude and causes take place early in the development of the TMDL's for Stanley and Lake Creeks. It will also be important the Troy Mine long-term reclamation plan be consistent with the development of TMDLs to improve water quality and restore full support for designated uses in these waterbodies.

> *<u>Response E-A-EPA 12:</u> This matter will be discussed with the TMDL program, but is outside the scope of this EIS. Table 3-7 has been expanded to include cadmium, lead and mercury.*

<u>Comment E-A-EPA 13:</u> As noted earlier, the Agency-Mitigated Alternative proposes constructing and burying a new pipeline that would transport water from the underground mine (Service and Conveyor Adits) to the decant ponds at the tailings impoundment instead of using the existing

tailings pipelines (page 3-80). The DEIS indicates that the new pipeline would include a leak detection system and be double-lined at creek crossings to minimize the potential of discharge directly to streams (page 3-80). It is important that attention directed at reducing risk of pipeline leaks and spills, since we understand that there have been past tailings pipeline spills at the Troy Mine that have resulted in elevated metals levels in surface waters.

Appendix G provides information on the conceptual design of the proposed new pipeline. It is stated that the pipeline would follow the existing tailings/slurry pipes, approximate the land gradient, and have the hydraulic capacity to handle all of the estimated peak discharge of 6.9 cfs under gravity flow (Appendix G, page 2). The volume of flow over time after closure as provided in Appendix C appears to be a rough estimate. What are the provisions for collecting additional information for input into the final engineering design for the pipeline? For example, as the groundwater flow fluctuates seasonally, a design flow based upon averages is not robust and additional data will be needed before final design. The analysis of discharge is based upon existing operating conditions rather than closure conditions, and appears to be based on a simplification of the groundwater fracture flow conditions at the mine site. We recommend that the pipeline be designed for the highest forecasted flow over the timeframe that it will be used, not the "extreme event of over a ten-year recurrence interval" as stated in Appendix C (page 4). Also, if the water pressure may fluctuate, those fluctuations also need to be taken into account. Pipeline design considerations for freeze/thaw and for stability with steep slopes and transitions from steep to gentle slopes are not well described.

We recommend burying the pipeline at a depth below the freeze level across the entire width of the stream, meander zone, and active floodplain, such that if there is any stream movement the pipe is not exposed to erosive action of bedload and debris in moving water. In addition, we recommend consideration of using a secondary sleeve similar to how water supply pipes are often put in at stream crossings, so in case there is a leak under the stream the pipe can be replaced by removing old pipe and inserting new pipe into the sleeve without disturbing the stream again - the sleeve can be placed using a boring system or a trench. Also, if the pipe is to be hung over the stream or gully, it should be high enough to clear any substantial flood (FEMA a 100 year flood is reasonably foreseeable). Additional valving should also be considered at major slope transitions where they may be a higher likelihood of pipeline failure (e.g., transitions from 12% slope).

Appendix G suggests that smooth HDPE pipe may be used, in which case pipe corrosion is likely not a concern (i.e., sometimes installation of a casing pipe around a metal pipeline at crossings of rivers may actually increase the probability of a spill at or near a river or stream, since air and moisture accumulation between the casing and pipe has potential to aggravate pipe corrosion, but this should not be a concern with HDPE pipe material). Other measures that the lead agencies and company may want to consider to reduce risk of a pipeline spills or leaks include:

- Locate pipeline as much as possible away from streams and wetlands, and minimize pipeline crossings of streams and wetlands
- Pipeline valving shut-off arrangements that limit the magnitude/volume of a spill at any one time (periodic block and check valves). Mainline block valves and check valves located

upstream and downstream of river/stream crossings to allow stoppage of flow should leaks or pipeline damage occur at river and stream crossings, and additional valving is also recommended at major slope transitions where they may be a higher likelihood of pipeline failure.

[We note that Appendix G states that the static capacity of the pipeline is about 250,000 cubic feet (-4.87 million gallons), which is the maximum amount of mine water that could drain from the pipe should a break occur at its lowest point (Appendix G, page 2). It is also stated that this amount could be reduced with the addition of automatically controlled valves along the length of the pipeline, but this design feature was not incorporated into the design. We recommend that additional automatic valving be incorporated into the design to reduce potential spill volumes.]

- Increase pipeline thickness at stream crossings.
- Use cathodic protection along the entire length of pipeline or coat pipeline with a minimum of 8 mils of fusion bonded epoxy coating (FBE), 6 mils of copolymer adhesive, and 40-75 mils of high density polyurethane (HDPE) to protect the pipe from corrosion (if metal pipe were used).
- Use state-of-the art "smart pig" system to detect deformities on the inside of the pipe, and "smart pig" internal pipeline inspections within three years of the initial hydrostatic pipeline testing, and schedule subsequent periodic inspections (e.g. every two years) to reduce the risk of undetected deformities causing spills.
- Regular hydrostatic testing to evaluate pipeline integrity during operations.
- Have a Contingency Plan and Emergency Response plan for the pipeline, containing information on spill response procedures to be followed and actions to be taken in the event of a spill. The Plan also should identify the specific procedures to mitigate potential adverse environmental impacts (i.e., on surface water, ground water, soils, fisheries, wildlife, recreation, human health and safety) and discuss the location of equipment and expertise available to each length of the route to respond to environmental cleanup. Special conditions such as weather impaired and cold weather response procedures should be included.

<u>Response E-A-EPA 13:</u> Please see response to Comment E1.

Each 8-inch diameter tailings line carries 1,250 gpm (2.8 cfs), so the two lines together would be able to carry a maximum of 5.6 cfs. The reclaim pipeline would also be available to handle additional flow beyond the predicted maximum flow. The modeling of the predicted maximum flow is limited by 1) the uncertainty in the time frame over which the pipelines would be used; and 2) the available existing data with which to model the interactions of surface water with the groundwater system empirically. Ten years of data exist; additional years of data would be needed to model this complex system for a longer time period.

Freezing problems have not occurred with the existing tailings pipelines when operated as tailings delivery lines. If there is an interruption in water delivery, the line would automatically drain, which would reduce the potential for freezing damage. However, an above ground line and above ground automatic controls would have an increased risk of freezing compared to an underground system.

Comment E-A-EPA 14: The DEIS states that an average of 2.3 cfs of water is displaced from the mine workings to areas (e.g., the decant ponds) more distant from the mine (page 3-67). How does the reference to 2.3 cfs being displaced from the mine workings to the decant ponds relate to the range of flows estimated between 300 gpm (0.67 cfs) to 3100 gpm (6.9 cfs) being directed from the underground mine workings to the decant ponds (page 3-76)?

> *Response E-A-EPA 14: Discharge from the mine workings to the decant ponds is estimated to range seasonally from 0.67 cfs up to 6.9 cfs, with an average discharge rate of 2.3 cfs.*

Comment E-A-EPA 15: The reclaim water line is proposed for use after mine closure as an emergency line for transport of mine adit discharge in the event of a leak in the new buried pipeline (Appendix G, page 2). However, it stated that the reclaim water line will only handle approximately half of the estimated maximum 6.9 cfs under gravity flow conditions (Appendix G, page 3). It is also stated that the reclaim water line could handle the full estimated flow if it is retrofitted with appropriate vacuum relief and pressure relief valves. We recommend that the reclaim water line be appropriately retrofitted to allow it to handle the highest potential flow over the timeframe that it will be used.

> *Response E-A-EPA 15: Retrofitting the reclaim water line will be included in the reclamation bond. Troy Mine, Inc. will have to install some secondary measures to route water while the main pipeline is being repaired.*

Comment E-A-EPA 16: The DEIS states that no activities are proposed under any alternative that would discharge fill materials into water bodies or that would impact wetlands (page 3-9 1), however, since there are statements that the proposed pipeline would be double-lined at stream crossings (page 3-80), it leads us to believe that there will be pipeline stream crossings, and there may be potential for stream impacts during pipeline construction, and/or impacts to wetlands which are often associated with streams. Figure 1 in Appendix G includes a map with a proposed pipeline routing, but streams and wetlands are not clearly depicted on this map. We did not see clear disclosure of the number of streams and wetlands acreage that may be crossed. The EPA recommends that the FEIS clearly disclose the number of streams the pipeline may cross and if it would cross any wetlands, and more fully evaluate and discuss potential stream and wetland impacts associated with pipeline construction.

There may also be potential for disturbing wet areas during removal of stockpiled soils below the toe ponds for use in tailings impoundment reclamation (page 3-2 14). Areas of disturbance from this activity should be assessed for the presence of, and potential impacts to, wetlands.

We also encourage the lead agencies and Troy Mine, Inc. to contact Mr. Todd Tillinger of the U.S. Army Corps of Engineers, Montana Office in Helena at 406-441-1375 or Ms. Christina Schroeder of the Corps of Engineers, Missoula Office at 406-541-4845 extension 328, to determine applicability of Clean Water Act Section 404 permit requirements to proposed pipeline and other mine reclamation construction activities in or near streams or wetlands. We also note that other federal, state and local regulatory requirements may be needed for project implementation should construction activities occur in or near streams and wetlands (e.g.,

Montana Section 318 turbidity exceedance authorizations, Clean Water Act Section 401 certification, Montana 310 permit requirements, Montana Stream Protection Act 124 permits, etc.).

The Council on Environmental Quality (CEQ) regulations for implementing NEPA state that federal agencies shall to the fullest extent possible integrate the requirements of NEPA with other planning and environmental review procedures required by law or by agency practice so that all such procedures run concurrently rather than consecutively (40 CFR 1500.2(c)). To ease the administrative burden the Federal and State agencies in Montana have developed a single permit application for the various potential permits or authorizations that may be needed (http://dnrc. mt. gov/permits/default.asp http://dnrc.mt.gov/perinits/streampermitting/joint application.asp). Also a Montana Stream Permitting Guide is available to explain the various permitting authorities http://dnrc.mt.gov/permits/streampermitting/guide.asp.

Response E-A-EPA 16: As noted in previous responses, the Agencies have revised the Agency-Mitigated Alternative such that it no longer requires burial of the replacement pipeline where it crosses stream channels or elsewhere that the existing tailings pipelines are not buried. A new figure has been added to Section 3.7 that shows the existing tailings pipeline in relation to the stream crossings and Riparian Habitat Conservation Areas. In addition, Section 3.9.4.1 Roads and Other Facilities of the Final EIS has been expanded to provide more detaiil on the existing tailings lines and operational issues. See also response to Comment E1.

No current wetland areas, other than the adjacent floodplain and the toe ponds, were observed during a field review conducted in August 2011 by the Agencies. During reclamation, stockpiled soils may be removed down to or near the original floodplain elevation. Appropriate BMPs would be implemented to control erosion during removal of the stockpiled soils and Lake Creek water quality or associated wetlands would not be impacted.

All necessary permits will be secured before reclamation activities begin.

Comment E-A-EPA 17: In the Agency-Mitigated Alternative, all drainage channels would be built from imported rock rather than from mine development rock to further minimize the potential for near-neutral metal mobility (page 3-40). EPA agrees with and supports the use of rock with low metal leaching or mobility potential for drainage channel construction. The source of this imported rock, however, is not identified. What is the source of the imported rock, and are there any adverse environmental impacts associated with collecting and transporting the imported rock to drainage channel construction sites?

Response E-A-EPA 17: Please see response to Comment E-6.

Comment E-A-EPA 18: Is it expected that the ore zones to be mined in the future will have a geochemistry similar to the ore zones mined in the past, and thus, confirm that metals leaching predictions for the future can be reliably predicted on prior experience and observations? We recommend that the geochemical testing and evaluation methods that will be used to confirm

that the new ore zones will be analogous to the previously mined areas be identified and described in the FEIS.

<u>Response E-A-EPA 18:</u> In 2009 Genesis, Inc. (now Troy Mine, Inc.) applied for a Permit Revision to allow mining in the "C" Beds, which were a new ore zone. Drill core and coarse reject samples were evaluated by the following tests:

- *Archived drill core was composited by drill hole into four samples (one per drill hole), which were analyzed for:*
  - *Multi-element ICP,*
  - *Acid-base accounting, and*
  - *Synthetic Precipitation Leaching Procedure (EPA Method 1312).*
- *A further composite was made up from 1.5 kg splits of each of the original drill-hole composites. This sample was subjected to a twenty-week humidity-cell test (which was extended to thirty-two weeks because of an apparent anomaly at twenty weeks). Humidity cell eluate fluid was analyzed for eighteen metals plus fluoride, phosphorus, and sulfate.*
- *A representative composite was made from cores taken from the waste rock zone and this composite was analyzed for:*
  - *Multi-element ICP,*
  - *Acid-base accounting, and*
  - *Synthetic Precipitation Leaching Procedure (EPA Method 1312).*

These tests showed that the ore zone would not produce acid during the course of weathering and that its neutral leaching product was similar to that from the previously mined ore zones. If mining is authorized in other ore zones, a similar testing protocol will be used for analysis prior to the start of mining.

<u>Comment E-A-EPA 19:</u> Reduction in groundwater flows to Ross and Stanley Creeks, especially Stanley Creek, are identified as a water quantity impact caused by pumping underground mine water to the decant ponds (page 3-80). However, the extent of surface water flow reduction is not quantified or estimated, and potential impacts on aquatic life associated with this reduction in streamfiow in Stanley Creek are not identified. The DEIS states that changes in surface water flows and locations are expected to be minimal after mine closure because discharges are not expected to vary measurably at the surface water monitoring sites and because the potential for new, higher elevation springs to develop would be limited. Although it is acknowledged that surface water flows after mine closure would likely remain less than pre-mining flows in the vicinity of the workings (page 3-67).

We recommend that additional information be provided regarding estimated flow reductions in Stanley Creek, and likely impacts to aquatic life associated with such streamfiow reductions (e.g., estimates of pre-project baseline streamfiows or ranges of flow vs. post-closure streamfiows or ranges of flow; estimates of potential impacts to aquatic life associated with flow reduction). If such information is not available we recommend that the direction in 40 CFR 1502.22 be followed for incomplete or unavailable information.

<u>Response E-A-EPA 19:</u> The Agencies disagree that the guidance provided in 40 CFR 1502.22 is relevant to this issue. The statute addresses incomplete information regarding reasonably foreseeable impacts which may result from a future action, whereas the question of flow reduction is one of impacts which may have resulted from a historic action but which cannot be quantified because baseline flow data were not collected.

Groundwater that enters the mine void would previously have discharged to adjacent watersheds in the form of springs, seeps, and stream baseflow. The precise locations where such discharges may have occurred, and associated flow rates, cannot now be accurately determined. However, based upon the relationship between the mine void location and local topography, it may be assumed that approximately half of the intercepted groundwater formerly flowed south toward tributaries to Ross Creek, while much of the remainder flowed north toward tributaries to Stanley Creek. A small fraction of the intercepted groundwater may have flowed eastward toward Weasel Gulch and Bull Lake.

***Section 3.9.5.1** of the Draft EIS and Table 3-12 present estimated discharge rates from the mine during the period 1999 to 2008. The minimum discharge rate of 0.67 cfs can be assumed to approximate the minimum flux of groundwater which would have discharged to adjacent watersheds during baseflow conditions. This would equate to approximately 150 gallons per minute of additional baseflow in both the Ross Creek and Stanley Creek watersheds; the percent reduction in baseflow cannot be reliably estimated because this would be dependent upon the stream reach within which the groundwater formerly discharged and that information does not exist.*

The Draft EIS also estimates the average rate of discharge from the mine to be 2.3 cfs. This value may represent the average reduction in groundwater discharge to watersheds adjacent to the mine. None of the alternatives, the No Action Alternative, the Proposed Action, or the Agency-Mitigated Alternative, would result in changes to mine void hydrology that could substantially alter the way in which the mine void currently intercepts groundwater. Consequently, mine closure is not predicted to substantially alter existing stream flow conditions in Stanley Creek or Ross Creek.

<u>Comment E-A-EPA 20:</u> EPA also suggests that regular multi-spectral aerial photography be used to monitor for presence of new springs, loss of springs, and changes in habitat and vegetative cover in and around aquatic systems. Preparation of a baseline conditions map is recommended to assist in future comparisons. The company should also clarify how trends will be determined and reported.

<u>Response E-A-EPA 20:</u> The Agencies question the efficacy of multi-spectral aerial photography for identifying changes in the flow of springs surrounding the mine void. The Mount Vernon area is heavily forested, densely vegetated, and has extremely rugged terrain. The area typically receives abundant precipitation. Slight changes in spring flow and/or location would not likely be easily detected with aerial photography, and would in any case require follow-up monitoring on the ground.

*The Agency-Mitigated Alternative (**Section 2.4.3**) notes that additional monitoring of springs and seeps would be required.*

<u>Comment E-A-EPA 21:</u> In regard to the allegations that 55 gallon drums were buried in the impoundment years ago by ASARCO (page 2-16), was it ever determined where those drums were buried and what was contained in them? Were the drums ever found and removed?

<u>Response E-A EPA 21:</u> Please see response to Comment E-13.

<u>Comment E-A-LCD 1:</u> Requiring the existing tailings pipelines to be removed and replaced with a buried line does not make environmental, nor economic sense. The current pipelines have carried millions of tons of slurry and have shown relatively zero wear to the liner in the pipe as was discovered in 2004 prior to resuming mining operations after 11 years of dormancy. These pipelines have many years of safe use left in them and should be used until it is determined otherwise. When it is determined that they are in need of replacement, they should be left above ground and along the existing access road to provide for easy and efficient monitoring.

The disturbance to the existing road when digging deep ditches and burying your proposed new tailing line will cause unnecessary soil sediment to enter the creek than there would be if left alone until they needed replaced and substituted with new lines above ground. The fact that the Troy mine waters quickly reached drinking quality standards without any treatment when operations were idle removes any validity to concerns about vandalism as it would be clean water that would not pose a threat to surface or ground water. It should also be pointed out that there has never been an incident of vandalism during the pipelines thirty year existence. We would also ask that the agencies consider the unintended consequences of having a buried pipeline that cannot be easily monitored. What should happen if a section did develop a leak? How long would it take for it to be found and how large of a subsidence or sluff would it take to be able to detect a leak? How much disturbance would we be creating in looking for it? The balance of harm needs to be recalculated and we firmly believe that burying the lines is an unnecessary action that will create more disturbance to the watershed from both a short and long term perspective.

<u>Response E-A-LCD 1:</u> Please see response to Comment E1.

<u>Comment E-A-LCD 2:</u> With two of us in this delegation having carried the TMDL bill last session the proposed action to remove the asphalt from the existing seven miles of road really makes us scratch our heads. With the single biggest mitigation (aside from closing the road) for sediments from road surfaces being to cover them with asphalt, this part of the alternative begs a couple questions.

<u>Response E-A-LCD 2:</u> The Forest Service has no easement on the first 2.33 miles of NFSR 4626 starting at Highway 56. The road is privately owned. Following mine closure, it would be up to the owners to determine if this segment of the road is open to the public and/or if the road is maintained as an asphalt road.

Following mine closure, NFSR under USFS jurisdiction would be greatly reduced. There is no rationale to have an asphalt road, which is expensive to maintain, on a road that has low traffic volumes. By leaving the asphalt surface on bridge approaches for a distance of 100 feet and on live stream crossings we can achieve water quality (BMP) standards under the greatly reduced traffic volume.

See also response to Comment E-CRG 1.

F. Recreation:

Comment F1: Commenters supported keeping the roads open for recreational access under the Proposed Action.

Response F1: None of the three alternatives would result in a change to public access as long as Troy Mine, Inc. does not gate NFSR 4626 at the junction with Hwy 56 on completion of mining activities. The USFS does not have an easement on the first 2.33 miles of NFSR 4626 which takes off from Hwy 56; that 2.33 miles of road is on private land owned by the Troy Mine, Inc. In all three alternatives the USFS will keep NFSR 4626 gated at its current location at the mill site.

Comment F2: Some commenters noted that any gate on the main road should be located just beyond the fork to Spar Lake in order to keep access open to Spar Lake while others supported the Agency-Mitigated Alternative that removes roads and minimizes vehicular access which would require hunters to access areas by foot.

Response F2: Please see the response to Comment F1.

Comment F-A-LCD 1: Is the USFS planning on closing this road from public use after the mine is decommissioned? Have the recreational values of the road remaining open to access very popular places like Spar Lake even been considered? Do we want the public driving on a dirt road rather than one covered with asphalt?

If the plan is to prohibit motorized use of this road after decommissioning it should be articulated by the USFS to the public now, rather than later.

Response F-A-LCD 1: There is no plan at this time by USFS to close the road up to the mine following the mine closure. The USFS believes there is a high recreational value to access Spar Lake. The public access to Spar Lake is currently asphalt and gravel. The USFS or any other public agency currently have no public easement on the first 2.33 miles of NFSR 4626 starting at Highway 56. The road is privately owned.

G. Socio economics

Comment G1: Many commenters noted that the Troy Mine operation supports jobs and the local economy with a low environmental impact.

Response G1: *Thank you for your comment, please refer to* ***Section 3.12*** *of the Final EIS.*

Comment G2: Some commenters felt that the cost of the Agency-Mitigated Alternative versus the Proposed Action is an unreasonable economic burden and goes beyond what is required by law.

Response G2: *Please refer to* ***Section 1.6*** *of the Final EIS. The Agencies must select an alternative that meets legal requirements.*

Comment G3: Many letters provided some socioeconomic background information on the existing condition (e.g. current recession; context of mineral production; number of jobs supported by the mine; employment trends) of Lincoln County and Northwestern Montana.

Response G3: *Thank you for your comment, please refer to* ***Section 3.12*** *of the Final EIS.*

H. Reclamation Materials:

Comment H1: Many commenters noted that the use of the soil stockpiled west of the toe ponds would disturb the existing vegetation and habitat for western toad, would result in sedimentation and erosion impacts to Lake Creek, and would disturb the fine-grained material which will create a dust impact that would not occur with use of the coarser borrow material. One commenter noted the need to reclaim the soil stockpiled below the impoundment.

Response H1:

Disturbance to Existing Vegetation by the Toe Ponds

The Agencies agree that the No Action and Agency Mitigated alternatives would disturb vegetation currently growing on the revegetated soil stockpiles between the toe ponds and Lake Creek. This includes areas used by western toads. Please see response to Comment H-TMI 1 for discussion of effects to western toads. These alternatives would require construction of additional temporary roads for hauling the soil up to the impoundment surface. These roads would disturb other reclaimed surfaces including part of the embankment face. See photo below.

Photo of a portion of the revegetated soil stockpile between Lake Creek and the toe ponds. The photo was taken from the top of the tailings embankment. Lake Creek is in the flood plain in the forested area in the background. The toe ponds are in the foreground at the base of the embankment.

The Agencies want to use the stockpiled soil from the area west of the impoundment because the soil is a substantially better growing medium. Please see response to Comment H-TMI-1 for a more detailed comparison of the stockpiled soil versus the borrow site material.

<u>Erosion and Sediment Impacts to Lake Creek and the Toe Ponds</u>

Sediment impacts to the toe ponds and Lake Creek are expected to be minimal. As stated in ***Section 3.16.2.4****, the Agency-Mitigated Alternative would avoid disturbing the revegetated plant community on the lower outer edges of the stockpiles and maintain a berm around the disturbance area in order to contain sediment. Along Lake Creek, the floodplain would remain undisturbed and provide a natural sediment trap for any sediment that bypasses the erosion control barriers. An undisturbed strip of vegetation would be left around the toe ponds. Erosion and sediment would be controlled by using standard best management practices (BMPs) commonly used in the construction and logging industries. BMPs such as erosion control fabric, wattles, and silt fences would be used to prevent sediment delivery to Lake Creek and the toe ponds.*

<u>Dust Impacts</u>

The Agencies agree that dust impacts from use of the soil stockpiles would potentially be greater than those from use of the borrow sites because of the greater proportion of silt and fine sand in the soil stockpiles. Dust would be required to be controlled on the haul roads using standard construction BMPs such as watering or dust abatement chemicals. Dust impacts would primarily be limited to the season during which the soil haul and spreading work occurs. The disturbed areas would be seeded and organic amendments added following the soil hauling. If necessary, the tailings impoundment area could be irrigated to

control dust and ensure revegetation success from the first seeding. Operationally the Troy Mine has been controlling dust impacts from the tailings impoundments during windy periods of the year using irrigation.

Need to Reclaim the Soil Stockpiled Below the Impoundment

The existing soil stockpile area is currently revegetated with predominantly introduced grasses that were seeded after placement of the material. There are some young trees that have naturally seeded in. This established vegetation would be lost under the Agency-Mitigated Alternative, however after the soil is removed, the stockpile area would be planted with native forbs, shrubs and trees resulting in a more diverse vegetation community than currently exists. Coarse woody debris, if added for western toad habitat, would provide additional organic material that is now lacking.

Comment H2: The EIS should identify borrow sites. Borrow materials are just as effective in providing a growth medium as the soil stockpiles proposed in the Agency-Mitigated Alternative. Although borrow materials may revegetate more slowly, speed is not a regulatory requirement.

Response H2: The borrow site locations are identified in the Final EIS on Figure 2-1. Please see response to Comment H-TMI 1 for discussion of borrow site material suitability.

Comment H3: The EIS should document why growth media amendments are needed and why organic amendments are required over chemical fertilizers. Additional discussion should be added as to the justification, benefits, rationale, or authority for requiring additional woody debris or mulch. Can a compromise be made with wood chips, hay, and compost? The EIS should describe what mycorrhizal fungi are.

Response H3:

Additional discussion as to the justification, benefits, rationale or authority for requiring woody debris or organic amendment:

*The Agency-Mitigated Alternative (described in **Section 3.13.5.3**) requires the use of organic amendments. These amendments provide compliance with agency guidelines and regulatory requirements that are listed in **Section 3.13.2**. Additional federal guidance is found in FSM 2800-90-1 Chapter 2840 Reclamation. Reclamation is defined as "those actions performed during or after mineral activities to shape, stabilize, revegetate, or otherwise treat the affected lands in order to achieve a safe and ecologically stable condition and land use that is consistent with long-term forest land and resource management plans and local environmental conditions." The land management objective on NFSL within the permit area (including the mine and mill sites) includes timber production, watershed protection, wildlife habitat enhancement, and recreation.*

Generally, lands disturbed by mining must be reclaimed to comparable stability and utility as that of adjacent areas (Section 82-4-336(9)(a), MCA), and can meet the desired land use after mining. Stability is interpreted to include geochemical conditions, as well as physical

stability. Geochemical stability includes minimizing the potential for metals in mine wastes to get into water or revegetated plant communities. The desired future land use at the tailings impoundment on private lands is timber production and wildlife habitat. The MMRA requires the Agencies to evaluate the reclamation plan and to determine whether the plan achieves the land use goals.

Use of organic amendments is regularly specified in modern reclamation and revegetation plans for mining (see the Rock Creek and Montanore EISs), highway construction, abandoned mine lands, road decommissioning, and other restoration projects.

In order to restore forest lands so that they are self-sustaining and provide for the desired land use objectives, reclamation must restore soil function so that appropriate native vegetation can be sustained in a healthy condition. As stated in ***Section 3.13.5.1****, organic matter amendments are expected to partially restore soil function by increasing water infiltration and water-holding capacity, improving soil biologic activity, and decreasing soil compaction.*

A native forest soil has considerable subsurface organic material in the form of roots and decaying logs. Incorporation of wood-based organic matter amendment into the soil would partially substitute for this missing component and support improved soil function over both the short and long term.

The required surface organic amendment would reduce erosion and dust, help retain surface soil moisture, prevent crusting of the soil surface, and provide material to support biological processes that normally occur in the humus layer in a forest soil. The organic amendment would allow young plants to get established and improve survival rates.

The coarse woody debris specified for the mine and mill site areas on federal land would provide long term nutrients and duff, and also provide shade and moisture for plants growing adjacent to the logs. The logs also provide habitat for insects, amphibians, reptiles, birds and small mammals. In a forested ecosystem down logs provide benefits for many decades. Coarse woody debris would be recommended on the reclaimed soil stockpiles on private land between Lake Creek and the toe ponds.

The reason for requiring the placement of organic material at the outset of the reclamation is that organic material would otherwise not naturally accrue to levels needed for adequate soil function for over 100 years.

<u>Document why growth media amendments are needed and why organic amendments are required over chemical fertilizers:</u>

Chemical fertilizers can be useful on a selective basis in combination with organic amendments. Chemical fertilizers used alone as proposed in the No Action and Proposed Action only provide a short term nutrient benefit of 1-2 years as compared to many years of slow nutrient release provided by organic amendments. Chemical fertilizers also have the disadvantage of increasing weed growth disproportionately as compared to native plants.

Chemical fertilizers do not provide the other benefits of organic amendments, including improving moisture holding capacity, providing material to support long term soil biological activity, decreasing compaction, preventing crusting of the soil surface, or providing wildlife habitat.

Can a compromise by made with wood chips, hay or compost?

These materials have different constituents and therefore different purposes in a reclamation context. The Agencies think that wood-based materials are probably the most appropriate and readily available organic amendment. Use of a wood-based organic material would increase the establishment of fungus-based, soil microbe communities which would favor forested plant community establishment. Straw, hay or manure based compost tends to promote bacteria-based soil processes that better support grassland communities.

Define mychorrhizal fungi:

A definition of mycorrhizal fungi has been added to the glossary in Chapter 7: "Mycorrhizae are important structures that develop when certain fungi and plant roots form a mutually beneficial relationship". Mycorrhizae serve as highly efficient extensions of plant root systems, especially for woody species. These associations are important to consider in plant establishment and productivity because most plants depend on mycorrhizae for adequate growth and survival (Mallock et al. 1980 In USDA Forest Service and DEQ 2001; Trappe 1981, In USDA Forest Service and DEQ 2001). This is especially true in nutrient deficient soils. Mycorrhizae are particularly important to plant phosphorus nutrition and water uptake (Christiansen and Allen 1980 In USDA Forest Service and DEQ 2001). Thus, the association of mycorrhizae with plants in the project area is especially critical because plant available phosphorus is expected to be low.

Mycorrhizae are eliminated in soil stored for prolonged periods because mycorrhizae can only exist close to the soil surface. Both the stockpiled lacustrine soils and the borrow site glacial outwash materials are lacking in mycorrhizae and would need to be reinoculated. In reclaimed areas, Agency-approved wood-based amendments would be incorporated into the upper 6-12 inches of re-spread soil to promote the rebuilding of mycorrhizae in the soil. Inoculated tree and shrub planting stock with the appropriate mycorrhizal fungi would also be used, or mycorrhizal fungi would be incorporated into the soil as pellets during seeding.

Comment H4: Commenters asked for further clarification of the proposed nitrogen loading as they felt it was unnecessary because trees would grow without it.

Response H4: The organic amendments are needed to improve soil quality in order to establish a stable and diverse vegetation community. Trees will grow better and be more disease resistant with improved soil quality. The objective is to reestablish soil quality that will support most or all the species that would normally grow on this site, not just the species that can survive nutrient-poor, moisture-limited conditions.

Comment H5: A commenter recommended an application rate of 10-15 tons per acre because a range would be easier to achieve (and therefore more practical) and that 25 tons per acre is very hard to achieve unless the pieces are very large which may mean that the desired soil amendment does not actually occur. The EIS should elaborate on how this rate was decided.

> *Response H5: The Agency-Mitigated Alternative has been modified in* ***Section 2.4.3.2*** *to require a range of coarse woody material on the mine and mill site from 25-33 tons/acre with a minimum piece size of 6" diameter. The recommended coarse woody debris to be left after timber harvest in the western hemlock habitat type at the mill site is 16 -33 tons acre (Graham et al 1994). This range is considered what is practical given reforestation and fuels considerations. Graham's recommendations are required by Regional guidelines (FSM 2500-99-1) in order to maintain forest productivity over a 100 year period in a typical regeneration harvest unit. Since the mill site will have virtually no organic material the upper end of this range (25-33 tons/acre) is more appropriate. Larger wood is preferred because it will persist for a longer period* of *time. Approximately one log truck load per acre would be needed for 25 tons/acre. In addition 16-25 tons of coarse woody debris would be recommended on the reclaimed soil stockpiles to enhance western toad habitat.*

Comment H-TMI 1: TMI disagrees with the agencies recommended use of the topsoil located below the toe ponds because:

1. An adequate and proven source of topsoil / growth medium exists on the east side of the tailing facility;
2. The topsoil area below the toe ponds has been successfully reclaimed with over 30 years of re-vegetation that would be re-disturbed;
3. The control of sedimentation to Lake Creek during reclamation activities and topsoil excavation will be a challenge; and
4. The area around the toe ponds is providing breeding habitat for the western toad which has been listed as a species of a concern.

The agency alternative in the DEIS indicates that that soil salvaged in the tailing pond area be used for reclamation rather than borrow soil. TMI is concerned that use of the toe pond salvaged soil will increase long term risk of sediment impacts to Lake Creek, will impact documented western toad habitat and will result in the same reclamation success outcome as using the borrow soil (return of similar forest vegetation to that before the mine). The existing topsoil piles are fully re-vegetated with a thick growth of grass, alders, brush and coniferous trees. The potential impacts to neighbors from dust during soil replacement is higher with the fine grained soils than with the borrow soil. TMI requests the agencies to reconsider their decision to require use of the salvaged soil.

TMI provides Appendix B (Westech, 2011), a report on borrow soil availability and suitability that supports the use of borrow soil for reclamation at the TMI. The following are some of the specific areas in the DEIS that address soil use and amendment issues that should be revisited in preparation of the FEIS. According to the Westech Report (Appendix B), the tailings embankment face supports a young forest of planted, healthy ponderosa pine, white pine and lodge pole pine at a stocking rate suitable for proposed post-mining land uses. Natural

reinvasion of trees is occurring. The understory is primarily herbaceous, dominated by hard fescue. Cover of trees, herbaceous species, litter, lichens, moss and rock is adequate to provide a stable surface. The presence of existing forest on soils with high coarse fragments and the analysis in the DEIS – [(Section 3.16.2.9, Resource Impact Summary (page 3-149)] demonstrate that borrow area material will support the proposed post-mining land uses of forest and wildlife habitat consistent with the MMRA.

The requirements for use of organic fertilizer, organic matter addition to soil, mulch and placement of coarse woody debris on reclaimed sites is by the DEIS's own admission not necessary to achieve reclamation goals. TMI recognizes its responsibility to successfully reclaim the land disturbed by the mine, but doesn't agree that use of unnecessary amendments are required; if it takes a few years longer to achieve the vegetation density to meet bond release criteria that is TMI's option. At the 19th Annual Mine Design, Operation and Closure Conference, May 2011, Mr. Rich Prodgers, Bighorn Environmental, provided a presentation; "Effectiveness of Two Compost Products and One Mycorrhizal Inoculum in Promoting Nutrient Cycling in Cover Soils Originating as Deep Borrow" (see Appendix C). According to Mr. Prodgers' field work, analyses and presentation, he was not able to conclude from vascular plant performance or microbiological analysis that compost confers a benefit. Further he presented information that composts role in establishing nutrient cycling was far less than expected.

TMI understands that the constructed toe ponds provide breeding habitat for the western toad that would not be available without the toe ponds. The toe ponds and toad habitat at the tailing impoundment are on private land and will remain in place at closure. Evidence provided in an attached report on western toad occurrence provided with this letter from Patrick Farmer, 2011 (Appendix D) indicates that the salvage soil stockpile is used by toads during the breeding season and may be important toad habitat during other seasons. This is another reason to reevaluate the removal of the soil stockpiles when a reasonable alternative exists.

Response H-TMI-1:

An adequate and proven source of soil / growth medium exists on the east side of the tailings facility and response to conclusions reached in Westech report:

The soils in the impoundment area prior to mine development were deep lacustrine fine-grained soils covered with a top soil layer of 4-14 inches of ash influenced loess. These soils developed for thousands of years and were highly productive, supporting western cedar and western hemlock habitat types. The excellent soil productivity was the result of high moisture holding capacity and high organic inputs. These soils were salvaged and stockpiled for use during reclamation at mine closure. The intent is to produce a plant community similar to the one that existed before mining began.

Photo of the soils in the soil stockpile area by the toe ponds showing the fine texture and low rock content in the stockpiled materials.

In addition to the superior texture of the soil stockpile source, the other requirements of the Agency-Mitigated Alternative (ripping and adding organic amendments) would lead to better reclamation success. If replaced soils are ripped to limit compaction and organic matter is incorporated into the soils, soil crusting would be limited improving seedling establishment, and improved soil function and productivity of the reclaimed plant community would result.

Ripping would promote better infiltration, deeper root growth, more favorable soil structure, and would set the stage for better overall soil quality on the reclaimed surfaces. Using the stockpiled soil with organic matter additions would provide soil texture conditions that best represent conditions that existed prior to mine development in the impoundment area.

The glacial outwash borrow sites east of the impoundment footprint contain rocky materials that have been developed to construct dikes which were used to separate cells in the impoundment, operational roads, and placed as a growing medium over tailings in reclamation test plots. The Proposed Action would use glacial outwash material from these existing borrow sites east of the tailings impoundment.

Photo of a portion of the glacial outwash material in the borrow area proposed for use a growing medium in the Proposed Action.

The water-holding capacity of the borrow materials is low because of the high rock content (59% to 81% based on Westech soil samples). This glacial outwash material has little innate biological activity and the Proposed Action does not include organic matter amendments. DEQ has a recommended guideline of using a maximum soil coarse fragment content of 50 percent for soils salvage operations at proposed mines, and the glacial borrow source does not meet this standard.

Photo of some of the glacial outwash material that has been placed on top of the tailings in the impoundment. Note the large coarse fragment content.

These subsoil and geologic materials have low fertility, low organic matter content, and a low water holding capacity. Using these materials for reclamation would mimic the harsh conditions that existed when the glaciers first receded and soil had not developed over the outwash material.

Below is a photo of the soil that exists in the glacial outwash material borrow sites area to illustrate the volcanic ash-influenced top soil that gradually developed over this rocky glacial substrate over thousands of years.

Photo of the soil (ash-influenced loess) over the glacial outwash material in the borrow site east of the impoundment. Note the fine textured soil over the rocky subsoil horizons. (This soil surface layer would be saved to reclaim the borrow area and would not be used on the surface of the impoundment for reclamation.)

While the proposed glacial outwash material would support vegetation (primarily pine species and grasses) low fertility, lack of water holding capacity, issues of compaction, and lack of organic matter would compromise soil function, and limit productivity. The types of vegetation supported by such soil conditions are much more limited, and the health and vigor would be substantially reduced. This was substantiated by observation of the tailings

test plots (DEQ 2008a). Some test plot areas exhibited much slower plant growth for all species where the glacial outwash material contained excessive rock fragments.

The Agencies have reviewed the two studies performed by the mining company consultants which compare the quality of soil and the quality of borrow materials. The 2011 Westech report discussed the embankment plant community, but did not indicate the source of the material used for covering the embankment. The report noted that the embankment had a tree cover of 14-45% with an understory of introduced grasses and knapweed. TMI told the Agencies that the embankment had been reclaimed with glacial borrow material during an inspection of the site on August 16, 2011. Based on two test pits (south and west slopes) dug on August 16, the Agencies believe the material on the tailings embankment has considerably more fines than most of the borrow site material, and the revegetation success on the embankments would not be duplicated on the impoundment surface. As noted in the Agencies inspection report from August 16th, "We stopped and dug a shallow pit on the embankment to check the thickness of the soil or borrow used to reclaim it (no photo was taken). The soil/borrow used to reclaim the embankment was about 8 inches thick and was less rocky than the borrow glacial gravels currently used."

The fine-grained soils on the impoundment footprint area were salvaged and stockpiled during mine development for use during reclamation. This was the best quality soil available in the impoundment area and the Agencies see no adequate justification for accepting poorer quality material. In the Westech Report, the consultant indicates that site index (a measure of productivity) varies with soil characteristics and higher productivity is found on lower rock content soils. The Agencies contend that use of material from the borrow site would result in a substantially lower quality growth medium than use of the soil in the stockpiles.

Concern about disturbing vegetation on the soil stockpile:

This soil stockpile area is revegetated but it is not considered reclaimed. It has a temporary vegetation cover while the soil is being stored for final reclamation. Please see response to Comment H1.

Potential sediment to Lake Creek:

Please see response to Comment H1.

Loss of western toad habitat:

The Agencies have reviewed Appendix D submitted with the mining company's comments. Appendix D indicates that the salvaged soil stockpile is used by toads during the breeding season as foraging habitat due to its proximity to the forested habitat along Lake Creek. Overwinter use is unlikely as the few rodent burrows observed were not deep enough to provide adequate protection. The Agencies would minimize potential loss of western toads during soil hauling operations. As stated in ***Section 3.18.5.11****, under the Agency-Mitigated Alternative, no seasonal restrictions would be applied to soil hauling operations. BMPs*

would be used to limit sediment impacts to Lake Creek and the toe ponds and to minimize impacts to toads during soil hauling operations. Troy Mine, Inc. would be required to map out potential haul routes and install silt fences properly (i.e. bury the lower four inches of the fence material) around the entire perimeter of both the stockpile and haul routes. The silt fences would isolate these areas and restrict toad movement between the toe ponds and Lake Creek during reclamation operation, limiting the loss of toads from crushing by heavy equipment. In addition in ***Section 3.13.5.3****, in the Agency-Mitigated Alternative, the mining company would use up to 90 percent of the lacustrine and volcanic ash-derived soil material stockpiles between Lake Creek and the toe ponds. At least 10 percent of the lower slopes of the lacustrine and volcanic ash-derived soil material stockpiles, which are currently vegetated, would be left to act as erosion control berms to prevent sediment delivery to Lake Creek and the toe ponds. These lower slopes would give the toads a place to forage near their breeding habitat during the soil hauling campaign.*

Western toads have been documented to have a high fidelity to breeding sites and could be expected to work their way around silt fences until they reach the toe ponds (Maxwell 2010). Culverts would be placed under the haul routes in two or more general locations: 1) between Lake Creek and the toe ponds; 2) between the toe ponds to allow toads to move between ponds; and 3) other areas identified during an Agency field review. There would be no seasonal restriction on hauling operations.

The Agency-Mitigated Alternative would reduce the potential effect on western toads and their breeding/metamorphosis habitat at the toe ponds as well as limiting direct loss of individuals from heavy equipment traffic. The placement of the culverts would allow restricted, but continual, western toad movement between Lake Creek and the toe ponds during the breeding/ metamorphosis period.

Reclamation of the tailings impoundment surface would not negatively affect the western toad and would increase the amount of upland foraging habitat potentially available over the long-term. The soil stockpile areas would be revegetated again after soil removal resulting in a short-term loss of toad habitat. Given that impacts to western toads can be minimized, there is no adequate justification to accept lesser soil quality. The toads were observed to use logs and other woody debris for cover. The Agencies would request the mining company to place (16-25 tons) coarse woody debris on the soils stockpile area between Lake Creek and the toe ponds to enhance toad habitat.

<u>Dust issues with using the soil:</u>

Potential dust impacts are discussed in response to Comment H3.

<u>Concern over use of organic amendments:</u>

Please see response to Comment H3. The Agencies are aware of Prodgers' research which has not been published or peer reviewed. According to Prodgers' field work, analyses, and presentation, vascular plant performance or microbiological analysis did not indicate that compost confers a benefit in the semi-arid region with a forb/shrub plant community over

the time periods studied. The research study areas were not representative of the precipitation regime and vegetation community found at the Troy Mine. In addition, there are many benefits to adding organic amendments to growth medium used in reclamation other than just stimulating soil micro-organisms. Incorporation of organic matter can reduce compaction, increase water holding capacity, and prevent crusting of soils (such as the lacustrine sediments at Troy). Research has found that organic material is essential to soil productivity in forested ecosystems (Page-Dumroese et al. 1990, Jurgensen et al. 1997, Page-Dumroese et al. 2000). Organic material tilled into the soil provides multiple benefits (Curtis and Claasen 2009). The Federal Highway Administration has found that organic amendments are important to the success of highway revegetation projects (FHA 2007).

ES-14- summarizes agency alternative for use of salvage soil and organic addition; no justification provided.

Response ES-14: Please see response to Comments H3 and H-TMI-1.

ES-17- The DEIS states: "*Under the Agency-Mitigated Alternative,*

No additional measures would be required to mitigate geochemical impacts to reclamation success. The use of the rocky glacial and the lacustrine and volcanic ash-derived soils as growth media would minimize root contact with mined materials. This would effectively minimize the potential effects of plant uptake of metals from the development rock and tailings."

This implies that the tailing has a deleterious or toxic effect on plant growth; there is no evidence known to TMI or provided in the DEIS that toxicity exists and this must be corrected in the FEIS.

Response ES-17: The potential toxicity to plants from the tailings has never been determined. The tailings contain metals (recovery in the mill varies from 60-80 percent). The Agencies noted during inspections during mine life that plants growing in the tailings over the years have exhibited yellowing of the leaves indicating potential nutrient deficiencies and/or metal toxicity effects. The cause of the yellowing was never investigated because the reclamation plan requires replacement of 18 inches of soil over the tailings, minimizing contact with the tailings. The coarse rocky glacial materials proposed for use in the Proposed Action would have the indirect effect of forcing plants to root deeper in order to obtain the moisture needed for adequate growth. As a consequence, metals in the tailings could be absorbed by the plants with possible deleterious effects from metals. The capping of the tailings with fine textured soils that have a larger water holding capacity would minimize the need for plants to extend their roots down into the tailings for water, and reduce the potential for uptake of metals. The majority of plant roots would be in the upper 18 inches within fine textured soils minimizing potential for uptake of metals.

ES-18- The DEIS indicates that under the agency alternative chemical fertilizer would not be used in reclamation. No justification, reason or authority for this decision is provided here or elsewhere in the document.

Response ES-18: Please see response to Comment H3.

ES-19- The summary statement that the TMI proposed action would not achieve comparable utility in not supported here or elsewhere in the document and in fact is contradicted elsewhere in the document. TMI strongly disagrees that this standard cannot be met with borrow soil and further that the agencies have presented any substantive analysis documenting this conclusion. According to the Westech Report, 2011, the tailings embankment face supports a young forest of planted, healthy ponderosa pine, white bark pine and lodge pole pine at a stocking rate suitable for proposed post-mining land uses. Natural reinvasion of trees is occurring. The understory is primarily herbaceous dominated by hard fescue. Diversity is low with few species present. Cover of trees, herbaceous species, litter, lichens, moss and rock is adequate to provide a stable surface. Previous re-vegetation trials on Cell 2; the presence of existing forest on soils with high coarse fragments; and, the analysis of the DEIS demonstrate that borrow area material will support the proposed post-mining land uses of forest and wildlife habitat consistent with the MMRA.

*Response ES-19: See **Section 3.13.5.7** Regulatory Compliance – Reclamation Materials, **Section 3.16.2.8** Regulatory Compliance - Vegetation, and the response to Comment H-TMI-1.*

*The MMRA requires the reclamation of all disturbed lands to comparable stability and utility as that of adjacent lands. Where practicable, soil materials from disturbed areas must be stockpiled and used. By proposing not to use the stockpiled material, the Proposed Action is not consistent with the direction in the MMRA. Furthermore, the high rock content of the East Borrow site does not meet DEQ standards for reclamation material. The existing forest growing on the East Borrow site is dependent on the mantle of topsoil that covers the site. The topsoil that supports the vegetation on this site has good soil quality including elevated organic matter content, adequate nutrients, a healthy soil biotic community, and good water holding capacity. These soil quality attributes would be addressed by the Agency-Mitigated Alternative through use of the fine-textured stockpiled soil material, ripping after placement, and application of amendments. The Proposed Action would not produce comparable utility with respect to soil quality as compared to the Agency-Mitigated Alternative. Also see Final EIS **Section 3.13.5.2** and response to Comment H TMI-1 regarding revegetation on the embankments and previous test plots on the impoundment.*

2-54: Soil amendments listed for the agency alternative include that all disturbed ground at mill site will be covered with mulch and 25 tons/acre wood debris. Nowhere in the document provides the justification, authority or even describes the potential benefits of this treatment.

Response 2-54: Please see response to Comment H3 for organic amendment requirement and response to Comment H5 for coarse woody debris requirement.

3-42: TMI is not aware of any documentation indicating "*plant uptake of metals*" has caused any problem at the tailing impoundment. The use of the borrow soils as compared to stockpiled topsoil will accomplish the same objective; therefore, this argument needs to be revised in the FEIS.

Response 3-42: Please see response to Comment on ES-17.

3-115: TMI is not aware of any data or evidence indicating metals phytotoxicity from the tailing exists nor was any data or evidence referenced in the DEIS. If such documentation exists TMI would like to have a chance to discuss this issue with the agencies prior to completion of the FEIS.

Response 3-115: Please see response to Comment on ES-17.

3-119, 2nd paragraph: "*However, using a glacial outwash material instead would result in gradual, but slower vegetative recovery."*

The DEIS states that borrow soils would result in successful but slower vegetative recovery and thus meet the "comparable utility" requirement. TMI agrees with this statement and argues that the long history of reclamation pilot tests supports it. The speed of re-vegetation is not a requirement of the Metal Mine Reclamation Act.

Response 3-119: Please see responses to Comments H-3 and H-TMI-1.

3-119, 5th paragraph: "The organic matter would increase infiltration, fertility, and the water-holding capacity of the rocky glacial materials, all of which would speed up soil development on the reclaimed areas."

This only establishes that the organic matter addition would speed up re-vegetation, not that it is necessary to meet the reclamation requirements.

Response 3-119: Please see responses to Comments H3 and H5.

3-119, 6th paragraph: "Twenty-five tons/acre of coarse woody debris (larger than three inches in diameter) would be scattered across the reclaimed areas at the mine portals and mill. All disturbed ground would be covered with an agency-approved mulch."

There is no discussion of the justification, benefits, rational or authority for requiring the addition of wood debris or mulch. More importantly, there is no discussion why this requirement in the Agency-Mitigated Alternative is more effective than the Proposed Action for achieving reclamation requirements.

Response 3-119, 6th paragraph: Please see response to Comment H3 regarding the requirement for organic amendment and response to Comment H5 regarding the requirement for coarse woody debris.

3-120, 3rd paragraph: "These materials would be used because they would produce better soil quality and a more productive plant growth medium due to their larger water-holding capacity.

The material proposed under this alternative would eventually produce a quality soil with a more productive forested plant community, even with the presence of noxious weeds."

This documents that the main benefit of using the stockpiled soils is increased forest productivity. Since the uses of the alternative borrow soils can achieve the DEQ's requirements for stability and utility on these private lands, the requirement to use the stockpiled soil is not warranted.

> *Response 3-120 3rd paragraph: The Proposed Action would not result in comparable utility with respect to soil quality. Please see response to Comment H TMI-1.*

3-121: "*All three alternatives would meet these guidelines on NFSL. However, the Agency-Mitigated Alternative would restore soil function in a shorter period of time*."

The DEIS documents the agencies are in agreement with TMI's Proposed Action which achieves Forest Service requirements. Therefore, there is no need for unnecessary activities just to shorten the time period.

> *Response 3-121: The sentence has been deleted from the Final EIS. See* ***Section 3.13.5.7*** *Regulatory Compliance, for the revised text. USFS guidance directs that timelines are included as part of reclamation plans.*
>
> *The USFS requires that the land be reclaimed so that it is ecologically stable and will support a sustainable forest community. Furthermore, USFS policy (FSM2800-90-1) requires that reclamation be undertaken in a timely fashion, and that timeframes be established with performance standards. Performance standards are provided in the Final EIS in Table3-19 and Table 3-20. The USFS maintains the requirements in the Agency-Mitigated Alternative are reasonable, practicable, and necessary to attain standards. The No Action and Proposed Action would implement a short term revegetation program, but is unlikely to sustain steady recovery in revegetation over time because of poor soil quality. Over many decades revegetation would occur naturally, but this is not considered an acceptable time frame for a reclamation effort. Furthermore, weeds will dominate the understory vegetation until soil quality is adequate to sustain native ground cover.*
>
> *Please also see response to Comment on ES-19 and the response to Comment H-TMI-1.*

3-121, last paragraph: "*The Proposed Action would not produce comparable utility on the reclaimed tailings impoundment*."

The statement is not justified and apparently relies on an interpretation of the MMRA "comparable utility" requirement that is not documented in any agency guidance but seems to be the "more is better" philosophy. The "comparable utility" wording is clearly meant to indicate a level of sustainable re-vegetation that achieves an acceptable level of cover and species diversity. There is no standard to support a minimum level of productivity. On page 3-146 (3rd paragraph) the DEIS indicates the Proposed Action achieves the "comparable utility standard". This statement must be corrected in the FEIS.

*<u>Response 3-121, last paragraph:</u> See **Section 3.13.5.7** Regulatory Compliance – Reclamation Materials, **Section 3.16.2.8** Regulatory Compliance – Vegetation, and the response to Comment H-TMI-1. The statement on page 3-146 (3rd paragraph) has been corrected in the Final EIS.*

<u>*Comment H-TMI 2:*</u> 3-114: "*Moreover, the water-holding capacity of the borrow materials is low and varies with the rock content.*"

The DEIS is correct that water holding capacity varies with rock content; however, the borrow materials proposed for growth media is composed of organics, clay, silt, sand and gravel. Test plots on Cell 2, embankment slopes and Cell 4 demonstrate the mixed borrow material has adequate water retention for growing grasses, shrubs and trees.

<u>Response H-TMI 2:</u> The Agencies disagree that the glacial outwash material contains organics. The organic surface horizon in the borrow areas would be salvaged to reclaim the borrow site. The subsoils and geologic materials in the glacial deposits have little to no organic matter as shown in the data submitted in the mining company's response in Appendix B.

<u>*Comment H-TMI 2 Continued:*</u> The borrow contains much less clay, silt, and sand than the stockpiled soils because the borrow has 59-81 percent rocks as noted in the Westech report.

<u>Response H-TMI 2 Continued:</u> Please see response to Comment H-TMI 1.

<u>Comment H-TMI 2, Appendix F:</u> Finally in Appendix F, TMI has included photographs of the tailings facility, that shows the excellent growth on borrow material, photographs of the secondary containment warning system installation, photographs of the topsoil stock pile area and the grass growth on cell #4 – borrow material growth media.

<u>Response H-TMI 2, Appendix F:</u> Thank you for the photos.

<u>*Comment H-CRG 1:*</u> Revett has expressed concern about disturbing the already re-vegetated topsoil stockpiled between the toe ponds and Lake Creek. We share this concern for the same and for other reasons (Refers to CRG letter of Dec.27, 2007, Appendices, Appendix A, Scoping Report, Appendix F, pgs 53-83), yet we also wish to see plenty of organic matter on the impoundment surface to help build soil structure, enhance water retention, and increase nutrients. We would like to suggest some ideas that may help address both these concerns.

Revett has told us it may be operating the Troy Mine for some years to come. The impoundment may well reach its' maximum capacity before the cessation of mining. Revett is looking into putting future tailings back into the mine.

If this were to start happening as soon as possible, reclamation could begin, and perhaps largely be completed at the impoundment while the mine is still in operation. This could, paradoxically, allow for a slower, more flexible pace of reclamations; methods could be tested and tweaked.

A composting program could begin now on an inactive cell of the impoundment, utilizing sawdust, wood chips, agricultural and livestock wastes, etc. Even if there is not enough material available in the area for a truly large-scale project, a significant quantity might be produced over the course of a few years. There are such operations in this region that could be consulted as to feasibility.

We understand that the US Forest Service and the University of Montana have developed a portable gasification plant, clean burning, that runs on waste wood. It can produce power and/or "char" a soil amendment (Operated by Community Power Corp., 8110 Shaffer Parkway, Littleton, CO 80127). There are other sources of information on such possibilities in the area, such as the Canadian company planning a bio-fuels operation in Thompson Falls (EcoTech Energy, 125 W. Granite, Butte, MT 59701). We encourage the agencies to seek innovative ways to put organic material on the impoundment while minimizing disturbance of the stockpiled topsoil.

At the north and south ends of those stockpiles, there are areas that do not yet have trees growing on them. Perhaps some small scale, experimental removal of soil from these areas could be tried seasonally, over several years, in order to determine if problems do arise before an irrevocable commitment is made. The dirt could be brought up and re-stockpiled near where it will finally be used.

We are dubious about the use of artificial fertilizer, particularly as it might affect trees. Finding the nutrients they need, they might put more growth into foliage that into root structure necessary to sustain that foliage growth when the fertilizer is used up.

> *<u>Response to H-CRG 1:</u> Thank you for your comment. Please see responses to Comments H1 and H-TMI-1 for the Agencies' responses about the use of the stockpiled soil versus material from the borrow sites. The Agencies are convinced that regardless of timing during operations or at closure that the stockpiled lacustrine soil would produce better soil quality. Reclamation on the impoundment can begin a cell at a time, minimizing the impacts at closure.*
>
> *With respect to organic amendments, please see response to Comment H3 and response to Comment H-TMI-1. The Agencies specified a wood-based organic amendment. The Agencies would consider the use of a variety of wood-based products. Agricultural and livestock wastes would not be acceptable. Please see response to Comment H3. The mining company can acquire agency-approved wood-based organic amendments during operations. The stockpiling of organic amendments during operations would reduce the reclamation bond. The research on char is not complete, but the Agencies would entertain its use.*
>
> *The Agencies appreciate your concern about commercial fertilizers and would prefer the use of organic amendments to produce slow release nutrients as well.*

<u>Comment H-A-LCD 1:</u> The topsoil piles are currently fully vegetated and have trees and alder brush that has created wonderful habitat for all sorts of terrestrial and aquatic wildlife, most importantly the Western Toad.

Requiring all of this to be undone is completely unnecessary as there is plenty of adequate borrow material that is located 3,000 feet away from Lake creek (think bull trout) and has been proven to work just as good as the topsoil would with test plots while not creating the dust problem that the fine particulates of the topsoil will. Many of the local conservation groups in the area also agree that this proposed action should be reconsidered. We recognize that you have statutory requirements that are driving this, and that the statute was created with the best of intentions, but we feel that this is a classic unintended consequence that can and should allow for a variance.

Response H-A-LCD 1: Please see response to Comments H1 and H-TMI-1.

Comment H-A-LCD 1, Organic Fertilizer: Further, requiring organic fertilizer, other organic matters additions to the soil, and 25 tons/acre of larger woody debris on reclaimed areas doesn't make sense either. 25 tons? Organic fertilizer? It seems that using the right amount of fertilizer than can be measured and applied using the best available science that can be calculated to the square inch is the appropriate and environmentally responsible thing to do. We thought nitrate levels in waterways were of concern to the DEQ?

Response H-A-LCD 1, Organic Fertilizer: The term "organic fertilizer" was mistakenly included in the document. The references should say "organic amendments". Please see response to Comment H3 regarding the use of organic amendments versus chemical fertilizers and response to Comment H5 regarding placement coarse woody debris. Chemical fertilizer application as called for in the No Action and Proposed Action Alternatives and organic amendments as specified in the Agency-Mitigated Alternative are not expected to increase nutrient levels in the streams.

I. Transportation:

Comment I1: Many commenters stated that the main road should remain paved because removing the pavement will result in greater impacts to air quality, water quality, and the economy (cost to remove and maintain). The paved road may also be needed for long-term monitoring. Several commenters noted that the road would be gated which would limit traffic and thus long-term maintenance costs.

Response I1: The cost to maintain an asphalt road over time, is much larger than it is to maintain a gravel surface road. A gravel road will serve for long-term monitoring just as well as an asphalt road. There is no proposal at this time to close NFSR 4626 below the mill site.

Comment I2: Some commenters noted that they assumed the gate on the main road would be located near the tailings impoundment while others requested that the gate on the main road be located just beyond the fork to Spar Lake allowing public access to Spar Lake.

Response I2: The gate on NFSR 4626 on National Forest will be located up at the mill site where public access is currently restricted. The first 2.33 miles of NFSR 4626 starting at Highway 56 is privately owned and the public has no legal access. The public is currently

permitted to use this road by TMI. If public access is prohibited on this road segment, then public access to Spar Lake would only be via Lake Creek Road 384.

<u>Comment I3:</u> Some commenters felt that the asphalt/concrete should be reused as gravel material to cover the road.

<u>Response I3:</u> The asphalt road is planned to be broken up into "black gravel" on the road by a milling machine. A 4-inch lift of crushed gravel is to be placed over the top of the milled asphalt as noted in ***Section 2.4.3.2*** *- Infrastructure.*

<u>Comment I4:</u> A commenter noted that many roads have been passively decommissioned and/or will be passively commissioned. These roads include 4626G, 4624B, most of 4624, the USFS part of 4551, and 4628A. Additionally, road 4628A will be passively decommissioned at mine closure and disturbing the steep, narrow, stable road prism in this area will cause undue environmental disturbances; increase risk of sedimentation to nearby streams; and the trail will become unstable and unusable.

<u>Response I4:</u> The USFS uses the term "decommissioning" for the administrative act of declaring a road has no future use, will not be maintained, and is not intended to be used again. Most roads naturally revegetate during periods of no motorized use; however, the presence of vegetation does not mean the road has already been decommissioned.

USFS policy is that roads designated for decommissioning should be reviewed for stability, sedimentation, and hydrologic issues. Roads that are well-vegetated can still adversely impact water resources through road failures, culvert washouts, surface erosion, and runoff diversion by roadways and ditches. Roads that have conditions that may or will contribute to water quality degradation may need physical treatment before declaring them decommissioned. The amount of sediment potentially created from doing the work is considered when evaluating the benefit of the work. As a result of the lack of risk to water quality and the extent of revegetation, many roads on Mt. Vernon have no ground-disturbing work proposed.

There are a few roads proposed for active decommissioning. These roads were field reviewed and were found to have problems that the Agencies determined should be addressed before considering them decommissioned. Vegetation will need to be removed to access portions of these roads in order to do stabilization work; however, the roads will be seeded and revegetation is expected to be rapid in this high precipitation area. The specific work proposed and the reason for the work is listed in the response to Comment I-TMI 1.

<u>Comment I-TMI 1:</u> The Agency-Mitigated Alternative road reclamation plan includes removal of several spur roads that have been passively decommissioned. TMI views reverting road 4626 to a gravel surface will cause undue environmental disturbance and increase risk of sedimentation to nearby streams. TMI performs annual maintenance on road 4626 and believes the surface will perform for decades after closure with minimal maintenance and cause no sedimentation risk to nearby streams. TMI believes roads 4626G, 4624B and most of 4624 to be passively decommissioned as of this date, and by closure of the Troy Mine, road 4624 will be passively

reclaimed. TMI agrees that the portion of road 4551 on private land should be decommissioned – converted to a trail; however, the portion of the road on national forest is already passively decommissioned and is little more than a trail. TMI believes that disturbing this road prism will cause undue environmental disturbance and increase risk of sedimentation to nearby streams. Additionally, TMI believes road 4628A will be passively decommissioned at mine closure and disturbing the steep, narrow, stable road prism in this area will cause undue environmental disturbance; increase risk of sedimentation to nearby streams; and, ultimately the trail will become unstable and unusable.

Response I-TMI 1:

Road	**Comment**	***Response***
4551	TMI agrees that the portion of NFSR 4551 on private land should be decommissioned – converted to a trail; however, the portion of the road on NFSL is already passively decommissioned and is little more than a trail. TMI believes that disturbing this road prism will cause undue environmental disturbance and increase risk of sedimentation to nearby streams.	*The action proposed for NFSR 4551 is simply a change in designation. No on-the-ground work is proposed.*
4624	TMI believes NFSRs 4626G, 4624B and most of 4624 to be passively decommissioned as of this date, and by closure of the Troy Mine, NFSR 4624 will be passively reclaimed.	*NFSR 4624 was field reviewed in September 2011 and was determined to pose a risk to water resources. The last 0.23 miles have signs of instability and risk factors including fill failures,, slumping shoulders, and water ponding on the road. This road has the potential to deliver substantial sediment to Ross Creek. Active decommissioning work is needed to reduce instability.*
4624B	TMI believes NFSRs 4626G, 4624B and most of 4624 to be passively decommissioned as of this date, and by closure of the Troy Mine, NFSR 4624 will be passively reclaimed.	*The Agencies concur that NFSR 4624B does not need additional on-the-ground work. The AMA will be modified to show passive decommissioning.*
4628A	TMI believes NFSR 4628A will be passively decommissioned at mine closure and disturbing the steep, narrow, stable road prism in this area will cause undue	*The Agencies have no intent to do on-the-ground work at closure on NFSR 4628A as long as existing waterbars remain functional.*

	environmental disturbance; increase risk of sedimentation to nearby streams; and, ultimately the trail will become unstable and unusable.	*Similar to NFSR 4551, the road would simply be designated as a trail. The KNF made the decision to convert NFSR 4628A to a trail in the 2001 Spar and Lake Record of Decision. At the time the KNF did not realize the mine might have future need for drilling access. The road decommissioning – convert to a trail designation has been postponed until mine closure.*
4626G	TMI believes NFSRs 4626G, 4624B and most of 4624 to be passively decommissioned as of this date, and by closure of the Troy Mine, NFSR 4624 will be passively reclaimed	*NFSR 4626G was field reviewed in September 2011 and was determined to pose a risk to water resources. An intermittent stream is routed out of its natural drainage by the road. The stream runs down the road for several hundred feet. The proposed active decommissioning work would return this stream to its natural channel and add waterbars to the road to prevent erosion. An additional benefit to this work is that this stream is probably the same stream that causes erosion above the west ventilation adit. Restoring this stream to its original channel will eliminate this problem and simplify reclamation at the adit opening.*

<u>Comment ES18-</u> "*Any additional sediment from untreated roads and stream erosion across the mill site would add to the already elevated sediment load that currently exists in Stanley Creek and would adversely impact beneficial uses for an extended period of time*."

This statement implies that Stanley Creek is impaired for sediment, <u>which is not the case</u>, and the claim that beneficial uses would be impacted is not substantiated. In early June 2011 Stanley Creek has been observed flowing at high flows while showing no visible sign of turbidity. Each year TMI sends the final report for the Comprehensive Water Quality Monitoring Program for streams adjacent to the TMI. To date, we have submitted reports for 25 years. According to Mr. Joe Volosin – Parametrix Inc., for 24 years, the benthic macroinvertebrate populations and water quality of the stream systems near the Troy Mine have been monitored. Samples have

been collected at locations above and below mining operations in Fairway-Stanley Creek Systems and in the Lake Creek System. The benthic macroinvertebrate and water quality monitoring over the past 24 years have not identified any pollution impacts or degradation of Fairway-Stanley Creek and Lake Creeks due to TMI Facilities.

Over all the years of monitoring, the numbers of clinger taxa in Stanley Creek have been similar to Fairway Creek and similar between Lake Creek Sites. This metric suggests that for both Fairway-Stanley and Lake Creek systems, little sedimentation effects have been noted in any of the streams evaluated. TMI has included the Comprehensive Water Quality Monitoring Programs for Streams adjacent to Troy Mine: Spring 1986 through Fall 2009, Year 25 in Appendix E to this letter.

Response I-TMI 1, ES18: In response to the comment regarding page ES18, the Agencies agree that this statement needs correction.

The Agencies concur that impacts to macroinvertebrates as currently monitored are not evident. However, the Agencies do not concur that there have been no impacts to water quality or aquatic biota from mining-related activities. Mine activities have clearly contributed sediment, and at least temporarily degraded water quality.

Roads used for mining activities have contributed substantial sediment to Stanley and Ross Creeks. Substandard road conditions and other mining related disturbances have contributed to slope failures and debris events. Sanding and snowplowing operations on Road 4626 provide a chronic source of sediment in the winter months.

The 2009 and 2011 tailings spills resulted in short term water quality impacts from turbidity and metal concentrations and longer term impacts as accumulated bedload sediment in Thicket and Stanley Creeks.

Comment I-TMI 1, 3-22; 2nd paragraph: "Under the Proposed Action, unneeded roads that pose a resource risk would not be treated, and restoration work on needed roads would not be implemented."

The definition is not clear as to "unneeded" and "needed" roads.

Response I-TMI 1, 3-22; 2nd paragraph: The Agencies agree that this paragraph is not clear. Text has been replaced with the following:

> *"Under the Proposed Action, some roads that pose a resource risk would not be treated. These roads are NFSRs 4626E and 4626G in Stanley Creek watershed, and NFSRs 4624 and 4628 in Ross Creek watershed. Sediment would probably continue to be contributed to Stanley and Ross Creeks from these roads, adversely affecting water quality."*

The term "needed" road only applies to roads under Forest Service jurisdiction. A needed road is a road determined by the transportation analysis to be required for current and/or future administrative or public access using highway vehicles. Roads that are determined to

be needed are considered long-term system roads. All Forest Service jurisdiction roads not identified for decommissioning are considered needed roads whether they are open or closed to traffic. Roads designated for Intermittent Stored Service are considered needed roads. Some segments of these roads have active or potential sediment sources, and/or water routing on the roads may pose water quality concerns. NFSRs 4626E, 4626G and 4624 are unneeded by the KNF. NFSR 4628 is needed for access to Mt. Vernon and Trail 398.

<u>Comment I-TMI 1, 3-23:</u> *"The Agency-Mitigated Alternative would reduce sediment loading both by implementing reclamation actions and by treating mining road-related sediment sources."*

The statement implies that the Agency-Mitigated Alternative reduces *road related sediment* more than the company's proposal. There is no analysis or discussion of how removing the asphalt surface from the road would reduce sediment more than the Proposed Action. Troy Mine was originally required to install asphalt to mitigate for sediment and it is used elsewhere in the KNF which indicates asphalt road cover is effective for sediment reduction.

<u>Response I-TMI 1, 3-23:</u> *The Agencies agree that this statement needs correction. The Agency-Mitigated Alternative would reduce sediment in Ross Creek by implementing reclamation actions and by treating mining road-related sediment sources. The Agency-Mitigated Alternative would increase road-related sediment in Stanley Creek by converting the pavement to gravel on NFSR 4626. This would be offset by decreasing sediment from the mill site with better reclamation techniques. It is expected that there would be a net decrease in sediment to Stanley Creek under the Agency-Mitigated Alternative because stream channel erosion at the mill site under the Proposed Action is likely to contribute more sediment than conversion to a gravel road under the Agency-Mitigated Alternative.*

<u>Comment I-TMI 1, 3-120:</u> "*Many roads used for drilling decades ago have revegetated and pose a low erosion risk to the watershed*."

The DEIS supports TMI's argument that natural re-vegetation is an appropriate solution for some of the older roads.

<u>Response I-TMI 1, 3-120:</u> *Please see responses to Comments I4 and I-TMI 1.*

<u>Comment I-CRG 1:</u> The Agency-Mitigated Alternative road reclamation plan call for the removal of spur roads that are already decommissioned and the removal of the blacktop surface of road 4626, the mine access road. The disturbance of these roads will increase the risk of environmental damage. Many of the roads built during the exploratory phase and not used since have already been reclaimed by natural vegetation as indicated in the DEIS page 3-120.

<u>Response I-CRG 1:</u> *Please see responses to Comments I4 and I-TMI 1.*

<u>Comment I-A-EPA 1:</u> We appreciate the inclusion of road improvement, reclamation and decommissioning activities in the Agency-Mitigated Alternative to reduce potential over the long-term for road sediment transport to surface waters and reduce road maintenance costs (Table 2-1, pages 2-30 to 2-32). We are pleased that the Agency-Mitigated Alternative would

result in the passive decommissioning of 3.8 miles of road and the active decommissioning of 2.7 miles of road (page 3-120); existing roads would be improved to USFS specifications and 6 miles of paved surface on NFSR 4626 would be replaced with gravel (page 3-134). Roads that are not needed would be ripped, covered with reclamation materials, and revegetated. The Agency-Mitigated alternative would implement BMPs on 19.2 miles of road needed for long-term access (includes stored service work) and decommissions 6.5 miles of unneeded road, thereby reducing long-term road maintenance costs as compared to the Proposed Action. Private roads on Troy Mine, Inc. property at the tailings impoundment would be field reviewed by the Agencies to decide if they are needed for post-mine land uses. We are pleased that this road stabilization work would be carried out and decrease long-term sediment delivery to Stanley and Lake Creeks in comparison to the existing conditions and the Proposed Action (pages 3-88, 3-89).

Response I-A EPA 1: Thank you for your comment.

Comment I-A-LCD 1: Is the USFS planning on closing this road from public use after the mine is decommissioned? Have the recreational values of the road remaining open to access very popular places like Spar Lake even been considered? Do we want the public driving on a dirt road rather than one covered with asphalt?

If the plan is to prohibit motorized use of this road after decommissioning it should be articulated by the USFS to the public now, rather than later.

Response I-A-LCD 1: NFSR 4626 will be restricted with a gate at the mill site. This will not change existing public access or affect access to Spar Lake. Please refer to Comment F-A-LCD 1 answered above. Regarding the road surface, please see response to Comment I1.

J. Vegetation:

Comment J1: Commenters noted that vegetation will re-establish itself and that the Draft EIS is incorrect in stating that vegetation will never fully re-establish. Commenters noted their observations that trees grow even without any replanting efforts in the geographic region around the mine.

Response J1: Yes, vegetation will re-establish but the native communities that existed before will not re-establish. Native tree species have a better chance than native herbaceous species to re-establish in communities similar to the pre-mining condition. Noxious weeds and aggressive introduced perennial and annual grasses have changed plant communities in the Troy area.

Comment J2: Commenters noted the need to control noxious weeds (especially if borrow is used to revegetate) and replant not only grass, but also trees.

Response J2: All alternatives would require control of noxious weeds to comply with the Montana Noxious Weed Control Act. All alternatives would require tree planting.

Comment J3: One commenter noted that there must be enough organic soil to properly revegetate the entire tailings impoundment.

Response J3: There are no organic soils in the impoundment area. All of the proposed reclamation materials lack organic matter because the soil has either been stockpiled for 30 years or buried at the mill site. The rocky glacial gravels near the impoundment also are low in organic matter. This is why the Agencies are requiring organic matter amendments to all reclamation materials in the Agency-Mitigated Alternative. Please see response to Comment H-TMI 1.

Comment J4: One commenter noted the importance of including steps to assure that the threats to surface habitat from subsidence is reduced or eliminated.

Response J4: The Final EIS outlines the steps that would be taken to reclaim and monitor for future subsidence in ***Section 3.8.5.3.***

K. Wildlife

Comment K1: Many commenters indicated that the use of the soils stockpiled to the west of the toe ponds will impact Western toad habitat and that this impact should be avoided.

Response K1: The primary habitats utilized by the western toad are the forested habitat adjacent to Lake Creek and the toe ponds themselves (breeding habitat), not the stockpiled soils areas that lie west of the toe ponds. The toe ponds and associated wetland habitat would not be removed under any of the alternatives (Final EIS ***Section 3.18.5.11****). Although the stockpiled soils areas have revegetated and provide habitat for a variety of species, including some foraging opportunities for western toads, these areas have relatively few trees, shrubs, downed woody material, or rodent burrows that provide hiding cover and protected movement areas for the toad. Between the toe ponds and Lake Creek, there are areas where the river and associated riparian habitat closely approaches the toe ponds and little if any stockpiled soil occurs (Final EIS Figure 2-1). These areas would be left undisturbed and would provide protected routes to the toe ponds both during and after reclamation of the tailings impoundment for the western toad. See also response to Comment H-TMI-1, "Loss of western toad habitat."*

Comment K2: There has been no impact to wildlife from 30 years of tailings disposal.

Response K2: Creation of the tailings impoundment resulted in the removal of upland forest habitat adjacent to Lake Creek's riparian habitat. Thirty years of tailings deposits have created an uncharacteristic and uniform "bench" that currently does not provide habitat for many species except some use by waterfowl in the decant ponds. Reclamation of the impoundment by encouraging the healthy growth of native grass, forb, shrub, and tree species would potentially provide characteristics in the future such as upland foraging habitat and cover for many species, including the western toad.

Comment K-A-EPA 1: Will the decant ponds and their metals levels present hazards to wildlife, including birds? Is there a need to keep the decant ponds fenced to prevent wildlife entry to these treatment ponds after mine closure?

Response K-A-EPA 1: Mine water is routinely analyzed for several metals. Copper is of primary concern as levels exceed chronic aquatic life standards (see Final EIS ***Section 3.9.4.1****). The decant ponds contain tailings water that has been routed through the impoundment from the mine and mill, as well as precipitation. After closure, the decant ponds would contain water derived from the flooded mine workings. Initially, there may be a slight increase in metals contamination of pool water that would be discharged from the mine. Final EIS Table 3-7 indicates mean copper values in mine water were 0.059 mg/L during the interim mine closure and flooding (2000 – 2003) compared to 0.041 mg/L during operations (2004-2009). This includes copper which would be released by dissolution of oxidized ore minerals contained within pillars in the flooding mine. However, the rates of oxidation and dissolution would decrease after the mine void has flooded. Water quality would be expected to improve or remain constant after closure (Final EIS Appendix F).*

Copper is an essential nutrient and animals obtain copper through their diets (Eisler 1995, Pascoe et al. 1995). Higher orders of species, including birds and mammals, are relatively resistant to copper and have regulatory mechanisms that help eliminate excess copper from their systems and reduce the potential risk of copper toxicity (Eisler 1995). Toxicity could still occur, but would require intakes of over 20–50 times the normal amount to result in effects in mammals (ibid).

Pascoe et al. (1995) studied the effects of a contaminated reservoir near Missoula, MT on wildlife species. They evaluated potential effects of increased metal levels through food chain analysis by estimating daily intakes (e.g. ingestion of food, water, and soil/sediments) and comparing it to toxicity values. In general, estimated metal doses to mammals and water/birds of prey were below the respective suites of toxicity values. Minimal health risks were expected due to increased presence of metals, including copper. The Bureau of Land Management developed a risk management criteria system which provides numerical action levels for metal contaminated areas (Ford 2004). Again, this was based on toxicity values compared to wildlife intake assessments. Similarly, the agency found that the rates of ingestion are small compared to toxicity levels. For an area to be considered "high risk," exceedances of 10-100 times the criteria would need to occur.

Surface water copper levels in the Pascoe et al. (1995) study ranged from 5-500 µg/L (approximately 0.005-0.500 mg/L). Dissolved copper at the decant ponds ranged between 0.003-0.200 mg/L (Final EIS Appendix F) and values are below or within the range of the Pascoe et al. (1995) study. Currently, ingestion would be primarily of water and soil/sediment and rates of ingestion, relative to toxicity values, would likely be lower for any wildlife species utilizing the decant ponds. Risk of metal contamination of species using the decant ponds is likely to be minimal.

With revegetation of the impoundment and decant ponds, wildlife species would also begin ingesting plant material. Some plants uptake copper and other metals in their tissues. Reclamation of the impoundment would cover the surface with 18 inches of growth medium to minimize the potential uptake of metals in plant tissue. The fine textured stockpiled soil would provide the most rooting medium and water holding capacity which would minimize the need for plants to root in the tailings. Reduced mineral uptake by plants coupled with maintained or improved water quality would provide wildlife habitat with minimal risk of metal toxicity. The rocky glacial gravels with their lack of water holding capacity would force plants to root deeper into the tailings increasing the potential for metals accumulation in plants grazed/browsed by animals post-closure.

The decant ponds would not be considered State waters, according to the Montana Water Quality Act (Title 75, Chapter 5 Montana Code Annotated), because the definition of State waters does not include "ponds or lagoons used solely for treating, transporting, or impounding pollutants" (75-5-103(29)(b)(1) MCA). Therefore the decant ponds are evaluated strictly in terms of the possible effects of incidental exposure of wildlife such as birds and mammals to the pond water.

The pond water is expected to meet human drinking-water standards except that it may slightly exceed the antimony standard. Therefore it is likely to be harmless to animals that drink it or have contact with it.

Comment K-A-FWP-CR 1: Seasonal road restrictions will benefit grizzly bears, as will the proposed road reclamation (minus clover). The proposed Agency-Mitigated road reclamations will also benefit elk, black bear, and other species. The proposal to prohibit/minimize ATV and snowmobile use in the project area will also afford protection to mountain goats during crucial winter and spring periods.

Response K-A FWP-CR 1: The Agencies agree that the proposed road reclamation and motorized restrictions on the remaining roads would benefit the many species that utilize the Mt. Vernon area, not just the grizzly bear.

Comment K-A-FWP-CR 2: The section on Wolf Background (3.18.4.2) should include the 2 most recent rulings, including that by the US Congress this spring, as well as the most recent ruling by Judge Malloy (8/4/11).

Response K-A-FWP-CR 2: Gray wolf status as an endangered species has changed several times over the past years. Indeed, since the completion of the Draft EIS the Northern Rocky Mountain distinct population of the gray wolf, excepting Wyoming's population, has been removed from the List of Endangered and Threatened Wildlife. This change will be updated in the Final EIS in ***Section 3.18.5.7***

Comment K-A-FWP-CR 3: The section on Wolverine Affected Environment (3.18.5.11) could also be updated to include the recently recorded wolverine sign near Billiard Table Lake (especially given that the area between Billiard Table and the Troy Mine is easily within a wolverine's home range).

Response K-A-FWP-CR 3: At the time the Draft EIS was completed, there were only two reported observations of wolverine within the project area. Since then, an update for the Inland Maritime Initiative, which conducted winter forest carnivore surveys, documented wolverine tracks near Billiard Table. This area is located within a few air miles of the southern extent of the Lake Creek Watershed. The Final EIS will reflect this new observation in ***Section 3.18.5.12****.*

Comment K-A-FWP-CR 4: Some of the information contained in the Mountain Goat section 3.18.6.2 needs updating. For the record, MFWP does not know the exact numbers of mountain goats in HD 101, however, goat hunter numbers, permit numbers, and goat harvest numbers across Region 1 have been decreasing since 1987. This causes me concern for the number of goats currently within HD 101 and using the project area.

Response K-A-FWP-CR 4: Based upon the stated concerns and updated information provided by FWP, the mountain goat population in the West Cabinet Mountains does not suggest a stable population as stated in the Draft EIS. This information will be updated in ***Section 3.18.6.2*** *of the Final EIS to more accurately reflect the status of the mountain goat in hunting district 101****.***

Comment K-A-LCD 1: We do not believe that requiring the topsoil that is now providing great habitat for wildlife be disturbed for the final reclamation plan. The topsoil piles are currently fully vegetated and have trees and alder brush that has created wonderful habitat for all sorts of terrestrial and aquatic wildlife, most importantly the Western Toad.

Response K-A-LCD 1: The revegetated soil stockpiles are now providing an early successional habitat used by open habitat/grassland associated species. While now providing habitat for a variety of species, it is not the primary habitat being utilized by the western toad. As addressed in Comment K1, the toe ponds provide shallow wetland characteristics necessary for successful breeding toads. The berms that hold the toe ponds in place would remain, maintaining the toe ponds and toad breeding habitat into the future. Although the disturbance to the soil stockpile areas would require revegetation and would not provide habitat as it currently does for several years, the grass and small shrub component would return relatively quickly to its current early successional habitat type and provide for open habitat/grassland associated species.

The Agencies disagree that borrow should be used instead of soil. Please see response to Comments H3 and H-TMI-1 above for the Agencies' arguments for using the soil rather than borrow and how the Agencies would mitigate impacts to toads.

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Agency, Elected Official, Organization Comments

2011-06-24 Stewart R_DOI.pdf

United States Department of the Interior

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June 24, 2011

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Paul Bradford, Forest Supervisor
Kootenai National Forest
31374 US 2
Libby, MT 59923-3022

Dear Mr. Bradford:

The Department of the Interior has reviewed the Draft Environmental Impact Statement (EIS) for the Troy Mine Revised Reclamation Plan, Kootenai National Forest, Lincoln County, Montana, and has no comments.

Sincerely,

Robert F. Stewart
Regional Environmental Officer

cc: Bobbie Lacklen, Project Coordinator, Kootenai National Forest
Emily Corsi, Project Coordinator, Montana DEQ

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8, MONTANA OFFICE
FEDERAL BUILDING, 10 W. 15th STREET, SUITE 3200
HELENA, MONTANA 59626

Ref: 8MO

June 29, 2011

Ms. Bobbi Lacklen
Kootenai National Forest
31374 U.S. Highway 2 West
Libby, Montana 59923-3022

and

Ms. Emily Corsi
Montana Dept. of Environmental Quality
P.O. Box 200901
Helena, Montana 59620-0901

Re: CEQ 20110149; Troy Mine Revised
Reclamation Plan DEIS

Dear Ms. Lacklen and Ms. Corsi:

The Environmental Protection Agency (EPA) Region VIII Montana Office has reviewed the Draft Environmental Impact Statement (DEIS) for the Troy Mine Revised Reclamation Plan in accordance with EPA responsibilities under the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act. Section 309 of the Clean Air Act directs EPA to review and comment in writing on the environmental impacts of any major Federal agency action. EPA's comments include a rating of both the environmental impact of the proposed action and the adequacy of the NEPA document.

The EPA is generally pleased with and supports the mitigation measures added to the proposed action with the preferred alternative for the Troy Mine Revised Reclamation Plan (Agency-Mitigated Alternative). However, we do have comments and questions regarding the revised reclamation plan alternatives and the environmental impact analysis and disclosure, which are identified and discussed below and in our enclosed detailed comments. We are particularly concerned regarding the long-term pollutant removal effectiveness associated with the plan to discharge mine water draining from the underground workings to the decant ponds within the tailings impoundment after mine closure.

E-A-EPA1

The DEIS states that mine water would be treated at the decant ponds through "natural attenuation mechanisms" as the water infiltrates, allowing metals concentrations to attenuate within the soils. Mechanisms for attenuating metals (removing them from groundwater) are stated to include dilution, precipitation, adsorption, and co-precipitation. It is further stated that the effectiveness of the natural

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attenuation mechanisms in treating mine water has been substantiated through monitoring of water at the tailings impoundment for the past 30 years as well as through studies directed at understanding the geochemical processes that occur in the underlying soils and groundwater system, and that the Agency-Mitigated Alternative would comply with the Clean Water Act and the Montana Water Quality Act.

The EPA acknowledges that there is empirical evidence that infiltration of mine water into groundwater beneath the Troy Mine tailings impoundment and decant ponds have apparently not resulted in elevated levels of copper and other metals in groundwater downgradient from the tailings impoundment or in Lake Creek (which is hydrologically connected to the groundwater beneath the impoundment). However, we are concerned that there may be a finite capacity for metals removal and/or immobilization, and/or that geochemical conditions may change over time reducing effectiveness of the removal/immobilization mechanisms, or that metals immobilized as precipitated metal compounds in decant pond sediments and groundwater have potential to become re-mobilized at some point in the future.

DEIS Appendix I states that the longevity of the natural attenuation mechanisms is dependent on the duration of the geochemical conditions conducive to attenuation and to the capacity of the tailing impoundment/aquifer sediments to continue to uptake metals. It concludes that the mineral precipitation
E-A-EPA1 and co-precipitation mechanisms are <u>expected to last indefinitely or in perpetuity as long as geochemical conditions remain similar to current conditions. The adsorption mechanisms are conservatively estimated to last a minimum of 600 years</u>. However, it is also acknowledged that there are limitations and uncertainties regarding the long-term effectiveness of the natural attenuation mechanisms, including:

1. The lack of actual post-closure mine water for evaluation;
2. The lack of the analysis of several metals in some previous investigations;
3. The very low or non-detectable concentrations of some metals;
4. The assumption of chemical equilibria or disequilibria in geochemical modeling;
5. Uncertainties in the thermodynamic data upon which geochemical calculations and modeling is based.

Mine adit flow volumes and decant pond infiltration rates over time also have certain data limitations and uncertainties. Appendix I states that in spite of the uncertainties it is felt that this study is a reliable prediction of post-mine closure water quality and the behavior of metals in the infiltration pond and groundwater system. The reliability of these predictions is bolstered by the empirical evidence of attenuation that has occurred for over thirty years.

The EPA remains concerned, however, about whether the "natural attenuation mechanisms" occurring in impoundment/decant pond sediments and groundwater will continue to function effectively in regard to metals removal or immobilization over the long-term, and/or that at some point immobilized metals may become re-mobilized (i.e., the natural attenuation mechanisms may be reversible). Long-term outcomes with natural attenuation are difficult to predict. What are the Kootenai National Forest's and Montana DEQ's contingency plans in the event that elevated levels of metals or other pollutants are found in groundwater downgradient from the impoundment/decant ponds and/or in Lake Creek at some point in the future after mine closure (e.g., decades into the future)?

It is also not clear to us if long-term water quality monitoring plans are adequate to allow detection of elevated metals levels in groundwater downgradient from the tailings impoundment should that occur in the future. The EPA has published technical guidance documents regarding the use of "Monitored Natural Attenuation" for the remediation of contaminated soil and ground water. EPA uses the term "Monitored Natural Attenuation" to emphasize the need to incorporate adequate monitoring when natural attenuation is relied upon for the remediation of contaminated soil and ground water.

E-A-EPA 2

While scientific understanding of natural attenuation processes is increasing, there is still much to be learned regarding the mechanisms governing natural attenuation processes and their ability to address contamination problems, particularly over the long-term. Therefore, while EPA believes monitored natural attenuation may be used where circumstances are appropriate, it should be used with caution commensurate with the uncertainties associated with a particular application. Furthermore, largely due to the uncertainty associated with the potential effectiveness of monitored natural attenuation to meet remediation or treatment objectives that are protective of human health and the environment, EPA expects that long-term performance monitoring must be a fundamental component of any monitored natural attenuation remedy.

Our detailed comments (enclosed) present and discuss EPA technical guidance documents regarding monitored natural attenuation. This technical guidance addresses long-term attenuation capacity and reversibility issues, and long-term monitoring and contingency plans. The EPA recommends that long-term attenuation capacity and reversibility issues, and long-term monitoring and contingency plans be more comprehensively addressed in the FEIS in a manner consistent with the EPA technical guidance documents.

We also note that an EPA contact person regarding monitored natural attenuation is Dr. Rick Wilkin of the EPA Ground Water and Ecosystem Restoration Division in Ada, Oklahoma (phone 580-436-8874). We have discussed the proposed natural attenuation mine water treatment at the Troy Mine with Dr. Wilkin, and he has indicated that he would be willing to discuss Monitored Natural Attenuation and monitoring and analysis needs further with the lead agencies in a telephone conference call if the lead agency staff are amenable to such discussions.

E-A-EPA 3

There are also uncertainties associated with the engineered design, operation and maintenance of the six mile pipeline from the underground mine to the decant ponds over the long term. Our detailed comments identify uncertainties and information/data needs for the pipeline, and include recommendations to reduce risk of pipeline leaks and spills. We also recommend that the FEIS provide additional information and clearer disclosure regarding the streams and wetlands that may be crossed by the pipeline, and more complete evaluation and discussion regarding stream and wetland impacts associated with pipeline construction, operation and maintenance.

E-A-EPA 4

Finally, it is EPA's understanding that discharge of mine water by infiltration into groundwater beneath the tailings impoundment has been occurring for many years (discharging at up to 1,170 gallons per minute to groundwater hydrologically connected to Lake Creek) without authorization by a Montana Pollutant Discharge Elimination System (MPDES/NPDES permit). Unpermitted discharges are expected to continue post-closure with transport of underground mine water to the decant ponds. While we understand that natural attenuation mechanisms are stated to occur in the decant pond sediments and groundwater that remove and/or immobilize metals, and it does not appear that elevated levels of metals

E-A-EPA4 are found in Lake Creek, we recommend that the MDEQ continue to monitor groundwater and Lake Creek, and carefully evaluate whether pollutants may move into Lake Creek via hydrologically connected groundwater in the future, and if so, reconsider the need for a MPDES Permit.

The EPA's further discussion and more detailed questions, comments, and/or concerns regarding the analysis, documentation, or potential environmental impacts of the Troy Mine Revised Reclamation Plan DEIS are included in the enclosure with this letter. Based on the procedures EPA uses to evaluate the adequacy of the information and the potential environmental impacts of the proposed action and alternatives in an EIS, the DEIS has been rated as Category EC-2 (Environmental Concerns - Insufficient Information) due to concerns regarding the long-term effectiveness of proposed mine water natural attenuation treatment and the adequacy of the long-term performance monitoring plan; uncertainties, environmental impacts and risk of spills from construction and operation of the mine water pipeline; and unpermitted mine water discharges to groundwater hydrologically connected to surface waters. A copy of EPA's DEIS rating criteria is attached.

The EPA appreciates the opportunity to review and comment on the DEIS. If we may provide further explanation of our comments please contact Mr. Stephen Potts of my staff in Helena at 406-457-5022 or in Missoula at 406-329-3313 or via e-mail at potts.stephen@epa.gov. Thank you for your consideration.

Sincerely,

Julie A. DalSoglio

Julie A. DalSoglio
Director
Montana Office

Enclosures

cc: Larry Svoboda/Peter Werner, EPA 8EPR-N, Denver
Dean Yashan/Robert Ray/Mark Kelley, MDEQ, Helena

EPA Detailed Comments on the Troy Mine Revised Reclamation Plan DEIS

Brief Project Overview: The Kootenai National Forest (KNF) prepared this DEIS to evaluate revised reclamation activities proposed at the Troy Mine, a copper-silver mine located about 15 miles south of the Town of Troy, Lincoln County, Montana, lying west and north of Bull Lake within the Stanley, Lake, and Ross Creek drainages. The mine permit area covers 2,782 acres of public, private, and patented land. Approximately 57 percent of the project area is on private and patented land, and the other 43 percent is on the KNF. Troy Mine facilities consist of an underground mine, mill, office facilities; the tailings and reclaim water pipelines; a power line; a tailings impoundment; and associated support facilities. The Troy Mine is operated by Troy Mine, Incorporated (Troy Mine, Inc.) formerly known as Genesis, Incorporated. The tailings facility and associated disturbances are located on approximately 430 acres of disturbed area owned by Troy Mine, Inc. Both the tailings and reclaim water pipelines and the power line are on KNF land, private, and patented land. The South Adit portal is located on patented land, while the North Adit portal and the mill and office/shop facilities are located on unpatented claims on the KNF. There are approximately 15.6 acres of disturbed land at the portal patios and 34 acres of disturbed lands at the mill site. Associated roads, pipelines and other small disturbed areas exist throughout the project area.

The purpose of the proposed reclamation plan is to return lands disturbed by mining to a condition appropriate for subsequent use of the area. A 1978 reclamation plan does not meet state or federal requirements for mine water discharge. The need for the revised reclamation plan stems from the need to meet state and federal requirements after mine closure; protect surface and groundwater quality and public health and safety; minimize environmental risk; and restore disturbed lands to productive use. The mining company prepared a revised reclamation plan and the final draft was submitted to the Agencies in March of 2006 (Genesis 2006). The 2006 Revised Reclamation Plan is the subject of this Draft EIS and is referred to as the Proposed Action.

Among the issues addressed in the DEIS are the potential for: discharges of mine water to surface water and exceedance of aquatic life standards; failure of the tailings pipeline potentially resulting in erosion and discharge of contaminants into Stanley or Lake creeks; and issues related to the long-term maintenance of the pipeline. Water Management issues include: 1) Adit closure and mine water distribution; 2) Water treatment and disposal; 3) Groundwater quality; 4) Surface water quality; and 4) Long-term monitoring of water quality. Reclamation issues include: 1) Reclamation materials; 2) Subsidence; 3) Revegetation; 4) Infrastructure (buildings and other structural materials and how they will be removed or reclaimed); and 5) Topography (disturbed areas).

Alternatives considered in detail include a No Action Alternative (the previously approved 1978 reclamation plan), the Proposed Action (Troy Mine, Inc.'s Revised Reclamation Plan), and an Agency-Mitigated Alternative (the Agencies preferred alternative). The DEIS analyzes Troy Mine, Inc.'s revised plan as well as agency-proposed modifications (e.g. adit closure, mine water management, water treatment and monitoring, reclamation cover requirements, subsidence monitoring, debris disposal, and road closures). The major state and federal actions include approval of a reclamation plan and any necessary permits to implement the reclamation activities including construction and long-term monitoring.

Comments:

B-A-EPA1

1. Thank you for including clear descriptions of the alternatives, including identification of the differences between No Action, the Proposed Action and the Agency-Mitigated Alternative, and Table 2-1 (pages 2-19 to 2-35) comparing features of the alternatives in relation to the major issues (i.e., Water Management, Adit Closure and Mine Water Distribution, Water Treatment and Disposal, Groundwater Quality, Surface Water Quality, Long-Term Monitoring of Water Quality, Reclamation, Reclamation Materials, Subsidence, Revegetation, Infrastructure, and Topography). This information improves project understanding and assists in providing a basis of choice among alternatives for both the decision maker and the public in accordance with the Council on Environmental Quality (CEQ) rules for implementing NEPA (40 CFR Part 1500). We also appreciate the inclusion of a clear watershed map in Figure 3-2 (page 3-46) showing locations of waterbodies in the project area in relation to mine facilities. Understanding of the location of waterbodies in relation to mine facilities is critical for environmental impact assessment.

Natural Attenuation Mechanisms for Metals Removal

E-A-EPA5

2. We want to reiterate and expand upon the discussion included in EPA's transmittal letter relating to our most significant concern regarding the preferred alternative (Agency-Mitigated Alternative), which is the long-term plan to discharge mine water draining from the underground workings to the decant ponds within the tailings impoundment after mine closure (page 2-52, ES-16). The preferred alternative proposes to capture mine water that would collect in the underground mine after closure and transport it via a new buried pipeline to the decant ponds at the tailings impoundment for final treatment and disposal in perpetuity. The DEIS states that mine water would be treated at the decant ponds through "natural attenuation mechanisms" as the water infiltrates, allowing metals concentrations to attenuate within the soils (page 3-77, and Appendices C, D, G, and I), such that the Agency-Mitigated Alternative would comply with the Clean Water Act and the Montana Water Quality Act (page 3-90).

   The DEIS states that the effectiveness of the natural attenuation mechanisms in treating mine-related water has been substantiated through monitoring of water at the tailings impoundment for the past 30 years as well as studies directed at understanding the geochemical processes that occur in the underlying soils and groundwater system. Table 3-11, "Groundwater Quality Data for Monitoring Wells at Tailings Impoundment 2000 – 2009" (page 3-59) indicates that antimony and copper concentrations downgradient of the tailings impoundment have consistently met groundwater quality standards; Table 3-9, "Surface Water Quality Data for Lake Creek, 2005 – 2009" indicates that antimony and copper water quality standards have been met at the Lake Creek monitoring station downstream of the impoundment (i.e., groundwater discharging to surface water in the vicinity of the impoundment does not compromise water quality in Lake Creek, page 3-53). The DEIS also states that during active operation of the mine up to 1,170 gpm of the decant pond water seeped through the unlined bottom of the ponds into the underlying aquifer, which is hydraulically connected to Lake Creek, yet elevated levels of metals have not been found in downgradient groundwater or in Lake Creek (pages 3-53, 3-61, 3-77).

Mechanisms for attenuating metals (removing them from groundwater) include dilution, precipitation, adsorption, and co-precipitation (page 3-77). DEIS Appendices D and I provide more detailed information regarding the natural attenuation mechanisms. The Appendix D, "Metals Attenuation Study," indicates that copper was attenuated within the upper foot of soil via the precipitation of secondary copper phases (carbonates, silicates, and oxides) as well as adsorption onto organic matter (Appendix D, page 1). Appendix D also states that should the initial removal mechanisms occurring beneath the decant ponds (i.e., precipitation) become less effective over time, there are additional existing geochemical mechanisms (i.e., co-precipitation and adsorption) capable of removing at least 73-98% of the copper, 11-59% of the antimony, and 35-84% of the uranium from groundwater (Appendix D, page 14).

The Appendix I, "Assessment of Natural Attenuation of Metals in a Decant Pond Disposal System," states that concentrations of metal parameters are much lower in the groundwater than in the mine water/decant pond, evidencing that metal parameters are attenuated (removed) in the groundwater system (Appendix I, page viii). Analyses of sediments in the decant pond reveal that metals are enriched in the sediments, supporting the view that metals attenuated/removed from groundwater are retained in the sediments. Geochemical modeling and lab experiments demonstrate that natural attenuation is provided by the precipitation of iron from mixing of mine water and decant pond water with natural ambient groundwater. Copper, iron, lead, and manganese minerals are oversaturated in mine water and are favored to precipitate from mine water. Appendix I states that precipitation of naturally-occurring iron and manganese in groundwater can significantly reduce the concentrations of arsenic, antimony, copper, lead, and uranium in mine water and decant pond water to levels below human health and aquatic life standards during groundwater transport within a short distance (ten to one hundred feet) of the decant ponds. (Appendix I, pages 1-5, 1-6). The geochemical mechanisms responsible for copper attenuation include primarily the formation of copper minerals and secondarily adsorption by organic matter in soils.

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The EPA acknowledges that there is empirical evidence that infiltration of mine water into groundwater beneath the Troy Mine tailings impoundment and decant ponds have apparently not resulted in elevated levels of copper and other metals in groundwater downgradient from the impoundment or in Lake Creek. Although it is not fully clear if all metals and metalloids of potential concern have been adequately evaluated. Monitoring should verify that all metals and metalloids that could potentially be present in mine waters are not present at the Troy Mine (at detectable levels), or if present, determine the concentrations at which they have been found (e.g., Ag, As, Bi, Cd, Co, Cr, Cu, Hg, Mn, Mo, Ni, Pb, Sb, Se, Tl, U, V and Zn).

The EPA is concerned about the long-term effectiveness of the "natural attenuation mechanisms," since this treatment and disposal system is proposed to occur in perpetuity. We are concerned that there may be a finite capacity for metals removal and/or immobilization, and/or that geochemical conditions may change over time reducing effectiveness of the removal/immobilization mechanisms, or that metals immobilized as precipitated metal compounds in decant pond sediments and groundwater, may become re-mobilized at some point in the future (i.e., the natural attenuation mechanisms may be reversible).

Appendix I states that the longevity of the natural attenuation mechanisms is dependent on the duration of the geochemical conditions conducive to attenuation and to the capacity of the tailing impoundment/aquifer sediments to continue to uptake metals (Appendix I, page 9-2). It concludes that the mineral precipitation and co-precipitation mechanisms are expected to last indefinitely or in perpetuity as long as geochemical conditions remain similar to current conditions. The adsorption mechanisms are conservatively estimated to last a minimum of 600 years.

However, it is also acknowledged that there are limitations and uncertainties regarding the long-term effectiveness of the natural attenuation mechanisms, including (Appendix I, page 1-8):

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1. The lack of actual post-closure mine water for evaluation;
2. The lack of the analysis of several metals in some previous investigations;
3. The very low or non-detectable concentrations of some metals;
4. The assumption of chemical equilibria or disequilibria in geochemical modeling;
5. Uncertainties in the thermodynamic data upon which geochemical calculations and modeling is based.

Appendix I states that in spite of these uncertainties it is felt that this study is a reliable prediction of post-mine closure water quality and the behavior of metals in the infiltration pond and groundwater system. The reliability of these predictions is bolstered by the empirical evidence of attenuation that has occurred for over thirty years.

The EPA remains concerned, however, about whether the "natural attenuation mechanisms" occurring in impoundment/decant pond sediments and groundwater will continue to function effectively in regard to metals removal or immobilization over the long-term, and/or that at some point immobilized metals may become re-mobilized. What are the Kootenai National Forest's and Montana DEQ's contingency plans in the event that elevated levels of metals (or metalloids) are found to develop in groundwater downgradient from the impoundment/decant ponds and/or in Lake Creek at some point in the future after mine closure (e.g., decades into the future)?

It is also not clear to us if long-term water quality monitoring plans are adequate to allow detection of elevated metals levels in groundwater downgradient from the tailings impoundment should that occur in the future. The EPA has published technical guidance documents regarding the use of "monitored natural attenuation" for the remediation of contaminated soil and ground water (EPA, Office of Solid Waste and Emergency Response, Directive 9200.4-17P, April 1999). EPA uses the term "Monitored Natural Attenuation" to emphasize the need to incorporate adequate monitoring when natural attenuation is relied upon for the remediation of contaminated soil and ground water.

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While scientific understanding of natural attenuation processes is increasing, there is still much to be learned regarding the mechanisms governing natural attenuation processes and their ability to address contamination problems, particularly over the long-term. Long-term outcomes are very difficult to predict. Therefore, while EPA believes monitored natural attenuation may be used where circumstances are appropriate, it should be used with caution commensurate with the uncertainties associated with a particular application. Furthermore, largely due to the uncertainty

associated with the potential effectiveness of monitored natural attenuation to meet remediation or treatment objectives that are protective of human health and the environment, EPA expects that long-term performance monitoring must be fundamental components of any monitored natural attenuation remedy.

EPA technical guidance regarding monitored natural attenuation that we draw to the lead agencies attention include:

"Monitored Natural Attenuation of Inorganic Contaminants in Ground Water, Volume 1 - Technical Basis for Assessment" (EPA/600/R-07/139, October 2007, http://www.epa.gov/nrmrl/pubs/600R07139/600R07139.pdf);

"Monitored Natural Attenuation of Inorganic Contaminants in Ground Water, Volume 2 Assessment for Non-Radionuclides Including Arsenic, Cadmium, Chromium, Copper, Lead, Nickel, Nitrate, Perchlorate, and Selenium" (EPA/600/R-07/140, October 2007, http://www.epa.gov/nrmrl/pubs/600R07140/600R07140.pdf);

E-A-EPA 5 "Metal Attenuation Processes at Mining Sites," ((EPA/600/R-07/092) September 2007, http://www.epa.gov/nrmrl/pubs/600r07092/600R07092.pdf).

See also the EPA website on Monitored Natural Attenuation, http://www.epa.gov/nrmrl/gwerd/gw/mna.html, and note that there is also a publication, "A Citizen's Guide to Monitored Natural Attenuation," EPA 542-F-01-004, April 2001, http://www.clu-in.org/download/citizens/mna.pdf).

These EPA technical guidance documents address long-term attenuation capacity and reversibility issues, and long-term monitoring plans in the context of Tier 3 and Tier 4 analyses. In Tier 3 analysis EPA recommends that long-term capacity and reversibility be specifically investigated. The DEIS states that mechanisms are expected to last indefinitely as long as geochemical conditions remain similar. This may be reasonable, but this type of broad conclusion typically requires a fairly detailed study of bonding/uptake mechanisms of metals in the solid phase and lab-based extractability assessments. It is not clear if the studies identified in Appendices D and I adequately address EPA Tier 3 analysis requirements. Tier 4 deals with the development of a long-term monitoring plan and the development of a contingency plan in case trends revealed by the monitoring data fail to meet expectations. We are including additional discussion of long-term water quality monitoring and Tier 4 analysis in our following comment (comment No. 3).

The EPA recommends that long-term attenuation capacity and reversibility issues, and long-term monitoring and contingency plans be more comprehensively addressed in the FEIS in a manner consistent with the EPA technical guidance documents referenced above.

Long-term Water Quality Monitoring

E-A-EPA6 3. DEIS Table 2-1 (page 2-23) includes information on long-term monitoring of water quality for each alternative, and brief narrative discussion of monitoring is included for each alternative

(pages 2-38, 2-39, 2-45, 2-46, 2-54). The DEIS states that the Agency-Mitigated Alternative includes water quality monitoring of springs in the analysis area to validate the prediction that water quality standards would be met post-closure (page 3-23). However, proposed long-term water quality monitoring is presented in a disjointed manner in the DEIS. The narrative monitoring discussions refer the reader to Table 2-2, "No Action Alternative Groundwater Monitoring Sites and Schedule" (page 2-36, 2-37), Table 2-3, "No Action Alternative Surface Water Monitoring Sites" (page 2-38), and Figure 2-5 "Proposed Surface and Groundwater Monitoring Sites" (page 2-40). The DEIS reader must flip back and forth between the narrative discussions of monitoring for each alternative and Tables 2-2 and 2-3 and Figure 2-5 in an effort to understand proposed long-term water quality monitoring.

It is not clear to us from Figure 2-5 which groundwater monitoring sites are immediately downgradient from the decant ponds at the tailings impoundment, or if these sites are adequate or appropriate groundwater monitoring sites. It is also not clear which pollutant parameters would be analyzed and which analytical methods would be used at each site. It appears that groundwater samples would be collected three times per year (spring, summer, fall, page 2-37), and that the preferred alternative includes a commitment to monitor water quality post-closure for a minimum of five years after mine water discharge actually commences (page 2-54), and/or until the Agencies agree that monitoring is no longer necessary (page 2-23).

E-A-EPA6

We believe a more detailed, comprehensive long-term water quality monitoring plan for groundwater and surface water, particularly for waters downgradient from the tailings impoundment decant ponds, must be disclosed to assure that adequate long-term performance monitoring is incorporated into the natural attenuation treatment plan. This is necessary to assure that the natural attenuation mechanisms continue to be effective in removing/immobilizing metals over the long-term, and that if metals levels increase for any reason, such increases will be identified and detected so they may be mitigated. A contingency plan in case trends revealed by the monitoring data fail to meet expectations is also needed.

We refer the lead agencies to the EPA monitored natural attenuation guidance documents referenced in our comment above for identification and discussion of factors that should be considered in developing a long-term performance monitoring plan for groundwater downgradient from the decant ponds. In particular we recommend pages 18 to 22 in the document, "Monitored Natural Attenuation of Inorganic Contaminants in Ground Water, Volume 1 - Technical Basis for Assessment," EPA/600/R-07/139, October 2007, http://www.epa.gov/nrmrl/pubs/600R07139/600R07139.pdf.

A list of pollutant parameters and proposed analytical methods at each monitoring site along with monitoring frequency should be clearly presented. The monitoring plan should be designed to monitor specific metals of concern. Monitoring parameters that should be considered include metals and metalloids that could be present or of concern in Troy Mine waters (e.g., Ag, As, Bi, Cd, Co, Cr, Cu, Hg, Mn, Mo, Ni, Pb, Sb, Se, Tl, U, V and Zn). Monitoring should also include other parameters that link to the proposed attenuation mechanisms, such as pH, redox conditions, dissolved oxygen, dissolved organic carbon, and concentrations of major cations (Ca, Mg, Na, K) and anions (SO4, Cl, HCO3), so that geochemical conditions required for natural attenuation can be tracked. Nitrogen parameters (total nitrogen, nitrite+nitrate nitrogen, kjeldahl nitrogen,

ammonia nitrogen) should also monitored to evaluate potential presence of contaminants from mine blasting residues.

Monitoring plans should also include well defined triggers that would initiate the implementation of additional evaluation and/or contingency remedial technologies if natural attenuation processes fail to fulfill expectations. Potential chemical and biological monitoring indicators that will be used to signify that natural attenuation treatment may be failing should be identified with trigger values defined. Long-term monitoring plans must be adequate to detect if natural attenuation may be failing at some point, and if monitoring triggers indicate potential failure that should result in follow-up monitoring and investigation. A different reclamation treatment approach may need to be implemented in the event of failure of natural attenuation. Such measures should be incorporated into a monitoring and contingency/corrective action plan.

E-A-EPA6 EPA's Monitored Natural Attenuation technical guidance documents for Tier 4 analysis recommends:

- Select monitoring locations and frequency consistent with site heterogeneity
- Select monitoring parameters to assess consistency in hydrology, attenuation efficiency, and attenuation mechanism
- Select monitored conditions that "trigger" re-evaluation of adequacy of monitoring program (frequency, locations, data types)
- Select alternative remedy best suited for site-specific conditions

We believe some level of monitoring will likely need to be conducted in perpetuity to assure that natural attenuation mechanisms remain effective in perpetuity. Although monitoring frequency can be reduced over time if monitoring results do not evidence contamination (e.g., reduce monitoring to twice per year, then annually, then biennially, etc.). However, some minimal level of monitoring will likely need to be conducted over the very long-term to validate continued effectiveness of natural attenuation. Bonding and financial assurances should provide adequate funding for long-term monitoring, and implementation of an alternative treatment reclamation approach in the event of failure of natural attenuation.

Decant Ponds

E-A-EPA7 4. The DEIS states that copper is attenuated within the upper foot of soil of the decant ponds via the precipitation of secondary copper phases (carbonates, silicates, and oxides) as well as adsorption onto organic matter (Appendix. D, page 1). It is also stated that the decant ponds would be cleaned out periodically (page 2-21). If heavy metals precipitate and accumulate in the upper foot of soil in the decant ponds and ponds are periodically cleaned out, it is not clear to us where the metal laden sediments removed from the decant ponds will be disposed. Disposal of metal laden sediments resulting from the periodic clean out of the decant ponds should be described in the FEIS (i.e., identification of the depository or landfill where metal laden sediments would be taken for final disposal).

E-A-EPA7 Also, is there any potential that the periodic clean out of sediments from the decant ponds will mobilize some pollutants, or over time impair the efficacy of the "natural attenuation mechanisms" and/or pollutant removal efficiency of the decant pond?

E-A-EPA8 5. The volume calculations for infiltration in the decant ponds appear to be based on an oversimplification of the hydrogeology in the area of the decant pond as demonstrated by the tracer tests described in Appendix C. We are concerned about the data limitations and uncertainties associated with decant pond infiltration rates over the long-term. Contingency planning should address this uncertainty.

E-A-EPA9 6. The DEIS states that domestic wells in the vicinity of the tailings impoundment would not be affected (page 3-89). The EPA recommends that the FEIS identify the location and proximity of nearby domestic wells to the tailings impoundment (e.g., wells within a mile).

Nutrients

E-A-EPA10 7. The DEIS states (page 3-58) that if nutrients in shallow groundwater discharge locally to surface water (as they may at the toe ponds) nuisance algal growth could occur, although numeric exceedances for the aquatic life standard for ammonia or for the human health standard for nitrate plus nitrite are not observed in the toe pond water quality data. Nonetheless, the DEIS states that nitrate plus nitrite levels may be high enough at times to promote nuisance algal growth in the toe ponds. Table 3-11 shows ammonia levels as high as 4.2 mg/l in groundwater (MW95-4) and nitrate+ nitrite levels as high as 1.19 mg/l. Table 3 in Appendix F (Appendix F, page 11) shows decant pond water ammonia levels from 4.4 to 11.2 mg/l, Nitrate+nitrite N from 14.5 to 37.6 mg/l; Mine water disused area ammonia levels of 0.39 mg/l and Nitrate+nitrite of 7.4 mg/l; and Adit discharge ammonia levels of 2.33 mg/l and Nitrate+nitrite of 7.99 mg/l. Currently, nitrate concentrations in the tailings decant pond water range between 10 mg/L and 30 mg/L, and concentrations in monitoring wells located close to the decant ponds are similar. However, monitoring wells and the toe ponds downgradient of the tailings impoundment generally have nitrate concentrations of less than 1 mg/L (Table 3-11).

The DEIS states that after cessation of mining, addition of nitrate to the tailings impoundment would cease (page 3-70), and residual nitrate would slowly be rinsed out of the tailings by precipitation and diluted in the groundwater, and concentrations of nitrate in the underlying aquifer would decline. Nitrate concentrations are expected to decline rapidly after mining ends, as was observed during the interim mine shut-down between 1993 and 2004, because nitrate-rich mine water will no longer be discharged in the tailings impoundment.

While we agree that nitrogen levels in mine waters discharged to the decant ponds are likely to decline after mining ends there does appear to be potential for elevated nitrogen levels to occur in groundwater and surface waters hydrologically connected to groundwater. It is important to recognize that recent scientific studies have increased concerns about impact of even low levels of nitrogen in surface waters in regard to stimulation of growth of algae and undesirable aquatic vegetation. The Montana DEQ is developing numeric water quality criteria intended to control excessive nutrient (nitrogen and phosphorus) pollution in Montana's streams, rivers, and lakes to

assure a level of water quality that will protect the beneficial uses of these waterbodies, (see DEQ website, http://deq.mt.gov/wqinfo/standards/NumericNutrientCriteria.mcpx).

E-A-EPA10 In 2008, DEQ released the report, "Scientific and Technical Basis of the Numeric Nutrient Criteria for Montana's Wadeable Streams and Rivers" which included draft numeric nutrient criteria that, if achieved, ensure protection of designated uses. The 2008 report proposed a total nitrogen criterion of 0.233 mg/l for the Northern Rockies ecoregion as the concentration that would ensure protection of aquatic life and recreational uses. We recommend that the revised reclamation plan take this science into consideration and that the closure and post-closure monitoring include monitoring for nitrogen parameters and growing season chlorophyll in the long-term water quality monitoring plan so that the response of the algal community to nitrogen loading can be identified and mitigated if need be.

MPDES/NPDES Permits

8. The DEIS states that during active operation of the mine, Troy Mine, Inc. typically uses the tailings impoundment and decant ponds to settle out suspended sediment from the tailings slurry, and then clarified tailings/decant pond water is pumped to the mill circuit via a return line (page 3-60). The DEIS also states that up to 1,170 gpm of the decant pond water seeps through the unlined bottom of the ponds into the underlying aquifer (i.e., or approximately 1.7 million gallons per day). The 2001 Hydrometrics report (Appendix H) indicated that, while deep groundwater and the decant ponds system are hydraulically connected, most of the decant pond water is transported downgradient (towards Lake Creek) via the shallow alluvial aquifer (page 3-61); and it is also stated that groundwater beneath the tailings moves in a westerly direction and eventually discharges to Lake Creek (Summit Envirosolutions 1996, page 3-77).

E-A-EPA11 It appears, therefore, that discharge of mine water by infiltration into groundwater beneath the tailings impoundment has been occurring for many years (groundwater hydrologically connected to Lake Creek). Such discharges are also proposed to occur after mine closure when underground mine waters will be piped to the decant ponds as the plan for treatment and disposal of mine waters over the long-term. It also appears that the amount of mine water infiltrating into groundwater may potentially increase after mine closure if the discharge to the decant ponds from the underground mine were to be anything close to the maximum pipeline design flow of 6.9 cfs (~3,100 gpm). It is our understanding that existing and proposed discharges of mine water to groundwater hydrologically connected to Lake Creek have been occurring without authorization by an Montana Pollutant Discharge Elimination System (MPDES) permit, and such unpermitted discharges are expected to continue post-closure.

While we understand that natural attenuation mechanisms are stated to occur in the decant pond sediments and groundwater that remove and/or immobilize metals, and it does not appear that elevated levels of metals are found in Lake Creek, we recommend that the MDEQ continue to monitor groundwater and Lake Creek and carefully evaluate whether pollutants may move into Lake Creek via hydrologically groundwater in the future, and if so, reconsider the need for a MPDES Permit.

303(d) Listed Streams and Total Maximum Daily Loads (TMDLs)

9. The discussion of exceedances of copper water quality standards in upper Stanley Creek indicates that the source(s) of these exceedances may be due to several factors, including sediment generated from surface water erosion of naturally copper-bearing soil, groundwater seeping from the mine void, erosion of copper-bearing soil from the portal patios, or groundwater containing naturally-elevated copper concentrations from mineralization in the area (page 3-85). The DEIS states that the occasional low-level naturally-occurring copper exceedances in upper Stanley Creek would be expected to continue through post-closure for all alternatives. There have historically been numerous detections of copper in Fairway Creek despite the Fairway site being upgradient of the mine. The DEIS indicates that the most likely reason for these detections is that copper occurs naturally in the region and is present in soils and sediment.

The MDEQ's Clean Water Act 303(d) listing website (http://cwaic.mt.gov/query.aspx) lists Stanley Creek as water quality impaired (from headwaters to confluence with Fairway Creek, 4 miles, MT76D002_010) with only partial support for aquatic life and cold water fishery uses with probable causes listed as unknown, copper, nutrients, and biological indicators, and probable sources listed as mine tailings and streambank modifications/destabilization. If natural sources of copper in the Stanley Creek drainage are believed to be causing water quality standards exceedances rather than mine tailings, it would be appropriate to revise the information on the MDEQ 303(d) listing website for Stanley Creek accordingly.

E-A-EPA12

Similarly the disclosure of Lake Creek water quality in Table 3-9 (page 3-53) suggests potential for only low level exceedances of copper water quality criteria. This table does not include identification of cadmium, lead or mercury levels, which are among the listed pollutants causing water quality impairment for Lake Creek on MDEQ's Clean Water Act 303(d) website. Lake Creek is listed as water quality impaired (Bull Lake outlet to mouth, 17.6 miles, MT76D002_070) with only partial support for aquatic life and cold water fishery uses, and no support for drinking water use, due to cadmium copper, lead, mercury and zinc, nitrate/nitrite, and sedimentation from mine tailings, natural sources, and forest roads.

It is also worthy of note that the DEIS states that copper and antimony are the constituents of concern (page 3-50) because they have exceeded water quality standards for surface water in the mine water (i.e., copper concentrations averaged 0.041 mg/L and antimony concentrations have averaged 0.010 mg/L during mine operations; and during an interim shutdown copper concentrations were somewhat higher, averaging 0.059 mg/L, and antimony concentrations averaged 0.011 mg/L (Table 3-7, page 3-51). However, copper, cadmium, lead, mercury and zinc are listed by MDEQ as the probable causes of Lake Creek water quality impairment, but the MDEQ website does not identify antimony as a probable cause of impairment. Table 3-7 in the DEIS does not identify cadmium, lead and mercury levels in mine waters.

The DEIS discussion of metals levels in Stanley and Lake Creeks appear, therefore, to be disconnected from the MDEQ's water quality impairment listings. It will be important that further evaluation of water quality impairments in Lake Creek and Stanley Creek and their magnitude and causes take place early in the development of the TMDL's for Stanley and Lake

E-A-EPA12 Creeks. It will also be important the Troy Mine long-term reclamation plan be consistent with the development of TMDLs to improve water quality and restore full support for designated uses in these waterbodies.

Pipeline Design

10. As noted earlier, the Agency-Mitigated Alternative proposes constructing and burying a new pipeline that would transport water from the underground mine (Service and Conveyor Adits) to the decant ponds at the tailings impoundment instead of using the existing tailings pipelines (page 3-80). The DEIS indicates that the new pipeline would include a leak detection system and be double-lined at creek crossings to minimize the potential of discharge directly to streams (page 3-80). It is important that attention directed at reducing risk of pipeline leaks and spills, since we understand that there have been past tailings pipeline spills at the Troy Mine that have resulted in elevated metals levels in surface waters.

Appendix G provides information on the conceptual design of the proposed new pipeline. It is stated that the pipeline would follow the existing tailings/slurry pipes, approximate the land gradient, and have the hydraulic capacity to handle all of the estimated peak discharge of 6.9 cfs under gravity flow (Appendix G, page 2). The volume of flow over time after closure as provided in Appendix C appears to be a rough estimate. What are the provisions for collecting additional information for input into the final engineering design for the pipeline? For example, as the groundwater flow fluctuates seasonally, a design flow based upon averages is not robust and additional data will be needed before final design. The analysis of discharge is based upon existing operating conditions rather than closure conditions, and appears to be based on a E-A-EPA13 simplification of the groundwater fracture flow conditions at the mine site. We recommend that the pipeline be designed for the highest forecasted flow over the timeframe that it will be used, not the "extreme event of over a ten-year recurrence interval" as stated in Appendix C (page 4). Also, if the water pressure may fluctuate, those fluctuations also need to be taken into account. Pipeline design considerations for freeze/thaw and for stability with steep slopes and transitions from steep to gentle slopes are not well described.

We recommend burying the pipeline at a depth below the freeze level across the entire width of the stream, meander zone, and active floodplain, such that if there is any stream movement the pipe is not exposed to erosive action of bedload and debris in moving water. In addition, we recommend consideration of using a secondary sleeve similar to how water supply pipes are often put in at stream crossings, so in case there is a leak under the stream the pipe can be replaced by removing old pipe and inserting new pipe into the sleeve without disturbing the stream again - the sleeve can be placed using a boring system or a trench. Also, if the pipe is to be hung over the stream or gully, it should be high enough to clear any substantial flood (FEMA a 100 year flood is reasonably foreseeable). Additional valving should also be considered at major slope transitions where they may be a higher likelihood of pipeline failure (e.g., transitions from 12% slope).

Appendix G suggests that smooth HDPE pipe may be used, in which case pipe corrosion is likely not a concern (i.e., sometimes installation of a casing pipe around a metal pipeline at crossings of rivers may actually increase the probability of a spill at or near a river or stream, since air and

moisture accumulation between the casing and pipe has potential to aggravate pipe corrosion, but this should not be a concern with HDPE pipe material). Other measures that the lead agencies and company may want to consider to reduce risk of a pipeline spills or leaks include:

-Locate pipeline as much as possible away from streams and wetlands, and minimize pipeline crossings of streams and wetlands

-Pipeline valving shut-off arrangements that limit the magnitude/volume of a spill at any one time (periodic block and check valves). Mainline block valves and check valves located upstream and downstream of river/stream crossings to allow stoppage of flow should leaks or pipeline damage occur at river and stream crossings, and additional valving is also recommended at major slope transitions where they may be a higher likelihood of pipeline failure.

[We note that Appendix G states that the static capacity of the pipeline is about 250,000 cubic feet (~1.87 million gallons), which is the maximum amount of mine water that could drain from the pipe should a break occur at its lowest point (Appendix G, page 2). It is also stated that this amount could be reduced with the addition of automatically controlled valves along the length of the pipeline, but this design feature was not incorporated into the design. <u>We recommend that additional automatic valving be incorporated into the design to reduce potential spill volumes.</u>]

E-A-EPA13

-Increase pipeline thickness at stream crossings.

-Use cathodic protection along the entire length of pipeline or coat pipeline with a minimum of 8 mils of fusion bonded epoxy coating (FBE), 6 mils of copolymer adhesive, and 40-75 mils of high density polyurethane (HDPE) to protect the pipe from corrosion (if metal pipe were used).

-Use state-of-the art "smart pig" system to detect deformities on the inside of the pipe, and"smart pig" internal pipeline inspections within three years of the initial hydrostatic pipeline testing, and schedule subsequent periodic inspections (e.g. every two years) to reduce the risk of undetected deformities causing spills.

-Regular hydrostatic testing to evaluate pipeline integrity during operations.

-Have a Contingency Plan and Emergency Response plan for the pipeline, containing information on spill response procedures to be followed and actions to be taken in the event of a spill. The Plan also should identify the specific procedures to mitigate potential adverse environmental impacts (i.e., on surface water, ground water, soils, fisheries, wildlife, recreation, human health and safety) and discuss the location of equipment and expertise available to each length of the route to respond to environmental cleanup. Special conditions such as weather impaired and cold weather response procedures should be included.

E-A-EPA14 11. The DEIS states that an average of 2.3 cfs of water is displaced from the mine workings to areas (e.g., the decant ponds) more distant from the mine (page 3-67). How does the reference to 2.3

E-A-EPA14 cfs being displaced from the mine workings to the decant ponds relate to the range of flows estimated between 300 gpm (0.67 cfs) to 3100 gpm (6.9 cfs) being directed from the underground mine workings to the decant ponds (page 3-76)?

E-A-EPA15 12. The reclaim water line is proposed for use after mine closure as an emergency line for transport of mine adit discharge in the event of a leak in the new buried pipeline (Appendix G, page 2). However, it stated that the reclaim water line will only handle approximately half of the estimated maximum 6.9 cfs under gravity flow conditions (Appendix G, page 3). It is also stated that the reclaim water line could handle the full estimated flow if it is retrofitted with appropriate vacuum relief and pressure relief valves. We recommend that the reclaim water line be appropriately retrofitted to allow it to handle the highest potential flow over the timeframe that it will be used.

13. The DEIS states that no activities are proposed under any alternative that would discharge fill materials into water bodies or that would impact wetlands (page 3-91), however, since there are statements that the proposed pipeline would be double-lined at stream crossings (page 3-80), it leads us to believe that there will be pipeline stream crossings, and there may be potential for stream impacts during pipeline construction, and/or impacts to wetlands which are often associated with streams. Figure 1 in Appendix G includes a map with a proposed pipeline routing, but streams and wetlands are not clearly depicted on this map. We did not see clear disclosure of the number of streams and wetlands acreage that may be crossed. The EPA recommends that the FEIS clearly disclose the number of streams the pipeline may cross and if it would cross any wetlands, and more fully evaluate and discuss potential stream and wetland impacts associated with pipeline construction.

There may also be potential for disturbing wet areas during removal of stockpiled soils below the toe ponds for use in tailings impoundment reclamation (page 3-214). Areas of disturbance from this activity should be assessed for the presence of, and potential impacts to, wetlands.

E-A-EPA16

We also encourage the lead agencies and Troy Mine, Inc. to contact Mr. Todd Tillinger of the U.S. Army Corps of Engineers, Montana Office in Helena at 406-441-1375 or Ms. Christina Schroeder of the Corps of Engineers, Missoula Office at 406-541-4845 extension 328, to determine applicability of Clean Water Act Section 404 permit requirements to proposed pipeline and other mine reclamation construction activities in or near streams or wetlands. We also note that other federal, state and local regulatory requirements may be needed for project implementation should construction activities occur in or near streams and wetlands (e.g., Montana Section 318 turbidity exceedance authorizations, Clean Water Act Section 401 certification, Montana 310 permit requirements, Montana Stream Protection Act 124 permits, etc.).

The Council on Environmental Quality (CEQ) regulations for implementing NEPA state that federal agencies shall to the fullest extent possible integrate the requirements of NEPA with other planning and environmental review procedures required by law or by agency practice so that all such procedures run concurrently rather than consecutively (40 CFR 1500.2(c)). To ease the administrative burden the Federal and State agencies in Montana have developed a single permit application for the various potential permits or authorizations that may be needed

E-A-EPA16 (http://dnrc.mt.gov/permits/default.asp , http://dnrc.mt.gov/permits/streampermitting/joint_application.asp). Also a Montana Stream Permitting Guide is available to explain the various permitting authorities http://dnrc.mt.gov/permits/streampermitting/guide.asp.

Drainage Channels:

E-A-EPA17 14. In the Agency-Mitigated Alternative, all drainage channels would be built from imported rock rather than from mine development rock to further minimize the potential for near-neutral metal mobility (page 3-40). EPA agrees with and supports the use of rock with low metal leaching or mobility potential for drainage channel construction. The source of this imported rock, however, is not identified. What is the source of the imported rock, and are there any adverse environmental impacts associated with collecting and transporting the imported rock to drainage channel construction sites?

Geochemistry of New Ore Zones

E-A-EPA18 15. Is it expected that the ore zones to be mined in the future will have a geochemistry similar to the ore zones mined in the past, and thus, confirm that metals leaching predictions for the future can be reliably predicted on prior experience and observations? We recommend that the geochemical testing and evaluation methods that will be used to confirm that the new ore zones will be analogous to the previously mined areas be identified and described in the FEIS.

Flow Reduction

E-A-EPA19 16. Reduction in groundwater flows to Ross and Stanley Creeks, especially Stanley Creek, are identified as a water quantity impact caused by pumping underground mine water to the decant ponds (page 3-80). However, the extent of surface water flow reduction is not quantified or estimated, and potential impacts on aquatic life associated with this reduction in streamflow in Stanley Creek are not identified. The DEIS states that changes in surface water flows and locations are expected to be minimal after mine closure because discharges are not expected to vary measurably at the surface water monitoring sites and because the potential for new, higher elevation springs to develop would be limited. Although it is acknowledged that surface water flows after mine closure would likely remain less than pre-mining flows in the vicinity of the workings (page 3-67).

We recommend that additional information be provided regarding estimated flow reductions in Stanley Creek, and likely impacts to aquatic life associated with such streamflow reductions (e.g., estimates of pre-project baseline streamflows or ranges of flow vs. post-closure streamflows or ranges of flow; estimates of potential impacts to aquatic life associated with flow reduction). If such information is not available we recommend that the direction in 40 CFR 1502.22 be followed for incomplete or unavailable information.

E-A-EPA20 17. EPA also suggests that regular multi-spectral aerial photography be used to monitor for presence of new springs, loss of springs, and changes in habitat and vegetative cover in and around aquatic

E-A-EPA20 systems. Preparation of a baseline conditions map is recommended to assist in future comparisons. The company should also clarify how trends will be determined and reported.

Roads

I-A-EPA1 18. We appreciate the inclusion of road improvement, reclamation and decommissioning activities in the Agency-Mitigated Alternative to reduce potential over the long-term for road sediment transport to surface waters and reduce road maintenance costs (Table 2-1, pages 2-30 to 2-32). We are pleased that the Agency-Mitigated Alternative would result in the passive decommissioning of 3.8 miles of road and the active decommissioning of 2.7 miles of road (page 3-120); existing roads would be improved to USFS specifications and 6 miles of paved surface on NFSR 4626 would be replaced with gravel (page 3-134). Roads that are not needed would be ripped, covered with reclamation materials, and revegetated. The Agency-Mitigated alternative would implement BMPs on 19.2 miles of road needed for long-term access (includes stored service work) and decommissions 6.5 miles of unneeded road, thereby reducing long-term road maintenance costs as compared to the Proposed Action. Private roads on Troy Mine, Inc. property at the tailings impoundment would be field reviewed by the Agencies to decide if they are needed for post-mine land uses. We are pleased that this road stabilization work would be carried out and decrease long-term sediment delivery to Stanley and Lake Creeks in comparison to the existing conditions and the Proposed Action (pages 3-88, 3-89).

Other

K-A-EPA1 19. Will the decant ponds and their metals levels present hazards to wildlife, including birds? Is there a need to keep the decant ponds fenced to prevent wildlife entry to these treatment ponds after mine closure?

E-A-EPA21 20. In regard to the allegations that 55 gallon drums were buried in the impoundment years ago by ASARCO (page 2-16), was it ever determined where those drums were buried and what was contained in them? Were the drums ever found and removed?

U.S. Environmental Protection Agency Rating System for Draft Environmental Impact Statements

Definitions and Follow-Up Action*

Environmental Impact of the Action

LO - - Lack of Objections: The Environmental Protection Agency (EPA) review has not identified any potential environmental impacts requiring substantive changes to the proposal. The review may have disclosed opportunities for application of mitigation measures that could be accomplished with no more than minor changes to the proposal.

EC - - Environmental Concerns: The EPA review has identified environmental impacts that should be avoided in order to fully protect the environment. Corrective measures may require changes to the preferred alternative or application of mitigation measures that can reduce these impacts.

EO - - Environmental Objections: The EPA review has identified significant environmental impacts that should be avoided in order to provide adequate protection for the environment. Corrective measures may require substantial changes to the preferred alternative or consideration of some other project alternative (including the no-action alternative or a new alternative). EPA intends to work with the lead agency to reduce these impacts.

EU - - Environmentally Unsatisfactory: The EPA review has identified adverse environmental impacts that are of sufficient magnitude that they are unsatisfactory from the standpoint of public health or welfare or environmental quality. EPA intends to work with the lead agency to reduce these impacts. If the potential unsatisfactory impacts are not corrected at the final EIS stage, this proposal will be recommended for referral to the Council on Environmental Quality (CEQ).

Adequacy of the Impact Statement

Category 1 - - Adequate: EPA believes the draft EIS adequately sets forth the environmental impact(s) of the preferred alternative and those of the alternatives reasonably available to the project or action. No further analysis of data collection is necessary, but the reviewer may suggest the addition of clarifying language or information.

Category 2 - - Insufficient Information: The draft EIS does not contain sufficient information for EPA to fully assess environmental impacts that should be avoided in order to fully protect the environment, or the EPA reviewer has identified new reasonably available alternatives that are within the spectrum of alternatives analyzed in the draft EIS, which could reduce the environmental impacts of the action. The identified additional information, data, analyses or discussion should be included in the final EIS.

Category 3 - - Inadequate: EPA does not believe that the draft EIS adequately assesses potentially significant environmental impacts of the action, or the EPA reviewer has identified new, reasonably available alternatives that are outside of the spectrum of alternatives analyzed in the draft EIS, which should be analyzed in order to reduce the potentially significant environmental impacts. EPA believes that the identified additional information, data, analyses, or discussions are of such a magnitude that they should have full public review at a draft stage. EPA does not believe that the draft EIS is adequate for the purposes of the National Environmental Policy Act and or Section 309 review, and thus should be formally revised and made available for public comment in a supplemental or revised draft EIS. On the basis of the potential significant impacts involved, this proposal could be a candidate for referral to the CEQ.

* From EPA Manual 1640 Policy and Procedures for the Review of Federal Actions Impacting the Environment. February, 1987.

2011-08-01 JMayoLincolnCoPortAuthority.pdf

LINCOLN COUNTY PORT AUTHORITY

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DEQ
DIRECTOR'S OFFICE

Board Members

Jim Mayo
Chair
Russ Barnes
Board Member
Craig Eaton
Board Member
Ardell Filler
Board Member
John Konzen
Lincoln County Commissioner
Doug Watson
Board Member
Sam Shupe
Board Member

P.O. 1071
Libby, MT. 59923

Phone: 406-293-8406
Fax: 406-293-2532
Email:krdc@frontiernet.net

H2

H1

C4

August 1, 2011

Emily Corsi
Montana DEQ
PO Box 200901
Helena, MT 59620-0901

Bobbie Lacklen
Kootenai National Forest
31374 US Highway 2
Libby, MT 59923-3022

Ms Corsi and Ms Lacklen,

Three members of the Lincoln County Port Authority Board attended the June 6 public meeting at Troy High School regarding the Troy Mine Revised Reclamation Plan. We reviewed the three options which were posted on the boards in the back of the meeting room and heard one of you review those proposals during the outset of the meeting.

While we understand your interest in assuring that the reclamation has minimal impact to the environment, we must agree with several of the speakers including our State Senator – Mr. Chas Vincent.

First, unless you have studies to the contrary, you should permit the Troy Mine ("Mine") to follow their plan to cover the reclaimed areas with pit-run and other immediately available products which were demonstrated to foster healthy trees and vegetation. If you have evidence that this study was flawed or if you possess other studies on this type of recovered area that demonstrate that plants cannot grow as reported, please make that evidence available to the public before you deny the Mine's request. The agency alternative in the DEIS indicates that that top soil salvaged in the tailing pond area be used for reclamation rather than borrow soil. We are concerned that use of the toe pond salvaged top soil will result with the following: 1) it would more than likely increase long term risk of sediment impacts to Lake Creek, 2) it will impact documented western toad habitat and 3) it will result in the same reclamation success outcome (return of similar forest vegetation to that before the Mine) as using the borrow soil. According to Mine Representatives the existing topsoil piles are fully revegetated with a thick growth of grass, alders, brush and coniferous trees. The potential impacts to neighbors from dust during soil replacement is higher with the fine grained soils than with the borrow soil. We concur with the Troy Mine request that the agencies to reconsider their decision to require use of the salvaged soil.

E1
E2
E3

Next, there is no need to bury the existing water/slurry lines. They are not an eyesore to the local population and pose no health and safety risk if left alone. In fact, it seems apparent to us that the disturbance to the existing road when digging deep ditches and burying your proposed new tailing line will have a far better chance of causing soil sediment to enter the creek than there would be if left alone. Further, it is our understanding that the Troy mine waters during the 11 year temporary shut-down quickly reached drinking quality standards without any treatment. The risk of future contamination from ground disturbance to bury a line seems unnecessary when the existing lines are carrying waters meeting groundwater standards." Again, if you have evidence that shows this to be untrue in a location like this with similar ore and waste byproducts, please present this evidence to the public before forcing your changes upon the Mine.

B1

We have no concern about the Mine leaving the old concrete foundations in place upon termination of activities. If they create an unacceptable eyesore (and I do not agree that they will) simply require them to be covered with pit run – borrow material and planted. Digging them up and re-burying the concrete in another location accomplishes nothing of value.

I1

Finally, the requirement to completely remove the existing paved road is also of no real value. Currently there are a number of paved road remnants in the area, mostly from former logging activities. The pavement is easier to ride upon than the surface of many local gravel roads. Erosion appears to be less than we see along the edges of most dirt or gravel roads. The process of removing the road is simply a waste of funds. If the ultimate plan is to close the roadway to motorized public use, that plan should be articulated to the public now.

We can all agree that mining practices have changed dramatically over the past fifty years. Some of this positive change was the result of increased regulations; the other key part is due to companies taking a stand for environmental stewardship.

Please seriously consider our thoughts and those of other area citizens before imposing additional unnecessary requirements upon the Troy Mine which has done a very good job of taking care of the property during its operations over the past few years.

Sincerely,

James E Mayo

James E Mayo
Chairman

2011-08-03 Lincoln Co Commissioners.pdf

BOARD OF COUNTY COMMISSIONERS

LINCOLN COUNTY

STATE OF MONTANA

ANTHONY J. BERGET, Commissioner
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DISTRICT NO. 2, TROY

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DISTRICT NO. 3, EUREKA

TAMMY D. LAUER
CLERK OF THE BOARD AND COUNTY RECORDER

August 3, 2011

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DEQ
DIRECTOR'S OFFICE

Bobbie Lacklen
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Emily Corsi
Project Coordinator
Montana DEQ
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Helena, MT 59620

FAX: (406) 444-4386
E-mail: DEQTroyMine@mt.gov

RE: Troy Mine Revised Reclamation Plan DEIS

Dear Project Coordinators:

After having reviewed the Draft EIS analysis of the revised Troy Mine reclamation plan, we would like to voice our support of the Agency-Mitigated Alternative, with some suggestions that we believe should be amended into the preferred Alternative that are found in the proposed action by Troy mine, Inc for your consideration. It seems to us that the actions proposed would satisfy all of the identified reclamation goals in a manner less cumbersome, less expensive, and in some cases, with less environmental risk than the Agency-Mitigated Alternative (Alt. 3) as proposed.

- For example, Alt. 3 proposes that the current mine water pipeline be replaced with a buried pipeline, whereas Alt. 2 proposes to retain the two surface tailings pipelines. Troy Mines, Inc.'s conclusion that buried pipelines, along with future maintenance and repair (or replacement), would create more surface impacts than the existing above-ground pipelines, which could also be more easily repaired/replaced and would provide ease of visual monitoring.

E1

E2

Further, it seems apparent to us that the disturbance to the existing road when digging deep ditches and burying your proposed new tailing line will have a far better chance of causing soil sediment to enter the creek than there would be if left alone. It is our understanding that the Troy mine waters during the 11 year temporary shut-down quickly reached drinking quality standards without any treatment. The risk of future contamination from ground disturbance to bury a line

E3

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seems unnecessary when the existing lines are carrying waters meeting groundwater standards. Again, if you have evidence that shows this to be untrue in a location like this with similar ore and waste byproducts, please present this evidence to this commission and the public before requiring this proposed action.

H3
H1

- For example, Alt. 3 proposes that soil salvaged in the tailing pond be used for reclamation, and would require organic fertilizer, organic matter additions to the soil, and the additional placement of 25 tons/acre of larger woody debris on reclaimed sites. This could actually increase the risk of sedimentation in Lake Creek, and would increase the risk of impacts to western toad habitat.

  In addition, the existing topsoil piles are fully re-vegetated with alder, brush, and trees and are now valuable habitat for a variety of wildlife. Eliminating this habitat is not justified when test plots indicate no additional reclamation success outcomes by doing so. Also, since there is no discussion of, nor evidence provided for, the benefits of all the organic amendments proposed in Alt. 3, we believe such action is unwarranted. If you have evidence that this study was flawed, or if you possess other studies on this type of recovered area that demonstrate that plants cannot grow as reported, please make that evidence available to this commission and the public before you requiring this proposed action in your preferred Alternative.

H2

B1
B2

- For example, Alt. 3 would require that all demolition materials be disposed of off USFS lands, whereas Alt. 2 provides for the removal of only the potentially hazardous materials for appropriate off-site disposal while burying inert and non-hazardous materials such as concrete, rebar, etc., on-site with appropriate covering and re-vegetation. On-site disposal of inert materials does not pose environmental risk. Requiring off-site disposal of these materials seems unwarranted as it would provide no significant benefit, but rather, would add significant effort and expense.

I1

- For example, Alt. 3 requirement to completely remove the existing paved road is also of no real value, and would actually result in increased sediments. We are well aware of MT DEQ's efforts to reduce Total Daily Maximum Loads (TMDL) in our watersheds and are very curious why this action is even being proposed. The most efficient way to mitigate road sediments to mitigate for TMDL concerns is to cover them with asphalt. Why would it be removed? This road provides great access to recreational opportunities such as Spar Lake and many of our county's citizens will benefit from an asphalt covered access road. If the ultimate plan is to close the roadway to motorized public use, that plan should be articulated to this commission and the public now, and before requiring this proposed action in your preferred alternative.

Thank you for this opportunity to comment. The Troy Mine is currently the largest private employer in our County. Its solvency and continued profitability is critical to our local economy, and it is very important that government agencies not require actions that are superfluous and do not provide identifiable environmental benefit.

The commission recognizes the positive steps that appropriate regulatory safeguards have taken to correct mistakes and mitigate future liabilities to the public's safety and welfare. We also believe that Troy Mine, Inc. is the kind of corporate citizen that stands up for responsible development and stewardship. We believe they are proposing common sense actions that will result in less environmental impacts and urge serious consideration of the above suggestions and ask that they be adopted by the regulatory environment that we believe is striving to achieve the same outcome.

Sincerely, Lincoln County Commissioners

Marianne B. Roose, Chairman Anthony J. Berget, Member Ron Downey, Member

2011-08-04 Chilton-Randt - FWP.pdf

From:	Chilton, Tonya
To:	TroyMineReclamation@fs.fed.us; DEQ Troy Mine
Cc:	Williams, Jim
Subject:	Comments to Troy Mine Reclamation
Date:	Thursday, August 04, 2011 1:17:37 PM
Attachments:	TroyMineRevisedReclamPlan_TC_Comments8_2011.doc

Please find my comments in the attached memo.

Thank you,
Tonya

Tonya Chilton-Radandt
Montana Fish, Wildlife, & Parks
Libby area Wildlife Biologist
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Libby MT 59923
#(406)293-4161, x209
tchilton@mt.gov

Montana Fish, Wildlife & Parks

MEMORANDUM

TO: Rebecca Cooper, Jim Williams

FROM: Tonya Chilton-Radandt, Libby Area Wildlife Biologist

DATE: 8/4/11

SUBJECT: Comments to ***Troy Mine Revised Reclamation Plan***

Thank you for this opportunity to comment on the TMRRP. In general, I agree that the Agency-Mitigated Alternative is preferred, in order to provide for the best possible outcomes for wildlife within the project area.

K-A-FWP-CR1 In particular, seasonal road restrictions will benefit grizzly bears, as will the proposed road reclamation (minus clover). The proposed Agency-Mitigated road reclamations will also benefit elk, black bear, and other species. The proposal to prohibit/minimize ATV and snowmobile use in the project area will also afford protection to mountain goats during crucial winter and spring periods.

K-A-FWP-CR2 I would also like to suggest that a few sections of the DEIS be considered for possible updates. The section on Wolf Background (3.18.4.2) should include the 2 most recent rulings, including that by the US Congress this spring, as well as the most recent ruling by Judge Malloy (8/4/11).

K-A-FWP-CR3 The section on Wolverine Affected Environment (3.18.5.11) could also be updated to include the recently recorded wolverine sign near Billiard Table Lake (especially given that the area between Billiard Table and the Troy Mine is easily within a wolverine's home range).

K-A-FWP-CR4 Finally, some of the information contained in the Mountain Goat section 3.18.6.2 needs updating. For the record, MFWP does not know the exact numbers of mountain goats in HD 101, however, goat hunter numbers, permit numbers, and goat harvest numbers across Region 1 have been decreasing since 1987. This causes me concern for the number of goats currently within HD 101 and using the project area.

2011-08-05 BennetG_CuffeM_and_VincentC.pdf

From:	Chas Vincent
To:	troyminereclamation@fs.fed.us; DEQ Troy Mine
Cc:	Gerald Bennett; Mike Cuffe
Subject:	Troy EIS Comments
Date:	Friday, August 05, 2011 2:46:40 PM
Attachments:	Lincoln County Delegation, Troy EIS.doc

Bobbie & Emily,

Please see the attached document from the Lincoln County delegation regarding the Troy Mine reclamation plan that is out for comment.

Have a great weekend!

Chas

Sen Chas Vincent
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E-mail: DEQTroyMine@mt.gov

RE: Troy Mine Revised Reclamation Plan DEIS

Dear Project Coordinators:

After having reviewed the draft EIS for the Troy Mine reclamation plan, the Lincoln County delegation would like to go on the record as supporting the Agency-Mitigated Alternative as our preference, but we cannot fully support your preferred alternative in its entirety. We believe that a great deal of excellent work has been done by both of you and your agencies, but we feel that you have missed the mark in a few places. Please consider the following suggestions as ways to meet reclamation goals, further minimize environmental impacts, reduce unnecessary costs, and garner our full support of the proposed mitigation measures.

- Requiring the existing tailings pipelines to be removed and replaced with a buried line does not make environmental, nor economic sense. The current pipelines have carried millions of tons of slurry and have shown relatively zero wear to the liner in the pipe as was discovered in 2004 prior to resuming mining operations after 11 years of dormancy. These pipelines have many years of safe use left in them and should be used until it is determined otherwise. When it is determined that they are in need of replacement, they should be left above ground and along the existing access road to provide for easy and efficient monitoring.

E-A-LCD1

The disturbance to the existing road when digging deep ditches and burying your proposed new tailing line will cause unnecessary soil sediment to enter the creek than there would be if left alone until they needed replaced and substituted with new lines above ground. The fact that the Troy mine waters quickly reached drinking quality standards without any treatment when operations were idle removes any validity to concerns about vandalism as it would be clean water that would not pose a threat to surface or ground water. It should also be pointed out that there has never been an incident of vandalism during the pipelines thirty year existence. We would also ask that the agencies consider the unintended consequences of having a buried pipeline that cannot be easily monitored. What should happen if a section did develop a leak? How long would it take for it to be found and how large of a subsidence or sluff would it take

E-A-LCD1

to be able to detect a leak? How much disturbance would we be creating in looking for it? The balance of harm needs to be recalculated and we firmly believe that burying the lines is an unnecessary action that will create more disturbance to the watershed from both a short and long term perspective.

- We do not believe that requiring the topsoil that is now providing great habitat for wildlife be disturbed for the final reclamation plan. The topsoil piles are currently fully vegetated and have trees and alder brush that has created wonderful habitat for all sorts of terrestrial and aquatic wildlife, most importantly the Western Toad.

K-A-LCD1

Requiring all of this to be undone is completely unnecessary as there is plenty of adequate borrow material that is located 3,000 feet away from Lake creek (think bull trout) and has been proven to work just as good as the topsoil would with test plots while not creating the dust problem that the fine particulates of the topsoil will. Many of the local conservation groups in the area also agree that this proposed action should be reconsidered. We recognize that you have statutory requirements that are driving this, and that the statute was created with the best of intentions, but we feel that this is a classic unintended consequence that can and should allow for a variance.

H-A-LCD1

Further, requiring organic fertilizer, other organic matters additions to the soil, and 25 tons/acre of larger woody debris on reclaimed areas doesn't make sense either. 25 tons? Organic fertilizer? It seems that using the right amount of fertilizer than can be measured and applied using the best available science that can be calculated to the square inch is the appropriate and environmentally responsible thing to do. We thought nitrate levels in waterways were of concern to the DEQ?

- Requiring the concrete and rebar to be dug up, broke up, and moved to another location to be buried doesn't make any sense either. Why not allow the non-hazardous material that is inert to be buried and covered with appropriate fill and then re-vegetated? There is no environmental benefit in burying these material in another location, the time and resources put into doing so have more of an impact to the environment. This proposed action is unwarranted and does nothing but increase costs.

B-A-LCD1

- With two of us in this delegation having carried the TMDL bill last session the proposed action to remove the asphalt from the existing seven miles of road really makes us scratch our heads. With the single biggest mitigation (aside from closing the road) for sediments from road surfaces being to cover them with asphalt, this part of the alternative begs a couple questions.

E-A-LCD2

F-A-LCD1
I-A-LCD1

Is the USFS planning on closing this road from public use after the mine is decommissioned? Have the recreational values of the road remaining open to access very popular places like Spar Lake even been considered? Do we want the public driving on a dirt road rather than one covered with asphalt?

If the plan is to prohibit motorized use of this road after decommissioning it should be articulated by the USFS to the public now, rather than later.

The Troy Mine is currently the largest private employer in our County. Without question, its ability to continue providing family wage jobs and stock options to its employees and unnecessary and unwarranted costs required by regulators has a symbiotic relationship.

The Troy Mine has displayed to us and our constituents that they are the kind of corporate citizens that we want and deserve. It makes us proud to provide suggestions to agencies of ways to minimize environmental impacts that are actually being proposed by the applicant. This company recognizes not only their role of providing precious metals that enable our quality of life, but also their responsibility to strive to do it with as little of a footprint as possible.

We strongly encourage the regulating entities that are charged with mitigating impacts to move forward with the Agency-Mitigated Alternative with the above recommendations amended into it.

Thank you all for your time and consideration.

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Libby, MT 59923
406.293.7012
jbenhd1@hotmail.com

Rep. Mike Cuffe
PO Box 1685
Eureka, MT 59917
406.889.5777
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Sen. Chas Vincent
34 Paul Bunyan Ln
Libby, MT 59923
406.293.1575
cvvincent@hotmail.com

2011-08-05 Smith TO - FWP.pdf

From:	Smith, T.O. (FWP)
To:	DEQ Troy Mine
Cc:	Risley, Dave; Satterfield, Jim; Vashro, Jim; Hensler, Mike; Cooper, Rebecca
Subject:	MFWP Official comments for the Troy mine
Date:	Friday, August 05, 2011 3:02:34 PM
Attachments:	Troy Mine Comments.doc

Please find attached MFWP's official comments

Montana Fish, Wildlife & Parks

August 5, 2011

In regards to the Troy mine reclamation plan, Montana Fish, Wildlife and Parks submits the below listed comments for consideration and inclusion in the official record.

Montana FWP generally agrees that the agency proposed alternatives appear to give the greatest possible successful outcomes and protections for fish and fish habitat in the affected area.

D-A-FWP-S1

3.7.4.1 The Fish Population Status
Several species of fish in addition to those noted from the report are in the Lake Creek drainage near, upstream and downstream of the affected area: mountain whitefish (*Prosopium williamsoni*), coarsescale sucker (*Catostomus macrocheilus*), longnose sucker (*Catostomus catostomus*), Northern Pikeminnow (*Ptychocheilus oregonensis*), Northern pike (*Esox lucius*), brown trout (*Salmo trutta*), peamouth chub (*Mylocheilus caurinus*), Smallmouth bass (*Micropterus dolomieu*).

D-A-FWP-S2

3.7.4.2 Bull trout
There is no evidence that there is not a fluvial bull trout population in Lake Creek. In October 2006, MFWP personnel collected bull trout between 210 – 330 mm in the Lake Creek dam indicating that a fluvial lifestyle is probable.

For any of the actions related to water quality note that, during some time in their lives, 100 percent of the bull trout in the Lake Creek drainage will be influenced by the water quality effects from the proposed alternatives.

D-A-FWP-S3

Page 3-23 Paragraph 3:
Note: Instream activities proposed in the Lake Creek drainage between Bull Lake and Keeler Creek should be accomplished between July 15 and September 1, unless there are approved mitigation plans.

Montana FWP appreciates the opportunity to comment. If there are questions concerning these comments, please do not hesitate to contact our agency.

T.O. Smith
Bureau Chief, FWP

2011-08-05 Bakke H_and_Martin B-CRG.pdf

From: Howard Bakke
To: TroyMineReclamation@fs.fed.us; DEQ Troy Mine
Subject: Troy Mine DEIS
Date: Friday, August 05, 2011 9:36:03 AM
Attachments: CRG comment pdf.pdf

Hello,
Attached are our comments on the DEIS for the Troy Mine Reclamation plan.
They are in 'pdf' format. If there is a problem opening attachments please
notify me and I will send them in the body of the letter. Thank you.
Howard Bakke

The Cabinet Resource Group

P O Box 238 ***Heron, MT***

August 4, 2011

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Dear Ms. Lacklen and Ms. Corsi;

The Cabinet Resource Group (CRG) submits the following comments pertaining to the draft EIS released by the U. S. Forest Service and the Montana DEQ as noticed in the Federal Register May 20, 2011. There are five specific comments and a brief list of additional questions and thoughts; they are:

Road Reclamation

I-CRG1 The Agency-Mitigated Alternative road reclamation plan call for the removal of spur roads that are already decommissioned and the removal of the blacktop surface of road 4626, the mine access road. The disturbance of these roads will increase the risk of environmental damage. Many of the roads built during the exploratory phase and not used since have already been reclaimed by natural vegetation as indicated in the DEIS page 3-120.

Also, DEIS pg: 3-23:

"The Agency-Mitigated Alternative would reduce sediment loading both by implementing reclamation actions and by treating mining road-related sediment sources. Thus, sediment levels in Stanley and Lake Creeks would be expected to decline over time.

E-CRG1

There is nothing in the DEIS supporting the claim that removing the asphalt surface of the mine road would reduce the risk of dust and sedimentation to nearby streams. Road 4626 is currently used heavily to access Spur Lake. Converting the industrial grade asphalt road to a gravel surface will defeat the original required mitigation of a blacktop road. The mine road from the Hwy 200 junction to the Spar Lake Road junction should be left in place.

Pipeline For Mine Water Transport

E-CRG 2

The major issue of difference between the proposed action and the Agency-Mitigated Alternative is the replacement the two above ground pipelines with a buried one. There are good arguments for both. Would the construction project cause environmental damage through loss of natural vegetation and siltation at stream crossings? However, the current pipeline has had incidents of failure, and with closure of the mine the opportunity for vandalism greatly increases. Also, the concrete support piers are not "natural" and would extend the amount of time needed to return the area to its natural state. With the exception of the prohibition of burying demolition debris (see the following comment regarding mill site demolition) CRG supports the Agency-Mitigated Alternative as it applies to the pipelines.

Mill Site Demolition Materials

E-CRG 3

The agency alternative includes: *"All demolition materials, whether originating above or below ground, would be disposed* of off *NFSL in appropriate disposal areas to comply with the Montana Solid Waste Act*". There is no justification for this requirement; there is no documentation of risk to water quality. Concrete and steel debris possibly buried in the mine, in the driest possible location, would not result in leaching of problematic constituents. In fact, the additional handling and transport of these materials increases the chance of impacting air and water quality.

Tailings Impoundment Reclamation

Revett has expressed concern about disturbing the already re-vegetated topsoil stockpiled between the toe ponds and Lake Creek. We share this concern for the same and for other reasons[1], yet we also wish to see plenty of organic matter on the impoundment surface to help build soil structure, enhance water retention, and increase nutrients. We would like to suggest some ideas that may help address both these concerns.

H-CRG1

Revett has told us it may be operating the Troy Mine for some years to come. The impoundment may well reach its' maximum capacity before the cessation of mining. Revett is looking into putting future tailings back into the mine.

If this were to start happening as soon as possible, reclamation could begin, and perhaps largely be completed at the impoundment while the mine is still in operation. This could, paradoxically, allow for a slower, more flexible pace of reclamations; methods could be tested and tweaked.

A composting program could begin now on an inactive cell of the impoundment, utilizing sawdust, wood chips, agricultural and livestock wastes, etc. Even if there is not enough material

[1] Refers to CRG letter of Dec.27, 2007, Appendices, Appendix A, Scoping Report, Appendix F, pgs 53-83.

available in the area for a truly large-scale project, a significant quantity might be produced over the course of a few years. There are such operations in this region that could be consulted as to feasibility.

We understand that the US Forest Service and the University of Montana[2] have developed a portable gasification plant, clean burning, that runs on waste wood. It can produce power and/or "char" a soil amendment. There are other sources of information on such possibilities in the area, such as the Canadian company planning a bio-fuels operation in Thompson Falls.[3] We encourage the agencies to seek innovative ways to put organic material on the impoundment while minimizing disturbance of the stockpiled topsoil.

H-CRG1

At the north and south ends of those stockpiles, there are areas that do not yet have trees growing on them. Perhaps some small scale, experimental removal of soil from these areas could be tried seasonally, over several years, in order to determine if problems do arise before an irrevocable commitment is made. The dirt could be brought up and re-stockpiled near where it will finally be used.

We are dubious about the use of artificial fertilizer, particularly as it might affect trees. Finding the nutrients they need, they might put more growth into foliage that into root structure necessary to sustain that foliage growth when the fertilizer is used up.

Barrels in the Tailings

This is an issue of great concern to CRG, one the DEQ has avoided since it was first brought to the agency's attention in 1996. The rationale for dismissing this "potential" issue as beyond the scope of this DEIS is disingenuous.

E-CRG4

CRG has not claimed to know the contents of the barrels. We have provided the DEQ with a list of possibilities –"solvents, waste oil, and grease"—that are known to have entered the mine, for which there is no record, as required by law, of disposal. [4] The DEIS states that "the allegations" (which we did not make) "were never substantiated, and....the U S. District Court dismissed the case without prejudice."

The only way to know what is in the barrels is to look inside them, an increasingly expensive proposition. This poses two questions: is there sufficient evidence to warrant further investigation, and if so, who is to pay for it?

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[2] Operated by Community Power Corp., 8110 Shaffer Parkway, Littleton, CO 80127

[3] EcoTech Energy, 125 W. Granite, Butte, MT 59701

[4] See note 1

Several years after the DEQ did not so much as acknowledge receipt of a citizen complaint alleging late night burials of 55 gallon drums in the tailings, CRG learned of it, and began to investigate. We found corroborating witnesses. We sued ASARCO to gain access to the tailings impoundment for a consulting firm of our hire to do a preliminary ground penetrating radar search for barrels. The U.S. Circuit Court let us do so. Anomalies consistent with barrels were located in places barrels were said to be buried.

ASARCO denied any such thing had ever happened, and vilified CRG with asperity. After over a year of such denials, a former mine manager, being deposed under oath, admitted that barrels had been buried. Until then, it was reasonable for the DEQ to take no action, as the allegations might have just been disgruntled ex-employees trying to cause trouble. After this admission however, that was no longer the case.

E-CRG4 Our lawsuit against ASARCO was dismissed with prejudice at our request. At the expenditure of great effort and considerable expense, we have established that there are several corroborating witnesses to the initial charge, that ASARCO admitted to burials, after having lied about it, and that there are targets that could be barrels where barrels are said to be buried. We feel we have done our part as citizens, and it is not CRG that should bear the expense and responsibility of pursuing this matter further, but rather this is the responsibility of the agencies that ostensibly exist to look out for the public's interests. For the agencies to blithely accept ASARCO's word that no contaminants were buried after it vehemently denied it had buried anything at all, for them to sweep this under the rug and make no inquiry into what was buried and why, why was it done at night and why it was lied about, would be unconscionable

We do not propose that the tailing impoundment be dug up to find every barrel in it, yet a more thorough look at areas that testimony has indicated as burial sites is by no mean unreasonable. Barrels will rust, and their unknown, possibly toxic contents, likely unmonitored for, will release into the groundwater, threatening yet another post-mining problem and expense for the people of Montana. This issue must no longer be ignored.

Additional Questions and Thoughts

Proposed action:

B-CRG 1 1. The proposed fill material for the adits is composed of large-sized development rock and a 12 " layer of growth medium; is this sufficient to preclude groundwater seepage from the adits?

B-CRG2 2. Why aren't the design details for the proposed non-hydraulic plugs and partial concrete damns or bulkhead in the Service and Conveyor adits included?

E-CRG5 3. What is the predicted attenuation rate for nitrogen and copper compounds to reach acceptable background quality?

E-CRG6 4. How much water is anticipated to dissipate into fracture zones from the mine pool?

E-CRG7 5. How would the monitoring plan be modified to account for groundwater seepage from the mine? What mitigation measures would be implemented to address groundwater seepage from the mine?

E-CRG8 6. Surface water quality monitoring should be collected at designated locations more frequently in order to promptly address any degradation to water quality. Remote monitoring systems that automatically upload to a website accessible by the public should be considered.

E-CRG9 7. What mitigation measure would be employed if the Agencies determined that water quality was not improving?

E-CRG10 8. The long term groundwater monitoring does not address how potential seeps or springs would be treated if water quality did not meet Agency standards.

B-CRG3 9. Why was subsidence not addressed as part of the Proposed Action? Given the history of subsidence at the Troy Mine, the potential impacts from this should be analyzed.

10. Surveys should be conducted to ascertain the structural stability of the mine and potential areas for future subsidence.

Agency-Mitigated Alternative

E-CRG11 1. What manner of "additional": monitoring would be required to ensure water quality at seeps and springs is met?

E-CRG9 2. What mitigation measure would be employed if the agencies determined that water quality was not improving?

E-CRG10 3. The long term groundwater monitoring does not address how potential seeps or springs would be treated if water quality did not meet Agency standards.

B-CRG3 4. Why was subsidence not addressed as part of the Proposed Action? Given the history of subsidence at the Troy Mine, the potential impacts from this should be analyzed.

5. Surveys should be conducted to ascertain the structural stability of the mine and potential areas for future subsidence.

We provide these comments in the hope that the Reclamation Bond for the Troy mine will be brought into compliance with the law.

Very truly yours,

Howard Bakke
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2011-07-26 Troymine Revett Comments DEIS.pdf

Troy Mine Inc.

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July 26, 2011

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Dear Ms. Lackien and Ms. Corsi;

Troy Mine, Inc. (TMI) provides the following comments on the Draft EIS released by the Forest Service and Montana DEQ and noticed in the Federal Register on May 20, 2011 regarding the TMI revised reclamation plan. The comments are grouped by subject and where possible, referenced to the page in the DEIS that is addressed. There are four primary issues of concern that TMI has identified, these are:

1. The requirement that the existing tailing lines be removed and replaced with another separate buried line at closure;

2. The requirement that TMI utilize essentially all of the toe pond soil stockpiles during reclamation thereby re-disturbing an area of significant size near Lake Creek;

3. The requirement that all site demolition materials and facility foundations and footings be disposed of off-site; and

4. The requirement that certain roads be reclaimed or converted to a gravel surface.

This letter also contains a number of general comments that are editorial in nature, question apparent inconsistencies in the document or address more minor points that require reassessment in the FEIS.

Pipeline to Transport Mine Water at Closure

E-TMI-1 The DEIS concludes that the existing dual 8" urethane lined steel pipelines that carry tailing slurry during operations need to be replaced with a new buried line at closure. TMI disagrees that the lines need to be replaced and there is little rational in the DEIS to justify this suggested replacement. The main reasons TMI disagrees with the installation of a new buried line are:

1) The existing two surface tailing lines and the existing buried pipeline have more than enough capacity and useful life to transport the mine water to the tailing facility as verified in discussions with the pipeline manufacturer;
2) The installation of a new buried line at closure would create significant new ground disturbance that will require additional reclamation;
3) There are areas in the pipeline and road corridor that are impractical for burial due to proximity of live streams (Stanley Creek and Lake Creek); and
4) TMI is installing additional secondary containment for monitoring and leak detection near stream crossings, on the existing tailing lines, that will allow better monitoring and the surface lines will be easier to repair if necessary.

It is TMI's opinion, based on actual review and testing by the pipeline manufacturer, that these lines currently have significant safe and useful life and should continue to be used following closure. TMI's proposed Closure Operations Manual (see Appendix A) summarized in this section provides a reasonable engineering approach to minimizing risk of a mine water spill during post closure.

The DEIS does not document any particular flaw or problem with the two existing 8" lines, but indicates that they are "old" and that above ground pipelines would be "more susceptible to vandalism". It is further indicated (with no documentation or explanation) that a leak from a buried pipeline would be less likely to cause sediment to reach surface water. The DEIS incorrectly implies that the current operations does not include secondary containment of the tailing pipelines and that there is no monitoring of possible pipeline leaks. The Closure Operations Manual addresses secondary containment and leak detection monitoring. TMI would like to note that the installation of a new buried line will include a number of stream crossings where the line will either have to be buried under the stream or attached to bridge structures creating new areas of both engineering and installation challenge.

E-TMI1

TMI has substantiated that the existing above ground tailing lines will have many years of service left at closure. Based on actual testing conducted in 2004 with the pipeline manufacturer (Irathane), the urethane lining in the existing pipelines is in excellent shape. At the time of the testing each of the slurry lines had a total of sixteen million tons of slurry flow through them, yet the lining was like new. In discussions with the manufacturer, they believe that the lining would last indefinitely with the continuous flow of mine water.

Therefore, TMI considers the addition of a 10 to 18 inch diameter buried pipeline for transporting mine water to the tailing storage facility unnecessary. The life and capacity of the two existing two surface 8 inch pipelines and the existing 10 inch buried pipeline will be every bit as effective as the proposed HDPE pipe and there is no new disturbance required.

TMI believes excavation for burial of the proposed pipeline will cause undue environmental disturbance; increase risk of sedimentation to nearby streams; and not provide any more assurance against discharge to nearby streams nor protect against

vandalism. Assuming that the pipe must be buried below the frost line, the 6.1 miles of pipeline will require disturbing a 25 ft width or a minimum additional disturbance of 18.5 acres.

E-TMI1 The DEIS documents concern with the tailings lines plugging and an over pressure event occurring which may break the lines. This will not happen for the following reasons:

1) The tailing line design includes a rupture disk installed in each tailings line that will open at 586 psi in the event of a pressure surge with the discharge directed to a containment pond. These rupture disks will prevent a tailing line breakage from an over pressure event from occurring; and
2) The tailings lines have been pressure tested at 1,110 psi. At closure, when running water in the line, the potential maximum pressure will be only 475 psi.

Soil Replacement and Amendment

TMI disagrees with the agencies recommended use of the topsoil located below the toe ponds because:

1. An adequate and proven source of topsoil / growth medium exists on the east side of the tailing facility;
2. The topsoil area below the toe ponds has been successfully reclaimed with over 30 years of re-vegetation that would be re-disturbed;
3. The control of sedimentation to Lake Creek during reclamation activities and topsoil excavation will be a challenge; and
4. The area around the toe ponds is providing breeding habitat for the western toad which has been listed as a species of a concern.

H-TMI1 The agency alternative in the DEIS indicates that that soil salvaged in the tailing pond area be used for reclamation rather than borrow soil. TMI is concerned that use of the toe pond salvaged soil will increase long term risk of sediment impacts to Lake Creek, will impact documented western toad habitat and will result in the same reclamation success outcome as using the borrow soil (return of similar forest vegetation to that before the mine). The existing topsoil piles are fully re-vegetated with a thick growth of grass, alders, brush and coniferous trees. The potential impacts to neighbors from dust during soil replacement is higher with the fine grained soils than with the borrow soil. TMI requests the agencies to reconsider their decision to require use of the salvaged soil.

TMI provides Appendix B (Westech, 2011), a report on borrow soil availability and suitability that supports the use of borrow soil for reclamation at the TMI. The following are some of the specific areas in the DEIS that address soil use and amendment issues that should be revisited in preparation of the FEIS. According to the Westech Report (Appendix B), the tailings embankment face supports a young forest of planted, healthy ponderosa pine, white pine and lodge pole pine at a stocking rate suitable for proposed

post-mining land uses. Natural reinvasion of trees is occurring. The understory is primarily herbaceous, dominated by hard fescue. Cover of trees, herbaceous species, litter, lichens, moss and rock is adequate to provide a stable surface. The presence of existing forest on soils with high coarse fragments and the analysis in the DEIS – [(Section 3.16.2.9, Resource Impact Summary (page 3-149)] demonstrate that borrow area material will support the proposed post-mining land uses of forest and wildlife habitat consistent with the MMRA.

The requirements for use of organic fertilizer, organic matter addition to soil, mulch and placement of coarse woody debris on reclaimed sites is by the DEIS's own admission not necessary to achieve reclamation goals. TMI recognizes its responsibility to successfully reclaim the land disturbed by the mine, but doesn't agree that use of unnecessary amendments are required; if it takes a few years longer to achieve the vegetation density to meet bond release criteria that is TMI's option. At the 19th Annual Mine Design, Operation and Closure Conference, May 2011, Mr. Rich Prodgers, Bighorn Environmental, provided a presentation; "Effectiveness of Two Compost Products and One Mycorrhizal Inoculum in Promoting Nutrient Cycling in Cover Soils Originating as Deep Borrow" (see Appendix C). According to Mr. Prodgers' field work, analyses and presentation, he was not able to conclude from vascular plant performance or microbiological analysis that compost confers a benefit. Further he presented information that composts role in establishing nutrient cycling was far less than expected.

H-TMI 1

TMI understands that the constructed toe ponds provide breeding habitat for the western toad that would not be available without the toe ponds. The toe ponds and toad habitat at the tailing impoundment are on private land and will remain in place at closure. Evidence provided in an attached report on western toad occurrence provided with this letter from Patrick Farmer, 2011 (Appendix D) indicates that the salvage soil stockpile is used by toads during the breeding season and may be important toad habitat during other seasons. This is another reason to reevaluate the removal of the soil stockpiles when a reasonable alternative exists.

ES14 – summarizes agency alternative for use of salvage soil and organic addition; no justification provided.

ES17 – The DEIS states: "*Under the Agency-Mitigated Alternative,*
No additional measures would be required to mitigate geochemical impacts to reclamation success. The use of the rocky glacial and the lacustrine and volcanic ash-derived soils as growth media would minimize root contact with mined materials. This would effectively minimize the potential effects of plant uptake of metals from the development rock and tailings."
This implies that the tailing has a deleterious or toxic effect on plant growth; there is no evidence known to TMI or provided in the DEIS that toxicity exists and this must be corrected in the FEIS.

ES18 – The DEIS indicates that under the agency alternative chemical fertilizer would not be used in reclamation. No justification, reason or authority for this decision is provided here or elsewhere in the document.

ES19 – The summary statement that the TMI proposed action would not achieve comparable utility in not supported here or elsewhere in the document and in fact is contradicted elsewhere in the document. TMI strongly disagrees that this standard cannot be met with borrow soil and further that the agencies have presented any substantive analysis documenting this conclusion. According to the Westech Report, 2011, the tailings embankment face supports a young forest of planted, healthy ponderosa pine, white bark pine and lodge pole pine at a stocking rate suitable for proposed post-mining land uses. Natural reinvasion of trees is occurring. The understory is primarily herbaceous dominated by hard fescue. Diversity is low with few species present. Cover of trees, herbaceous species, litter, lichens, moss and rock is adequate to provide a stable surface. Previous re-vegetation trials on Cell 2; the presence of existing forest on soils with high coarse fragments; and, the analysis of the DEIS demonstrate that borrow area material will support the proposed post-mining land uses of forest and wildlife habitat consistent with the MMRA.

H-TMI 1 2-54: Soil amendments listed for the agency alternative include that all disturbed ground at mill site will be covered with mulch and 25 tons/acre wood debris. Nowhere in the document provides the justification, authority or even describes the potential benefits of this treatment.

3-42: TMI is not aware of any documentation indicating "*plant uptake of metals*" has caused any problem at the tailing impoundment. The use of the borrow soils as compared to stockpiled topsoil will accomplish the same objective; therefore, this argument needs to be revised in the FEIS.

3-115: TMI is not aware of any data or evidence indicating metals phytotoxicity from the tailing exists nor was any data or evidence referenced in the DEIS. If such documentation exists TMI would like to have a chance to discuss this issue with the agencies prior to completion of the FEIS.

3-119, 2nd paragraph: "*However, using a glacial outwash material instead would result in gradual, but slower vegetative recovery.*"

The DEIS states that borrow soils would result in **successful** but slower vegetative recovery and thus meet the "comparable utility" requirement. TMI agrees with this statement and argues that the long history of reclamation pilot tests supports it. The speed of re-vegetation is not a requirement of the Metal Mine Reclamation Act.
3-119, 5th paragraph: "*The organic matter would increase infiltration, fertility, and the water-holding capacity of the rocky glacial materials, all of which would speed up soil development on the reclaimed areas.*"

This only establishes that the organic matter addition would speed up re-vegetation, not that it is necessary to meet the reclamation requirements.

3-119, 6th paragraph: "*Twenty-five tons/acre of coarse woody debris (larger than three inches in diameter) would be scattered across the reclaimed areas at the mine portals and mill. All disturbed ground would be covered with an agency-approved mulch.*"

There is no discussion of the justification, benefits, rational or authority for requiring the addition of wood debris or mulch. More importantly, there is no discussion why this requirement in the Agency-Mitigated Alternative is more effective than the Proposed Action for achieving reclamation requirements.

3-120, 3rd paragraph: "*These materials would be used because they would produce better soil quality and a more productive plant growth medium due to their larger water-holding capacity. The material proposed under this alternative would eventually produce a quality soil with a more productive forested plant community, even with the presence of noxious weeds.*"

This documents that the main benefit of using the stockpiled soils is increased forest productivity. Since the uses of the alternative borrow soils can achieve the DEQ's requirements for stability and utility on these private lands, the requirement to use the stockpiled soil is not warranted.

H-TMI 1

3-121: "*All three alternatives would meet these guidelines on NFSL. However, the Agency-Mitigated Alternative would restore soil function in a shorter period of time.*"

The DEIS documents the agencies are in agreement with TMI's Proposed Action which achieves Forest Service requirements. Therefore, there is no need for unnecessary activities just to shorten the time period.

3-121, last paragraph: "*The Proposed Action would not produce comparable utility on the reclaimed tailings impoundment.*"

The statement is not justified and apparently relies on an interpretation of the MMRA "comparable utility" requirement that is not documented in any agency guidance but seems to be the "more is better" philosophy. The "comparable utility" wording is clearly meant to indicate a level of sustainable re-vegetation that achieves an acceptable level of cover and species diversity. There is no standard to support a minimum level of productivity. On page 3-146 (3rd paragraph) the DEIS indicates the Proposed Action achieves the "comparable utility standard". This statement must be corrected in the FEIS.

Disposal of Mill Site Demolition Materials

B-TMI 1

TMI disagrees that burial of concrete foundations and steel at the mill site pose any risk to water quality. On-site burial of demolition waste is an accepted practice during mill

site reclamation. The unnecessary handling and haulage of inert materials to an offsite disposal area would increase risk to air and water quality.

TMI's Proposed Action is as follows:

1. Equipment from the mill, shops, office and associated facilities will be salvaged or disposed of offsite. Buildings will be removed and salvaged or demolished. The mill site materials which will be buried on site are primarily concrete, but also may include some metal, glass, plastic and wood. All of these materials will be buried on site with a minimum of three feet of cover material.

2-15: The agency alternative includes: *"All demolition materials, whether originating above or below ground, would be disposed of off NFSL in appropriate disposal areas to comply with the Montana Solid Waste Act."*

B-TMI 1

The need or benefit of this unnecessary action is not provided anywhere in the document.

3-75: There is no evidence, documentation or reason that "buried demolition debris could contaminate surface water". This rational for requiring the removal of concrete foundation materials and structural steel from the mill site area is not based on fact and should be corrected in the FEIS.

3-82: There is no documentation of any "risk" to water quality from burial of building and foundation materials. Concrete and steel would not result in leaching of problematic constituents in the oxidizing conditions of shallow burial. In fact, the increased alkalinity and iron potentially available from these materials are documented in the metals fate and transport discussions, at the tailing impoundment, provides a beneficial effect on metals of concern.

Road Reclamation

The Agency-Mitigated Alternative road reclamation plan includes removal of several spur roads that have been passively decommissioned. TMI views reverting road 4626 to a gravel surface will cause undue environmental disturbance and increase risk of sedimentation to nearby streams. TMI performs annual maintenance on road 4626 and believes the surface will perform for decades after closure with minimal maintenance and cause no sedimentation risk to nearby streams. TMI believes roads 4626G, 4624B and most of 4624 to be passively decommissioned as of this date, and by closure of the Troy Mine, road 4624 will be passively reclaimed. TMI agrees that the portion of road 4551 on private land should be decommissioned – converted to a trail; however, the portion of the road on national forest is already passively decommissioned and is little more than a trail. TMI believes that disturbing this road prism will cause undue environmental disturbance and increase risk of sedimentation to nearby streams. Additionally, TMI believes road 4628A will be passively decommissioned at mine closure and disturbing the steep, narrow, stable road prism in this area will cause undue

I-TMI 1

environmental disturbance; increase risk of sedimentation to nearby streams; and, ultimately the trail will become unstable and unusable.

ES18 – "*Any additional sediment from untreated roads and stream erosion across the mill site would add to the already elevated sediment load that currently exists in Stanley Creek and would adversely impact beneficial uses for an extended period of time.*"

This statement implies that Stanley Creek is impaired for sediment, which is not the case, and the claim that beneficial uses would be impacted is not substantiated. In early June 2011 Stanley Creek has been observed flowing at high flows while showing no visible sign of turbidity. Each year TMI sends the final report for the Comprehensive Water Quality Monitoring Program for streams adjacent to the TMI. To date, we have submitted reports for 25 years. According to Mr. Joe Volosin – Parametrix Inc., for 24 years, the benthic macroinvertebrate populations and water quality of the stream systems near the Troy Mine have been monitored. Samples have been collected at locations above and below mining operations in Fairway-Stanley Creek Systems and in the Lake Creek System. The benthic macroinvertebrate and water quality monitoring over the past 24 years have not identified any pollution impacts or degradation of Fairway-Stanley Creek and Lake Creeks due to TMI Facilities.

I-TMI 1 Over all the years of monitoring, the numbers of clinger taxa in Stanley Creek have been similar to Fairway Creek and similar between Lake Creek Sites. This metric suggests that for both Fairway-Stanley and Lake Creek systems, little sedimentation effects have been noted in any of the streams evaluated. TMI has included the Comprehensive Water Quality Monitoring Programs for Streams adjacent to Troy Mine: Spring 1986 through Fall 2009, Year 25 in Appendix E to this letter.

3-22; 2nd paragraph: "*Under the Proposed Action, unneeded roads that pose a resource risk would not be treated, and restoration work on needed roads would not be implemented.*"

The definition is not clear as to "unneeded" and "needed" roads.

3-23: "*The Agency-Mitigated Alternative would reduce sediment loading both by implementing reclamation actions and by treating mining road-related sediment sources.*"

The statement implies that the Agency-Mitigated Alternative reduces *road related sediment* more than the company's proposal. There is no analysis or discussion of how removing the asphalt surface from the road would reduce sediment more than the Proposed Action. Troy Mine was originally required to install asphalt to mitigate for sediment and it is used elsewhere in the KNF which indicates asphalt road cover is effective for sediment reduction.

3-120: "*Many roads used for drilling decades ago have revegetated and pose a low erosion risk to the watershed.*"

I-TMI 1 The DEIS supports TMI's argument that natural re-vegetation is an appropriate solution for some of the older roads.

General Comments

A-TMI-1 ES3 – Discussion of "patented" land may be confusing, may be better to just use private land and NFSL.

B-TMI 2 ES6/ES7 – The No Action description of ground water monitoring is inaccurate and misleading by implying there are only two ground water monitor wells. Currently TMI samples 15 monitoring wells, two of which are at the Libby Load-out Facility. TMI also samples the Service Adit ditch, Service Adit pipe and the EP-1 pump-back station.

The surface water program includes 16 surface water locations for a total of 34 sample locations. Lake Creek 1, 2 and 4; Stanley Creek - 2 and Fairway Creek – 1 are the bio-monitoring (macroinvertebrate) sampling locations. As a point of clarification Lake Creek 1 and 2, date back to 1979.

E-TMI 2 ES10 – *"The surface water quality monitoring sites that would be sampled are the same sites as those identified under the No Action Alternative."*

TMI adds the following points for clarification: As of 2005/2006, the TMI surface water quality monitoring includes 16 locations as follows:
LC-1, LC-2, LC-4
SC-2, SC-15, SC-17A
FC-1
Emma Gulch,
Weasel Lake, Weasel Gulch
Ross Creek 1 and 2
Toe Ponds: 4, 3, 2
Decant Pond

1-11: "*Based on the analyses in this EIS, the Deciding Officers only determine whether the Proposed Action is in compliance with respective state and federal laws.*"

A-TMI 2 The statement does not seem to be correct. The Deciding Officers prepare a Record of Decision (Rod) that determines what if any stipulations may be required to mitigate any impacts. The further discussion that indicates the Rod can only select from one of the alternatives is also incorrect. The Rod may select or modify any alternative including the preferred alternative to address a variety of issues.

B-TMI 3 2-25: "*Annual aerial inspections of the mine shadow area would be conducted by Troy Mine, Inc. with agency participation. Surveys would be conducted until bond release, and the subsidence portion of the reclamation bond would be held for a minimum of*

twenty years after the mine has been decommissioned and the adits have been plugged."

B-TMI 3 The requirement for annual aerial inspections for subsidence is not necessarily an accurate method for determining subsidence based on actual site experience. Surface road erosion could appear to be a subsidence event when viewed from the air. Other methods of field inspection should be considered. Twenty years of subsidence inspection before bond release is excessive.

B-TMI 4 2-36: This is the No Action and Proposed Action water monitoring plan, which is the one proposed in the Appendix F of the Revised Reclamation Plan with some additions. TMI adds the following Point of clarification: Table 2-2 is the one we proposed in the Revised Reclamation Plan during March 2006. As of 2005, TMI takes samples at 13 monitoring well sites – (two of which are at the Libby Loadout Facility). We also sample the mine's service adit ditch, service adit pipe and the Enviro-pump station and these sites are in the monitoring program. During the summer of 2010, two additional monitoring wells were drilled on the north end of the tailing facility, bringing the total to 15 monitoring wells.

The surface water program includes 16 surface water locations. In all we sample 34 locations including the monitoring wells, surface locations, plus the adit ditch, adit pipe and the spring at the Enviro-pump station.

Lake Creek 1, 2 and 4; Stanley Creek - 2 and Fairway Creek – 1 are the bio-monitoring (macroinvertebrate) sampling locations. As a point of clarification Lake Creek 1 and 2, date back to 1979.

B-TMI 5 2-57: *"If needed, the domestic water well located southeast of the tailings impoundment would be used for irrigation during the first three growing seasons; after which time, the well would be plugged and abandoned as required by ARM 36.21.810."*

The company objects to abandoning the well at the industrial site and abandoning the irrigation well at the decant pond area, because these private wells will have future uses.

B-TMI 6 2- 59: 6th bullet; "*The East Impoundment, North East Impoundment, and Cell 3 borrow areas would be planted with lower elevation forest type vegetation."*

The references to an East impoundment and NE impoundment should be **East Borrow and North East Borrow.**

C-TMI 1 3-7: "*The Libby loadout facility is not addressed in the No Action Alternative.*"

This is not correct. The Libby Load-out is currently permitted, bonded and has a reclamation plan. TMI submitted a "Minor Revision" to our Operating Permit for the New Libby Load-out facility on February 7, 2011. We received Approval for the Minor

C-TMI1 Revision from the MT DEQ on February 16, 2011. TMI started using the new load-out during March 2011.

3-26: "*requiring lands disturbed by mining...be reclaimed to comparable stability and utility.*"

A-TMI3 30CFR 228.8(g) is not the USFS's responsibility in this case to interpret DEQ's regulations. In fact 228.8(h) indicates that "certification or approval" by state agencies can be taken as acceptance of compliance with parallel regulations. The State and Federal responsibilities and authorities should be accurately described and kept separate from each other.

E-TMI3 3-47 1st paragraph: "*along an approximately 200 foot length of a tributary of Ross Creek.*"

The FEIS should note the tributary is ephemeral.

3-86 1st paragraph: "*In Lake Creek, non-mine sediment sources are somewhat more substantial, but would still be substantially less than the sediment generated by the reclamation.*"

E-TMI4 The statement is not reasonable. The Proposed Action will not produce sediment to Lake Creek or Stanley-Fairway Creek because the topsoil stockpiles would be left in the current reclaimed condition and FR4628 paved surface would not be removed and replaced with a gravel surface.

Over all the years of monitoring, the numbers of clinger taxa in Stanley Creek have been similar to Fairway Creek and similar between Lake Creek Sites. This metric demonstrates that for both Fairway-Stanley and Lake Creek systems, little sedimentation effects have been noted in any of the streams evaluated. TMI has included the Comprehensive Water Quality Monitoring Programs for Streams adjacent to TMI: Spring 1986 through fall 2009, Year 25 in the Appendix E to this letter.

E-TMI5 3-86, last paragraph: TMI believes the Proposed Action concrete closure/water capture structures in the service and conveyor adits would not have any more potential to "seep" resulting "*in water quality impacts*" than the agencies concrete water capture and diversion structure. No design was included in the DEIS.

3-90, 1st paragraph: "*Because nitrate concentrations would decrease after blasting ceases, closure and reclamation of the mine would reduce nutrient loading to surface water under all alternatives.*"

E-TMI6 The analysis and conclusions provided elsewhere in the DEIS indicate there has been no nutrient impact to Stanley or Lake Creeks from the mine. The implication that the mine has caused impairment to Stanley of Lake Creeks or that mine closure will somehow "reduce nutrient loading" to these creeks is not accurate.

3-114: "*Moreover, the water-holding capacity of the borrow materials is low and varies with the rock content.*"

H-TMI 2

The DEIS is correct that water holding capacity varies with rock content; however, the borrow materials proposed for growth media is composed of organics, clay, silt, sand and gravel. Test plots on Cell 2, embankment slopes and Cell 4 demonstrate the mixed borrow material has adequate water retention for growing grasses, shrubs and trees.

Finally in Appendix F., TMI has included photographs of the tailings facility, that shows the excellent growth on borrow material, photographs of the secondary containment warning system installation, photographs of the topsoil stock pile area and the grass growth on cell #4 – borrow material growth media.

Thank you for the opportunity to provide comments on the DEIS. If you have any questions regarding TMI's comments or would like to discuss the comments or potential changes to the FEIS resulting from the comments, please let us know.

Regards,

Douglas P. Miller
General Mine Manager
Troy Mine, Inc.

Appendix:

A: Closure Operations Manual

B: Dean Culwell, Westech Report, 2011: "Evaluation of Tailings Embankment Revegetation and Borrow Materials, Troy Mine, Lincoln County, Montana, 2011"

C: Rich Prodgers, Bighorn Environmental, "Effectiveness of Two Compost Products and One Mycorrhizal Inoculum in Promoting Nutrient Cycling in Cover Soils Originating as Deep Borrow"

D: Patrick Farmer, "Westech Report Western Toads / Topsoil Stockpiles, July 2011"

E: Comprehensive Water Quality Monitoring Programs for Streams adjacent to Troy Mine: Spring 1986 through Fall 2009, Year 25.

F: Troy Mine Photographs

Individual Comments

2011-06-07 Bernhart B.pdf

Bob Bernhart
4108 Bull Lake Rd
Troy, MT 59935
406-295-5498

June 7, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Kootenai National Forest and Montana DEQ:

Thank you for accepting the following comments on the revised reclamation plan for the Troy mine. I would like to focus my comments on the DEIS to the pipeline and impoundment mitigation recommendations. In general, I support the reclamation plan but there are areas that don't make a great deal of sense to me and that I find contradictory or unnecessary.

E1 Why would you want to dig up and disturb more ground if you were going to decommission the existing water pipeline and replace it with a new one for adit discharges? Aren't we trying to minimize TMDL impacts in the watershed? Why not just make safety precautions or improvements to the existing pipeline that has more than adequate capacity and seems to be working just fine?

If you did require replacement, why would you want it buried when it would be much more difficult to monitor in the future? Why would you want to disturb ground to bury it originally and perhaps again to repair or replace the line when it is completely unnecessary?

K1 Wouldn't using the toe pond stockpiled top soils for reclamation impact the western toad that currently has great habitat there now? Why not just use the coarse borrow material east of the impoundment instead? The DIES indicates that this could be just as successful in achieving reclamation goals and criteria. Are the wood based organic amendments that

H3 add 1,100 lbs of nitrogen per acre for the mill and impoundment really necessary? What is mycorrhizal fungi and why is it needed for reclamation at the mill? Why are the agencies requiring organic versus chemical fertilizer for reclamation in general?

Thank you for listening and I look forward to seeing the final reclamation plan include some further modifications to address some of the areas I have outlined above.

Respectfully,

Sincerely,

Bob Bernhart

2011-06-07 Erickson I.pdf

Issac Erickson
3367 mt hwy 200
Trout Creek, MT 59874
827-3391

June 7, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

G3 The Troy Mine Reclamation plans needs to be approved and permitted for several reasons. The operation is a huge asset to northwest Montana and provides over 190 good paying family wage jobs in an area that has the highest unemployment in the state.

For over thirty years the mine has been depositing its tailings in the impoundment and there has not been any significant impact to the areas streams or wildlife.

E7 K2 Several studies have been done that confirm this and I believe that allowing them to amend their reclamation plan to continue operating is a no brainer. It seems that both the USFS and the DEQ has done a thorough job of analyzing the revised reclamation plans, though there seems to be some recommendations that would actually create more disturbance than should be necessary.

E1 E2 Removing the water pipeline that is buried below the surface (if it is decided that it needs to be replaced) seems impractical as it wouldn't hurt anything to just leave it and remove the pipeline that is above ground. Completely burying a new pipeline (which I'm not convinced is even needed) seems to contradict the desire of all parties to ensure that the lines can be monitored and that there is ability to quickly detect any leakage or break in the line and just as quickly get necessary repairs made while disturbing the least ground or water resources as possible.

That being said, I'm confident the agency will listen to those that have more experience than I in this area and arrive at common sense mitigations while approving this reclamation permit. But I would like to go on record as supporting the preferred alternative with some modifications to the requirements for the pipeline.

Thank you for your time,

Sincerely,

Issac Erickson

2011-06-07 Jellesed E.pdf

Earlene Jellesed
39 Swanson Ldg. Rd
Troy, MT 59935
406-295-4201

June 7, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:
I work at the Troy Mine and several members of my family work here also. It is very important to me because my children and grandchildren are directly affected by these decisions.
Please accept my comments for the Troy Mine revised reclamation plans that have been submitted to your agency. After reading most of the DEIS, I wanted to applaud the agency and the diligent work that it has done in coming up with its preferred alternative.

E1 I would like to comment on two things that I believe may need changed before the final decision to move forward with your preferred approach is made. One is the pipeline that you are requiring to be buried. I'm no hydrologist, but it just seems silly to be burying a pipeline that may need dug up and replaced later if in fact you are accurate that the water needs to go through the infiltration process at the impoundment. Why tear up the entire hillside when you could just put it above ground next to the road as it is now for easy access in case there is a problem decades down the road?

H1 K1 Another is with regards to the toe ponds that have all the topsoil that is being recommended to cover the impoundment for reclamation. There has been a lot of praise to the company because of the habitat that has been created for the western toad. It would seem like a no brainer that they use the course borrow to reclaim it even if it takes a bit longer to achieve the standards required. How long will it take to replace the habitat for the western toad?

Thanks for your consideration,

Sincerely,

Earlene Jellesed

2011-06-08 Lloyd S.pdf

Steve Lloyd
Box 983
Hot Springs, MT 59845
406-295-5882 x238

June 8, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Montana DEQ and Kootenai National Forest:

Thank you for accepting my comments to the proposed revisions to the Troy Revised Reclamation Plan preferred alternative. I have just a couple of suggestions for you before you make your final determination.

I1 I would like to see the asphalt remain on the main road leading to the mine site. Removing it and returning it to dirt will just create more BMP work trying to mitigate for TMDL's in the watershed. You might require the asphalt to be repaired in places that it needs to be, but I believe it would be a short term investment that will pay long term dividends for the watershed.

H1 I also believe that using the readily available materials that is suitable for growth medium located on the mine to reclaim the tailing impoundment would be the better option. The topsoil that has been saved for that purpose has become great habitat for the western toad, elk, deer and moose, and I believe that using the other material instead will grow the trees and shrubs necessary to ensure proper reclamation.

B1 I also think that breaking up the foundations and burying the concrete onsite would be just fine rather than digging them up, breaking them up and burying them somewhere else. It's just concrete and won't impact water quality any more than the rip rap along the Bull Trout stream at the bottom of the mountain.

E1 Requiring the company to bury the pipeline when it could just be replaced with another above ground line doesn't make sense either. It seems that if you are serious about water quality and TMDL impacts, you wouldn't want to be disturbing an entire hillside to bury the line not to mention disturbing the ground and the advanced reclamation down the road if the line were to need replacement or repair. Leaving the pipeline above ground and next to the road with asphalt on it makes the most sense in my opinion.

I am really amazed at how well the disturbed areas have grown over druring the last 28

H3 years. Many areas are fully reclaimed and the trees are over 15 feet tall. It seems like the agency is putting a lot of emphasis on growth material, that is not really needed.

Thanks for your time and consideration.

Sincerely yours,

Sincerely,

Steve Lloyd

2011-06-08 Morkert H. pdf

Troy Mine Revised Reclamation Plan
Draft Environmental Impact Statement

If you would like to provide written comments, you may use this form today and drop it in the comment box at the registration table. You can also take this form home and mail it later to either Emily Corsi (DEQ) or Bobbie Lacklen (USDA Forest Service) at the addresses below. Comments may be faxed to (406) 283-7709 (KNF) or 406-444-4386 (DEQ Director's Office), or hand-delivered to the KNF Supervisor's Office and DEQ Director's Office between the hours of 8:00 a.m. and 4:30 p.m. Written comments must be postmarked by the Postal Service, e-mailed, faxed, or otherwise submitted by 11:59 pm on July 5, 2011.

Bobbie Lacklen
Kootenai National Forest
31374 U.S. Highway 2
Libby, MT 59923-3022
TroyMineReclamation@fs.fed.us

Emily Corsi
Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
DEQTroyMine@mt.gov

Name/Organization: Howard Morkert
Address: #Lightning Lane
Trout Creek Mt. 59874
E-mail: lhmork@blackfoot.net **Phone:** 406-827-4090

Comments: No where in the information provided does the matter of cost of each alternative come up, but in these times of government excess higher taxes and high unemployment it should have some weight, (a lot of weight)

G2 The DEQ and KNF alternative would appear to have the highest cost by far - soprise, its some one else's money that they are spending.

It seems to me that no action is not feasable but the government proposal is exceptionally costly and ultimatly the greatest initial land disturbance.

The company proposal may also require some tweaking but offers some of soundest ideas, those that are based in history and experience not subjective ideas, proposals and what ifs.

The ultimate question is will any of the comments matter or is the pride of authorship so strong within the agencies that no matter what is said nothing will change.

Put me down in favor of the proposed action alternative ~~[illegible]~~ (the Company plan) with some tweaking.

But I will be surprised if any of this affects the agencies agenda to put forth the highest possible cost alternative

2011-06-09 Blomdahl J. pdf

Jill Blomdahl
26 Lazy River Rd
Troy, MT 59935
2956056

June 9, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi:

Please consider my comment on the Troy Mine Revised Reclamation Plan Draft EIS.

The northwestern area of Montana has been in a deep recession for a decade longer than the rest of our nation. Much of this is because of the systematic dismantling of the forestry management system of the United States Forest Service. The resultant collapse of the local economies of the area has been catastrophic. Over 3500 industrial, family wage jobs have been lost in the logging and milling businesses of Lincoln and Sanders Counties. The social ills such as alcoholism, drug addictions, family destructive behaviors, suicides, domestic abuse that follow these types of economic losses are well documented and were tragically predicted.

G3

For the last several years, there has been a growing hope that mineral activity could replace some of the lost jobs and help to lower the unemployment rates of 20% that is found in these two counties. That hope will not be met with reality unless mines like the Troy Mine can stay in business. The economic benefit of nearly 200 jobs that average over $55,000 per year - not counting the benefits packages that includes health insurance, retirement plans and stock options â€“ cannot be overstated. The impact the Troy Mine has with $14 million in payroll, $10 million in local purchases of goods and services, $250,000 in property taxes, $1 million in gross proceeds taxes, $1.4 million in metal mines taxes cannot be overstated.

With this economic need as a backdrop to the discussion of the future of the mine, I would like to offer my support for the agency's preferred alternative â€“ with some suggestions for necessary changes.

H2

First, I do not think it is in the best interest of the environment to remove the topsoil from the toe of the impoundment area. Although it is true that this soil was once topsoil on the site, it has now been in place of over 30 years and it seems unnecessary and possibly even foolish to disturb the area so close to the water courses that have successfully protected

H2 during mine operation. Surely, in order to grow the trees and other vegetation that is native to the area, the soil from area borrow pits can be utilized with success and without the potential impacts associated with gross disturbance of areas near streams that have already healed up.

Thank you for accepting and considering my comment.

Sincerely,

Sincerely,

Jill Blomdahl

2011-06-09 Garcia S. pdf

From: Soraya Garcia
To: DEQ Troy Mine
Subject: Troy Mine Revised Reclamation PLan comments
Date: Thursday, June 09, 2011 9:20:46 AM

Soraya C Garcia
490 Waterfront Rd
Troy, MT 59935

6/9/11

To: Emily Corsi,

After attending the hearing in Troy, MT on 6/8/11 regarding the Troy mine reclamation plan, I do have some comments as a resident of Lincoln County.

E2

First of all, I would like to comment on the subject of the slurry pipe. How many people drive on the mine road to site see???? How many residents live on the mine road??????
Gee.....can I have the power lines along any road in Montana put underground because I dont like what it looks like? So instead of being environmentally safe by having the pipes above ground, it is recommmended that the pipes be buried to ensure the beauty of the surroundings because a few persons dont like how it looks.. Sounds to me like some common sense is not being put into practice over that particuliar issue and one of the reasons behind wanting the pipes put underground.

I would also like to comment on the issue regarding the habitat in that particular area.....It seems that the environmental protection specialists are always finding some sort or animal,plant, or bird to be disturbed when it comes to the organization wanting to change something. Well what about the grizzley bear being transplanted to the area where the mine is located.....Did the F&G think for one minute about the lives of all those employees being put into danger from a bear attack? Those persons are being disturbed and their livelyhood is being attacked also. No common sense was used in that decision, especially when the bears could have been transplanted back to Alaska, to their natural habitat.
Why does it seem like nobody cares about the the economy of our area? The only economy these changes will affect, will be the pocketbooks of the KNF & MDEQ. With no economy in this area....there will be no persons driving around on the mine road to judge whether it is beautiful or not. These agencies are making it impossible for businesses to grow and to help make the economy grow. The mine is so busy jumping through everyone else's hoops to ensure the environmental quality of this area, dont you think that they would ensure the public that they will make sure that the area is left environmentally safe when it ceases to operate.

2011-06-12 Brus C.pdf
(page 1-2)

From: Cary Brus
To: "troyminereclamation@fs.fed.us"; DEQ Troy Mine
Subject: Comment on Troy Mine DEIS
Date: Sunday, June 12, 2011 9:06:36 AM

Dear Bobbie and Emily,

I appreciate the opportunity to comment on the Troy Mine DEIS. I am a geologist with a keen interest in mining. I have read the DEIS and offer the following comments.

I strongly favor alternative **ES.6.2 Proposed Action.**

In summation, this proposal strikes the balance between (a) minimizing adverse environmental impacts associated with a mine reclamation, and (b) economic common sense.

The following comments are directed in support of **ES.6.2 Proposed Action** and against specific actions contemplated in **ES.6.3 Agency-Mitigated Alternatives** as follows:

B3
- Plugging the South Adit an additional 100 feet is overkill and unnecessary. The additional 100 feet of development rock fill has no subsurface benefit and serves only as a "more is better" change.

E2
- A new, buried mine water pipeline replacing (a) two existing 8-inch surface pipelines and (b) the already buried reclaim water line is not a wise idea. A buried line has just as much probability of leaking – some would argue a greater probability – than a surface line. A line is a line, whether underground or on the surface. Underground leak detection systems are beneficial to the vendor selling you the system, but otherwise are grossly unreliable. This adds an additional layer of complexity and human error to an otherwise simple process as someone has to monitor the leak detection system. A leak detected – whether above or below ground – is a post event occurrence. Use the existing above ground lines. They are easier to monitor, detect and repair.

E4
- The agency-mitigated alternative does not take into account the secondary containment systems already being installed on the tailings lines where they cross both Lake and Stanley Creeks. The Troy Mine has been proactively working to address agency concerns for both creek crossings.

E9
- One additional surface water monitoring site and 4 additional monitoring wells near the decant ponds are an unnecessary and wasteful use of capital resources.

H1

- Existing stockpiled topsoil should be left as berms to (a) continue to provide current habitat and (b) prevent sediment loading at Lake Creek. Disturbing and ultimately using the material increases the opportunity for sediment loading. And, the biolife – including a favored toad - currently residing in the berms and topsoil piles will be disturbed.

H3
H4

- The prescription to use "agency-approved, wood-based, organic amendment to raise organic matter content to achieve 1,100 lbs of nitrogen per acre" contradicts a later statement that "chemical fertilizers would not be used under the Agency-Mitigated Alternative." You are specifying a nitrogen load in one sentence.....and later specifying no chemical loading. **Use common sense**. The mine is located in, essentially, a rain forest with an annual rainfall of 30 inches. Almost anything will grow without any fertilizer, nitrogen or otherwise. Second, the unintended consequences of nitrogen loading 1,100 lbs per acre cannot be accurately assessed. Nitrogen is not the issue. Cover material is the critical issue for plant growth. The borrow material for the east borrow pit has already been proven in test plots to successfully grow plant life.

E6

- The use of "imported non-mineralized rock" rather than mine development rock for drainage channel fill is another violation of common sense and fiscal efficiency. The entire mountain is made up of quartzite. Bringing in "imported rock" with its non-native chemical and crystal structure puts the Law of Unintended (*Leaching*) Consequences directly in play. Use the waste rock on hand that is directly native to the specific, localized area. Any concern over using angular waste rock onsite vs. using rounded imported rock for drainage channel fill is a discussion that wastes time. All rock rounds over time.

I1

- The Agency Mitigated Alternative plan for reclaiming roads would, in fact, **INCREASE** the sediment load. The conclusion that replacing 6 miles of **paved surface** on NFSR 4626 with gravel would lead to a decrease in sediment loading is erroneous. The objective of the reclamation is environmental protection, not advancing Kootenai National Forest preferred road maintenance methods.

F1

- The Proposed Action allows maintenance of existing roads for recreational access.

J1

- The statement that "…..the diverse native plant communities that were originally present **would never fully re-establish**" is, again, erroneous. "Never" is a long time. The mine is located in an alpine rain forest where darn near everything will grow in a relatively small amount of borrow

cover material. The bias towards the Agency-Mitigated Alternative is readily apparent.

- And, again, when evaluating alternatives and what is being asked I ask you to please use some common sense and put this in perspective. The mine permit of 2,782 acres a relatively minor footprint in the overall KNF. Furthermore, the 430 acres of surface (on mostly private land, to boot) disturbance is even smaller yet, 85% smaller.

A5

- **Personal comment**: The proposed increase in bonding being contemplated is egregious and harmful to the overall mine project. Jobs, families and people's lives are at stake.

G1

Finally, it is with regret I did not read anywhere in your DEIS any discussion about the unnamed fauna most affected by the Agency-Mitigated Alternative plan: humans, their families, their communities, their mortgage payments, their college savings funds for their children, etc. Job creation and job destruction were never mentioned. This has *always* been the fatal flaw of EIS and DEIS efforts, and is simply wrong.

In summation, I strongly favor alternative **ES.6.2 Proposed Action.**

Cary E. Brus

Cary E. Brus, Sr. VP
Nerd Gas Company LLC
P.O. Box 3003
1701 East "E" Street
Casper, Wyoming 82602

ph: 307.234.0583
fax: 307.234.4631
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email: cary@mcmurry.net

2011-06-12 Brus T.pdf

Tim Brus
73 road 2daw
Cody, Wy 82414
307 250 4747

June 12, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

I would like to provide some comments regarding the Troy reclamation revision that is open for public comment.

E7 It seems that the agency has done a very thorough examination of all the data that has been collected over the last 30 years and has made an accurate assessment of the water being discharged. From what I have seen, there is simply going to be clean water flowing out of the adit down to the impoundment, and requiring a water treatment facility will not be required.

E1 One thing that really makes me scratch my head though has to do with the pipeline analysis. Is the existing pipeline in a condition that requires replacement immediately upon the mine being decommissioned? I would suggest leaving the existing pipeline infrastructure in place until it needs replacement, and I can't see the logic in burying it when it does get replaced. Wouldn't it be easier to detect leaks and work on it if it was above ground? Aren't we going to be disturbing much more ground by doing it this way? This just doesn't make a whole lot of sense to me.

Thank you for accepting my comments. I eagerly await your response!

Sincerely,

Sincerely,

Tim Brus

2011 - 06 - 13 Bailey H.pdf

From:	Hank Bailey
To:	DEQ Troy Mine
Cc:	lib@bsh-law.com
Subject:	DEIS Troy Mine, Lincoln County, Montana
Date:	Monday, June 13, 2011 8:46:54 AM

To Whom It May Concern:

I write as a concerned citizen. I am familiar with the Troy Mine and the Draft Environmental Impact Statement related thereto. I am aware of the need to balance responsible and environmentally sound mining practices with economic development and stability, and the need to protect jobs. Though not a citizen of Montana at present, I grew up there and I am quite familiar with its "Big Sky" beauty.

With due regard for all the competing interests and factors, I urge your support of **ES.6.2 Proposed Action.**

I believe this proposal strikes the balance between minimizing adverse environmental impacts and fostering economic stability and growth. I believe **EX.6.3. Agency-Mitigated Alternatives** goes far beyond what is necessary to protect the environment and will have significant detrimental impact on the economy and employment. I freely admit I am not an expert in geology, nor in environmental science, or any related field. Although my undergraduate degree was in Economics, I claim no special abilities in that field either. I simply know that our nation is in the throes of a horrible recession and that excessive government regulation, while often well intentioned, tends to stifle economic activity and growth, and that the costs are unavoidably passed on to every citizen. And that includes me and my family. I also represent a number of rural electric cooperatives who have seen their costs, and thus the costs to their consumer members, rise significantly due to increased government regulation.

With that in mind, I offer the following:

Plugging the South Adit an additional 100 feet is unnecessary. The additional 100 feet of development rock fill has no subsurface benefit and serves only as a "more is better" change.

E2
- A new, buried mine water pipeline replacing (a) two existing 8-inch surface pipelines and (b) the already buried reclaim water line is not a wise idea. A buried line has just as much probability of leaking – some would argue a greater probability – than a surface line. A line is a line, whether underground or on the surface. Underground leak detection systems are beneficial to the vendor selling you the system, but otherwise are grossly unreliable. This adds an additional layer of complexity and human error to an otherwise simple process as someone has to monitor the leak detection system. A leak detected – whether above or below ground – is a post event occurrence. Use the existing above ground lines. They are easier to monitor, detect and repair.

E4
- The agency-mitigated alternative does not take into account the secondary containment systems already being installed on the tailings lines where they cross both Lake and Stanley Creeks. The Troy Mine has been proactively working to address agency concerns for both creek crossings.

E9
- One additional surface water monitoring site and 4 additional monitoring wells near the decant ponds are an unnecessary and wasteful use of capital resources.

H1
- Existing stockpiled topsoil should be left as berms to (a) continue to provide current habitat and (b) prevent sediment loading at Lake Creek. Disturbing and ultimately using the material increases the opportunity for sediment loading. And, the biolife – including a favored toad - currently residing in the berms and topsoil piles will be disturbed.

H3
H4
- The prescription to use "agency-approved, wood-based, organic amendment to raise organic matter content to achieve 1,100 lbs of nitrogen per acre" contradicts a later statement that "chemical fertilizers would not be used under the Agency-Mitigated Alternative." You are specifying a nitrogen load in one sentence.....and later specifying no chemical loading.

H3
H4

Common sense must prevail here. The mine is located in, essentially, a rain forest with an annual rainfall of 30 inches. Almost anything will grow without any fertilizer, nitrogen or otherwise. Second, the unintended consequences of nitrogen loading 1,100 lbs per acre cannot be accurately assessed. Nitrogen is not the issue. Cover material is the critical issue for plant growth. The borrow material for the east borrow pit has already been proven in test plots to successfully grow plant life.

E6

- The use of "imported non-mineralized rock" rather than mine development rock for drainage channel fill is another violation of common sense and fiscal efficiency. The entire mountain is made up of quartzite. Bringing in "imported rock" with its non-native chemical and crystal structure puts the Law of Unintended (*Leaching*) Consequences directly in play. Use the waste rock on hand that is directly native to the specific, localized area. Any concern over using angular waste rock onsite vs. using rounded imported rock for drainage channel fill is a discussion that wastes time. All rock rounds over time.

I1

- The Agency Mitigated Alternative plan for reclaiming roads would, in fact, increase the sediment load. The conclusion that replacing 6 miles of paved surface on NFSR 4626 with gravel would lead to a decrease in sediment loading is erroneous. The objective of the reclamation is environmental protection, not advancing Kootenai National Forest preferred road maintenance methods.

F1

- The Proposed Action allows maintenance of existing roads for recreational access.

J1

- The statement that "…..the diverse native plant communities that were originally present would never fully re-establish" is, again, erroneous and not scientifically based. "Never" is a long time. The mine is located in an alpine rain forest where darn near everything will grow in a relatively small amount of borrow cover material. The bias towards the Agency-Mitigated Alternative is readily apparent.
- And, again, when evaluating alternatives and what is being asked I ask you to please use some common sense and put this in perspective. The mine permit of 2,782 acres a relatively minor footprint in the overall KNF. Furthermore, the 430 acres of surface (on mostly private land, to boot) disturbance is even smaller yet, 85% smaller.

A5

- Personal comment: The proposed increase in bonding being contemplated is egregious and harmful to the overall mine project. **Jobs, families and people's lives are at stake**. PLEASE TAKE THAT INTO CONSIDERATION!

G1

I believe all the focus on "endangered species" and similar environmental concerns often loses sight of what is today, perhaps, an even more endangered species - the family of man, our jobs, our communities, our way of life. Enough is enough. It's time to let the pendulum swing back.

I strongly favor alternative **ES.6.2 Proposed Action.**

Thank you for taking time to read and consider my thoughts.

Henry F. Bailey Jr.
Bailey, Stock & Harmon P.C.
221 East 21st Street
Cheyenne, Wyoming 82001
307.638.7745
307.638.7749 Fax

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2011-06-13 Bakke H_CRG.pdf
PB

The Cabinet Resource Group

June 13, 2011

Paul Bradford, Forest Supervisor
Kootenai National Forest
31374 US 2
Libby, MT 59923-3022

Re: Troy Mine Reclamation Bond; Draft Environmental Impact Statement

Mr. Bradford,

A1 I am writing on behalf of the Cabinet Resource Group to address the situation with the Troy Mine Reclamation Bond Draft Environmental Impact Statement. As you are aware, CRG has been involved since the bond was declared insufficient in 1999. Since that time, there has been confusion regarding the necessity of an Environmental Assessment or an Environmental Impact Statement. Finally, on or about May 20, 2011 it was published in the Federal Register of the intent to issue an DEIS; that action started a 45 day comment period although the document itself didn't become generally available for several days. Since most of the members of CRG are involved in other endeavors requiring their time, the document is over 1,000 pages, and, after all, it has been eleven years, we feel it is not unreasonable to ask that the comment period be extended for a minimum of 30 days to allow sufficient time to analyze and comment.

I am taking this opportunity to pass along another suggestion made by several people at the public meeting held June 8 in Troy, Montana. Members of CRG's board, including this writer, representatives of MTDEQ, USFS, and Revett Minerals management had informal conversations before and after the formal meeting. What became apparent was a lack of understanding how some of the proposals in the DEIS would translate into

The Cabinet Resource Group

physical operations. The idea, the suggestion, was put forward to have another meeting with representatives from all the interested parties. Perhaps a much more informal meeting in Missoula, while necessarily a public meeting, but conducted as a "round table" discussion where details could be explained and possibly even negotiated. If such a meeting is possible and CRG can be of assistance in organizing it please let me know.

To contact me directly:

Howard Bakke
P O Box 1627
Noxon, MT 59853-1627
406-847-9390
406-531-0925 cell
E-mail: Howlb@Blackfoot.net

Thank you for your attention and consideration of these matters.

Sincerely,

Howard Bakke

Howard Bakke, President
Cabinet Resource Group
P O Box 238
Heron, MT 59844

Cc: Richard Opper, Director
MT DEQ
Helena, MT

2011-06-13 DeVore K_a .pdf

Kim DeVore
205 Storey Blvd
Cheyenne, WY 82009
307-773-7781

June 13, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi,

I am writing to support the Troy Mine and provide comment on their Revised Reclamation Plan Draft EIS.

G3 This project is incredibly important to the communities of Lincoln County and our state. The 190 plus jobs are the last industrial, wealth generating jobs in the County. These jobs and the $14,000,000 per year payroll they represent coupled with $20,000,000 per year spent on services â€“ one half of which are purchased in Montana â€“ are huge factors in the local economy. The $1.4 million paid annually on Montana Metal Mines license taxes and the $250,000 paid in property taxes benefits the local, county and state schools $1million paid annually on gross proceeds taxes benefits the State of Montana's bottom line.

None of this would matter if the mine were not environmentally sound. Thankfully, it is â€“ and I applaud the EIS's conclusion, specifically with water impacts, that backs this conclusion.

E1 However, I do have some issues with the EIS and the potential impact on the environmental footprint of the closure requirements. Specifically, I take issues with the need to bond for removal of the pipelines above ground and replace them with lines below ground when the mine is done. The above ground pipelines are not hurting anything. Digging to bury a new line will cause more impacts to the environment than leaving them in place. Further, every time the pipes need work done to them or replaced the impacts will be revisited. When we are doing all we can to disallow the potential of sediment into our streams, it seems inconsistent to require such ground disturbances being repeated in perpetuity.

Thank you for taking my comment.

Sincerely yours,
Kim DeVore

Sincerely,

Kim DeVore

2011-06-13 DeVore K_b.pdf
(pages 1-2 of 3)

From: Kim DeVore
To: DEQ Troy Mine
Subject: Troy Mine
Date: Monday, June 13, 2011 2:02:10 PM

Dear Bobbie and Emily,

I appreciate the chance to comment on the Troy Mine DEIS. I am a bank CFO with a seemingly odd interest in mining. Actually the company I indirectly work for has strong interests in mining, land development and oil/gas exploration, therefore I have learned quite a bit just listening. I have read the DEIS and offer the following comments.

I strongly favor alternative **ES.6.2 Proposed Action.**

In summation, this proposal strikes the balance between (a) minimizing adverse environmental impacts associated with a mine reclamation, and (b) economic common sense.

The following comments are directed in support of **ES.6.2 Proposed Action** and against specific actions contemplated in **ES.6.3 Agency-Mitigated Alternatives** as follows:

B3
- Plugging the South Adit an additional 100 feet is overkill and unnecessary. The additional 100 feet of development rock fill has no subsurface benefit and serves only as a "more is better" change.

E2
- A new, buried mine water pipeline replacing (a) two existing 8-inch surface pipelines and (b) the already buried reclaim water line is not a wise idea. A buried line has just as much probability of leaking – some would argue a greater probability – than a surface line. A line is a line, whether underground or on the surface. Underground leak detection systems are beneficial to the vendor selling you the system, but otherwise are grossly unreliable. This adds an additional layer of complexity and human error to an otherwise simple process as someone has to monitor the leak detection system. A leak detected – whether above or below ground – is a post event occurrence. Use the existing above ground lines. They are easier to monitor, detect and repair.

E4
- The agency-mitigated alternative does not take into account the secondary containment systems already being installed on the tailings lines where they cross both Lake and Stanley Creeks. The Troy Mine has been proactively working to address agency concerns for both creek crossings.
- One additional surface water monitoring site and 4 additional monitoring

E9 wells near the decant ponds are an unnecessary and wasteful use of capital resources.

- H1 Existing stockpiled topsoil should be left as berms to (a) continue to provide current habitat and (b) prevent sediment loading at Lake Creek. Disturbing and ultimately using the material increases the opportunity for sediment loading. And, the biolife – including a favored toad - currently residing in the berms and topsoil piles will be disturbed.
- H3 H4 The prescription to use "agency-approved, wood-based, organic amendment to raise organic matter content to achieve 1,100 lbs of nitrogen per acre" contradicts a later statement that "chemical fertilizers would not be used under the Agency-Mitigated Alternative." You are specifying a nitrogen load in one sentence.....and later specifying no chemical loading. **Use common sense**. The mine is located in, essentially, a rain forest with an annual rainfall of 30 inches. Almost anything will grow without any fertilizer, nitrogen or otherwise. Second, the unintended consequences of nitrogen loading 1,100 lbs per acre cannot be accurately assessed. Nitrogen is not the issue. Cover material is the critical issue for plant growth. The borrow material for the east borrow pit has already been proven in test plots to successfully grow plant life.
- E6 The use of "imported non-mineralized rock" rather than mine development rock for drainage channel fill is another violation of common sense and fiscal efficiency. The entire mountain is made up of quartzite. Bringing in "imported rock" with its non-native chemical and crystal structure puts the Law of Unintended (*Leaching*) Consequences directly in play. Use the waste rock on hand that is directly native to the specific, localized area. Any concern over using angular waste rock onsite vs. using rounded imported rock for drainage channel fill is a discussion that wastes time. All rock rounds over time.
- I1 The Agency Mitigated Alternative plan for reclaiming roads would, in fact, **INCREASE** the sediment load. The conclusion that replacing 6 miles of **paved surface** on NFSR 4626 with gravel would lead to a decrease in sediment loading is erroneous. The objective of the reclamation is environmental protection, not advancing Kootenai National Forest preferred road maintenance methods.
- F1 The Proposed Action allows maintenance of existing roads for recreational access.
- J1 The statement that "....the diverse native plant communities that were originally present **would never fully re-establish**" is, again, erroneous. "Never" is a long time. The mine is located in an alpine rain forest where

J1 darn near everything will grow in a relatively small amount of borrow cover material. The bias towards the Agency-Mitigated Alternative is readily apparent.

- And, again, when evaluating alternatives and what is being asked I ask you to please use some common sense and put this in perspective. The mine permit of 2,782 acres a relatively minor footprint in the overall KNF. Furthermore, the 430 acres of surface (on mostly private land, to boot) disturbance is even smaller yet, 85% smaller.

A5

- **Personal comment**: The proposed increase in bonding being contemplated is egregious and harmful to the overall mine project. Jobs, families and people's lives are at stake.

G1 Finally, it is with regret I did not read anywhere in your DEIS any discussion about the unnamed fauna most affected by the Agency-Mitigated Alternative plan: humans, their families, their communities, their mortgage payments, their college savings funds for their children, etc. Job creation and job destruction were never mentioned. This has *always* been the fatal flaw of EIS and DEIS efforts, and is simply wrong. Anywhere you look within the internet, news, print or just general discussion between Americans.....jobs are king. Please do not find yourself guilty of ignoring what the public is worried about and demanding, as your role is to listen and respond knowledgably and appropriately.

In summation, I strongly favor alternative **ES.6.2 Proposed Action.**

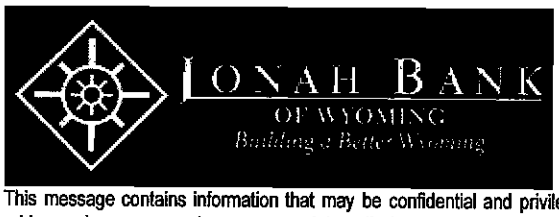
Kim DeVore

Chief Financial Officer

Office: (307) 773-7781 | Fax: (307) 637-2894

205 Storey Boulevard | Cheyenne | WY | 82009

www.jonahbank.com



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2011-06-13 LymanDe.pdf

June 13, 2011

RECEIVED
JUN 15 2011
DEQ
DIRECTOR'S OFFICE

OFFICIAL RECORD

Dear Mr. Opper,

A1 I am writing to request an extension of 45 to 60 days for public comments concerning the Troy Mine Reclamation Plan.

The reclamation plan has dragged on for 11 years and is a large document. Folks that have been following the process and wish to comment have not been given enough time to study the document and comment upon it in a thoughtful manner.

Please reconsider the current time line and extend it so it is fair to the public and their concerns.

This is very important.

Thank you,

Debbie Lyman
34 Beaver Peak Rd 847-2388
Heron, MT 59844
lastlyman@blackfoot.net

2011-06-13 Thompson B.pdf
(pages 1, 2 of 3)

From: Bill Thompson
To: troyminereclamation@fs.fed.us; DEQ Troy Mine
Subject: DEIS Troy Mine
Date: Monday, June 13, 2011 9:09:52 AM

Dear Bobbie and Emily,

I appreciate the opportunity to comment on the Troy Mine DEIS. I am a Banker with a keen interest in economic development of natural resources located in the United States of America. I have read the DEIS and offer the following comments.

I strongly favor alternative **ES.6.2 Proposed Action.**

In summation, this proposal strikes the balance between (a) minimizing adverse environmental impacts associated with a mine reclamation, and (b) economic common sense.

The following comments are directed in support of **ES.6.2 Proposed Action** and against specific actions contemplated in **ES.6.3 Agency-Mitigated Alternatives** as follows:

B3

- Plugging the South Adit an additional 100 feet is overkill and unnecessary. The additional 100 feet of development rock fill has no subsurface benefit and serves only as a "more is better" change.

E2

- A new, buried mine water pipeline replacing (a) two existing 8-inch surface pipelines and (b) the already buried reclaim water line is not a wise idea. A buried line has just as much probability of leaking – some would argue a greater probability – than a surface line. A line is a line, whether underground or on the surface. Underground leak detection systems are beneficial to the vendor selling you the system, but otherwise are grossly unreliable. This adds an additional layer of complexity and human error to an otherwise simple process as someone has to monitor the leak detection system. A leak detected – whether above or below ground – is a post event occurrence. Use the existing above ground lines. They are easier to monitor, detect and repair.

E4

- The agency-mitigated alternative does not take into account the secondary containment systems already being installed on the tailings lines where they cross both Lake and Stanley Creeks. The Troy Mine has been proactively working to address agency concerns for both creek crossings.
- One additional surface water monitoring site and 4 additional monitoring

E9 wells near the decant ponds are an unnecessary and wasteful use of capital resources.

H1
- Existing stockpiled topsoil should be left as berms to (a) continue to provide current habitat and (b) prevent sediment loading at Lake Creek. Disturbing and ultimately using the material increases the opportunity for sediment loading. And, the biolife – including a favored toad - currently residing in the berms and topsoil piles will be disturbed.

H3
H4
- The prescription to use "agency-approved, wood-based, organic amendment to raise organic matter content to achieve 1,100 lbs of nitrogen per acre" contradicts a later statement that "chemical fertilizers would not be used under the Agency-Mitigated Alternative." You are specifying a nitrogen load in one sentence.....and later specifying no chemical loading. **Use common sense**. The mine is located in, essentially, a rain forest with an annual rainfall of 30 inches. Almost anything will grow without any fertilizer, nitrogen or otherwise. Second, the unintended consequences of nitrogen loading 1,100 lbs per acre cannot be accurately assessed. Nitrogen is not the issue. Cover material is the critical issue for plant growth. The borrow material for the east borrow pit has already been proven in test plots to successfully grow plant life.

E6
- The use of "imported non-mineralized rock" rather than mine development rock for drainage channel fill is another violation of common sense and fiscal efficiency. The entire mountain is made up of quartzite. Bringing in "imported rock" with its non-native chemical and crystal structure puts the Law of Unintended (*Leaching*) Consequences directly in play. Use the waste rock on hand that is directly native to the specific, localized area. Any concern over using angular waste rock onsite vs. using rounded imported rock for drainage channel fill is a discussion that wastes time. All rock rounds over time.

I1
- The Agency Mitigated Alternative plan for reclaiming roads would, in fact, **INCREASE** the sediment load. The conclusion that replacing 6 miles of **paved surface** on NFSR 4626 with gravel would lead to a decrease in sediment loading is erroneous. The objective of the reclamation is environmental protection, not advancing Kootenai National Forest preferred road maintenance methods.

F1
- The Proposed Action allows maintenance of existing roads for recreational access.

J1
- The statement that ".....the diverse native plant communities that were originally present **would never fully re-establish**" is, again, erroneous.

J1 "Never" is a long time. The mine is located in an alpine rain forest where darn near everything will grow in a relatively small amount of borrow cover material. The bias towards the Agency-Mitigated Alternative is readily apparent.

- And, again, when evaluating alternatives and what is being asked I ask you to please use some common sense and put this in perspective. The mine permit of 2,782 acres a relatively minor footprint in the overall KNF. Furthermore, the 430 acres of surface (on mostly private land, to boot) disturbance is even smaller yet, 85% smaller.

A5
- **Personal comment**: The proposed increase in bonding being contemplated is egregious and harmful to the overall mine project. Jobs, families and people's lives are at stake.

G1 Finally, it is with regret I did not read anywhere in your DEIS any discussion about the unnamed fauna most affected by the Agency-Mitigated Alternative plan: humans, their families, their communities, their mortgage payments, their college savings funds for their children, etc. Job creation and job destruction were never mentioned. This has *always* been the fatal flaw of EIS and DEIS efforts, and is simply wrong.

In summation, I strongly favor alternative **ES.6.2 Proposed Action.**

Bill Thompson

Vice President

Office: (307) 268-7302 | Cell: (307) 259-9345

777 West First Steet | Casper | WY | 82604

bthompson@jonahbank.com

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2011-06-14 Swanson T.pdf

From: Tom Swanson
To: troyminereclamation@fs.fed.us; DEQ Troy Mine
Subject: DEIS Troy Mine
Date: Tuesday, June 14, 2011 10:07:20 AM

TWIMC:

G1 I would like to voice my opinion that I strongly support the adoption of ES.6.2 Proposed action in this matter as this alternative is the best outcome for families of Lincoln County. This Mine is the largest private employer in Lincoln County and needs to be encouraged to stay and prosper.

G2 I reject the Agency Mitigated Alternative ES.6.3 as an attempt to put undo costly requirements on a project that has done a good job of mitigating environmental issues in spite of over-regulation. This 2,782 acre mine permit is a small footprint relative to the jobs the Mine creates for the families of Lincoln County. Additionally, I would advocate that the bond increase for this project is

A5 punitive and outrageous and completely unjustified and without reason; this motive for this increase in bonding should be reexamined.

ES.6.2 Proposed Action makes much better sense than the other considered alternatives; please adopt ES. 6.2 Proposed Action .

Thank you. Tom E. Swanson, 2231 Miracle Drive, Casper, Wy 82609

2011 - 06-14 Waekerlin R.pdf

From: Ron Waeckerlin
To: toyminereclamation@fs.fed.us
Cc: DEQ Troy Mine; "Cary Brus"
Subject: Troy Mine DEIS
Date: Tuesday, June 14, 2011 5:09:13 PM

Greetings,
My name is Ron Waeckerlin. I am a frequent visitor to Montana and have family in the Missoula and Helena regions. I am interested in the current DEIS and alternatives being considered for the Troy Mine in Lincoln County. After review of many of the documents and discussion with experts in the mining and geology fields I urge favorable consideration for ES.6.2 Proposed Action and oppose the ES.6.3 Agency Mitigated Alternatives. The former is a reasonable common sense approach which balances the need for long term environmental protection and sound economic principles. Specifically the added bonding requirements and many of the specific points in the 6.3 AMA seem unrealistic, poorly thought out, and intended for prevent appropriate development of a needed resource. Thanks for your consideration.
Ron Waeckerlin

A5

2011-06-15 LymanDa.pdf

OFFICIAL RECORD

Dear Mr. Opper,

A1 I have been informed that the EIS for the Troy mine reclamation plan has been released for comment. I understand that the interval allowed for comment is 30 days and that interval began some time back. I have been following this issue for years and I would like to submit reasoned comments. There is simply not enough time to adequately appraise the plan as it now stands. I would like to see at least a 60 day extention of the comment period. 90 days would be better and fairer and would allow time for the information to reach all interested parties. Revett has operated for years with no valid reclamation plan. The public should have a good opportunity to review the plan that has finally been submitted. Thank you for any help you can give to extend this comment period.

Sincerely,

Dave Lyman
34 Beaver Peak Road
Heron, MT 59844

406-847-2388

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JUN 15 2011
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2011-06-16 Ballard D.pdf

From: Dave Ballard
To: DEQ Troy Mine; TroyMineReclamation@fs.fed.us
Subject: Attn: Troy Mine Revised Reclamation Plan
Date: Thursday, June 16, 2011 10:53:18 PM

Bobbie Lacklen
Project Coordinator
Kootenai National Forest

Emily Corsi
Project Coordinator
Montana Department of Environmental Quality

RE: Troy Mine Revised Reclamation Plan

Dear Project Coordinators

I strongly favor the **Proposed Action Alternative**.

G2
A5

The Proposed Action Alternative strikes the best balance between minimizing adverse environmental impacts associated with a mine reclamation, and economic common sense. The additional measures included in the Agency-Mitigated Alternative plan for pipelines, soil replacement, and demolition debris disposal extend beyond the measures necessary to achieve the desired reclamation The resulting extreme increase in bonding requirements places an undue hardship on the ability of the mine to sustain jobs badly needed in this region of Montana. I urge you to choose the common sense balance in the **Proposed Action Alternative.**

Thank you for the opportunity to comment.

Sincerely,

Dave Ballard
5425 Billy Casper Dr.
Billings, MT 59106

2011-06-17 Hough P_FSPW .pdf

Friends of Scotchman Peaks Wilderness

www.ScotchmanPeaks.org

FSPW
PO Box 2061
Sandpoint, ID 83864

Board and Staff

Phil Hough
Chairman,
Exec Director
(208) 946-9127

Doug Ferrell
Vice-Chair
Montana Director
(406) 827-4341

Carol Jenkins
Vice-Chair
Idaho Director
(208) 265-9204

Sarah Lundstrum
Secretary
(406) 755-6304

Jacob Styer
Treasurer
(208)-265-7206

Neil Wimberley
East Bonner County Director
(208) 264-5379

Bill Martin
Board Member
(406) 295-5258

Will Valentine
Board member
(208) 255-1114

Sandy Compton
Program Coordinator
(208)-290-1281

Molly Kieran
Lincoln County Coordinator
(406) 293-2934

Emily Corsi
Montana Department of Environmental Quality
PO Box 200901
Helena, MT 59620-0901

Bobbie Lacklen
Kootenai National Forest
31374 U.S. Highway 2
Libby, MT 59923-3022

Via email: DEQTroyMine@mt.gov
TroyMineReclamation@fs.fed.us

Re: Troy Mine Revised Reclamation Plan, Draft EIS

Dear Ms. Corsi and Ms. Lacklen,

We appreciate all the work that has gone into preparing the draft EIS for the Troy Mine Revised Reclamation Plan. Undoubtedly the final plan will be an improvement over the existing one as a result of these efforts.

We believe that the proposals and efforts of the mine operators as well as the additional mitigation measures suggested by the US Forest Service, when combined in some meaningful measure, and when improved upon further, should be able to produce a much stronger reclamation plan.

A1 The details of the EIS are impressive in their volume, as one would expect in a draft plan so long in the development. We are requesting an extension in the public review and comment period, in order to provide adequate time for ourselves, as well as others, to review, evaluate and make suggestions for improvements. In the end, we think this will enhance the final product.

Please let us know as soon as possible if this will be granted, so that we can respond according to the time frame we will have available to us.

Sincerely,

Phil Hough

Philip Hough
Executive Director
Friends of Scotchman Peaks Wilderness

2011-06-21 Coryell L.pdf

June 21, 2011

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JUN 30 2011

DEQ
DIRECTOR'S OFFICE

Bobbie Lacklen
Project Coordinator
Kootenai National Forest
31374 US 2
Libby, MT 59923-3022

RE: Troy Mine Reclamation Draft Environmental Impact Statement

Greetings:

I support the Preferred Alternative, Agency-Mitigated Alternative for reclamation at the Troy Mine.

B1 I1 Debris from the Troy Mine should be sorted for recycling and disposed of at approved landfill or hazardous waste disposal sites. Waste and construction/demolition debris should not be buried on site. I think the asphalt surface on the access road should remain and be allowed to deteriorate naturally over time.

H5 B5 Tailings pond reclamation should be done according to Agency specifications with two(2) exceptions. I recommend reducing the woody debris placement to 10-15 tons/acre. A flexible range for tonnage is easier to achieve and 25 tons/acre is quite high unless the piece size is very large. Woody debris for reclamation in a forest environment has been a standard practice for decades. I have personally required it and seen it performed over 20 years ago in mine reclamation. Also, I think it would be beneficial to leave approximately 1 (one) acre of the tailings un-reclaimed in case there is renewed interest in using this material for the manufacture of building blocks.

E5 Surface tailings pipelines should not be allowed after mine closure and reclamation. Surface pipelines are too subject to vandalism and significant erosion could occur. Leaving exposed pipelines would be like leaving a time-bomb on site. If in-fact the Mine drainage water would not need treatment, then I would recommend a discharge permit for delivery into the closest channel deemed satisfactory to handle the water load. I think piping water for a long distance after reclamation is a fatal flaw in this reclamation plan.

Sincerely,

Larry Coryell

LARRY CORYELL
109 W. Kootenai Ave.
Troy, MT 59935
406-295-5143

CC: Emily Corsi, Project Coordinator
Montana DEQ
PO Box 200901
Helena, MT 59620-0901

2011-06-22 Ziegler S.pdf

Sam Ziegler
57490 153rd St
Good Thunder, mn 56037
507-524-3674

June 22, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

I would like to comment on the Troy Mine Revised Reclamation Plan Draft EIS.

I am a consumer of products that come out of this mine. I am thankful your research shows that the product can be mined at this site and the WATER can be protected.

G3

The Troy Mine has emerged as a shining light in the tough economic picture of northwestern Montana. The mine made it through the dark days of the recession with pay cuts from top to bottom but not one single employee was laid off. The mine, now with ownership that includes the employees themselves through stock options, now underscores the hopeful economic potential of mining for an area that, for a decade, has led the state with catastrophically high unemployment.

Numbers tell the story. Troy Mine now represents over 190 jobs, over $14 million in payroll, over $10 million in goods and services purchased in Montana, over $1.4 million in metal mines taxes for our schools, and over $1.25 in other state and local taxes.

If an incredibly conservative rollover factor of 2 is used to generate an idea of total local impact in this isolated and depressed area, the Troy Mine serves to economically support an additional 380 local jobs in other main street businesses and local government. This is a huge impact on the area.

E7

Thankfully, this economic impact comes with little impact to the environment. In fact, the EIS recognizes this fact when it repeats the conclusions of 30 years of evaluation of water quality that have shown no impacts to the water quality in the mine's area streams. If society wants to have 'green' metals production, Troy Mine is a good source for providing that need.

I generally support the conclusions of the preferred alternative. I have some questions about the reclamation requests in the document â€“ specifically as it concerns the water

E1 delivery pipeline. It is currently above ground for the vast majority of its route. It bas been in use for nearly 30 years and seems to be functioning as needed and desired. Once the mine is no longer operating, this pipe will just carry water. Therefore, I think it is not in the best interest of the environment to disturb ground for the many miles that would be need to remove the above ground line and install a new line underground the entire way. This just seems to reflect a desire to remove the visual of the pipe â€“ as if it is a negative thing to share with the public of the future.

E2 I, for one, like to see evidence of the ingenuity of man and think that personal opinion about visual qualities should not trump the need to be environmentally sound. Repair and replacement work in the future would be way less disturbing if the pipe was above ground and easy to access. The agency claims that the above ground pipeline would provide a target for vandalism does not square with the local experience of 30 years of that same pipeline's existence without one incident.

Thank you for considering my comment.

Sincerely,
Sam Ziegler

Ps. Thank you for mining this out of MT vs over the ocean.

Sincerely,

Sam Ziegler

2011-06-23 Vincent P.pdf

Patti Jo Vincent
34 Paul Bunyan Lane
Libby, MT 59923
406.293.6137

June 23, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

I would like to comment on the Troy Mine Revised Reclamation Plan Draft EIS.

G3 The Troy Mine has emerged as a shining light in the tough economic picture of northwestern Montana. The mine made it through the dark days of the recession with pay cuts from top to bottom but not one single employee was laid off. The mine, now with ownership that includes the employees themselves through stock options, now underscores the hopeful economic potential of mining for an area that, for a decade, has led the state with catastrophically high unemployment.

Numbers tell the story. Troy Mine now represents over 190 jobs, over $14 million in payroll, over $10 million in goods and services purchased in Montana, over $1.4 million in metal mines taxes for our schools, and over $1.25 in other state and local taxes.

If an incredibly conservative rollover factor of 2 is used to generate an idea of total local impact in this isolated and depressed area, the Troy Mine serves to economically support an additional 380 local jobs in other main street businesses and local government. This is a huge impact on the area.

E7 Thankfully, this economic impact comes with little impact to the environment. In fact, the EIS recognizes this fact when it repeats the conclusions of 30 years of evaluation of water quality that have shown no impacts to the water quality in the mine's area streams. If society wants to have 'green' metals production, Troy Mine is a good source for providing that need.

E1 I generally support the conclusions of the preferred alternative. I have some questions about the reclamation requests in the document â€" specifically as it concerns the water delivery pipeline. It is currently above ground for the vast majority of its route. It has been in use for nearly 30 years and seems to be functioning as needed and desired. Once the mine is no longer operating, this pipe will just carry water. Therefore, I think it is not

E1 in the best interest of the environment to disturb ground for the many miles that would be need to remove the above ground line and install a new line underground the entire way. This just seems to reflect a desire to remove the visual of the pipe â€“ as if it is a negative thing to share with the public of the future.

E2 I, for one, like to see evidence of the ingenuity of man and think that personal opinion about visual qualities should not trump the need to be environmentally sound. Repair and replacement work in the future would be way less disturbing if the pipe was above ground and easy to access. The agency claims that the above ground pipeline would provide a target for vandalism does not square with the local experience of 30 years of that same pipeline's existence without one incident.

Thank you for considering my comment.

Sincerely,

Sincerely,

Patti Jo Vincent

2011-06-24 Byers G.pdf

George Byers
5901 W. Lehigh Ave. #12
Denver, CO 80235
720-201-7078

June 24, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To the Montana DEQ and Kootenai National Forest,

G3 I strongly support approval of the Troy Mine's revised and updated reclamation plans. Like all safe and well-run mining operationss, the Troy MIne provides safe, high-tech and well-paying jobs - in this case, nearly 200 of them. This makes the Troy Mine one of the significant job providers in northwestern Montana.

G1 The Troy Mine has been operating for 30 years, and can carry on its operations until closure and through reclamation in a manner that continues to provide jobs and economic benefit while protecting the environment.

E7 DEQ and the USFS have properly chosen the Agency-Mitigated Alternative as the preferred alternative. The thirty-years of responsible and safe mine operations have made a minimal (if any) impact to surface water and wildlife in the area.

E1 The responsible agencies have done a commendable and highly sufficient job of study on the Troy Mine's plans. However, the agencies should reconsider requiring the now-buried water pipeline to be removed as that would cause unneeded surface disturbance. A buried line is harder to monitor and repair if a leak were to occur, so a pipeline on the surface would have environmental benefits exceeding those of a buried pipeline.

Again, I support the preferred alternative with the tweak outlined above with respect to the pipeline.

Thanks for considering my comments,

Sincerely,

George Byers

2011-06-24 Freeman C.pdf

Cort Freeman
2950 bayard St.
Butte, MT 59701
406-782-1719

June 24, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Corsi and Ms. Lacklen:

I'm a resident of Butte, Montana, and understand the value mining has provided to our area. Montana is a resource rich state, and although I know some are outspoken critics of any resoruce extration, I believe the Troy Mine can operate in an envrionmentally sound manner well into the future.

E1 I would like to give my support for the preferred alternative of the resource/reclamation plan as selected by the agencies. However, please give some consideration for not burying the pipeline.I remember when a rock came off the Beartrap hillside and crashed through the wooden flowline that served the Madison Dam Hydroelectric Powerplant near Ennis. That flowline was replaced with steel without any adverse consequences that I know of. It looks just fine.

E3 Maintenance personnel for PPL Montana travel the road daily and keep an eye on it so that timely repairs can be made. And this flowline is right above the Madision River. while burrying it would make the pipeline susceptable to all sorts of unforseen circumstances that could adversly affect the river if there were a blowout.

I1 I also wouldn't dig up the asphalt on the road. but I would have it repaired, maintained, and removed as part of the recalamation plan at the end of he Mine's life.

Thanks for the opportunity to comment. We need good-paying resource jobs in Montana.

Sincerely,

Sincerely,

Cort Freeman

2011-06-24 Johnson M.pdf

Martin Johnson
PO Box 624
whitehall, MT 59759
406-498-8480

June 24, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

I would like to provide some comments regarding the Troy reclamation revision that is open for public comment.

E7 It seems that the agency has done a very thorough examination of all the data that has been collected over the last 30 years and has made an accurate assessment of the water being discharged. From what I have seen, there is simply going to be clean water flowing out of the adit down to the impoundment, and requiring a water treatment facility will not be required.

E7 One thing that really makes me scratch my head though has to do with the pipeline analysis. Is the existing pipeline in a condition that requires replacement immediately upon the mine being decommissioned? I would suggest leaving the existing pipeline infrastructure in place until it needs replacement, and I can't see the logic in burying it when it does get replaced. Wouldn't it be easier to detect leaks and work on it if it was above ground? Aren't we going to be disturbing much more ground by doing it this way? This just doesn't make a whole lot of sense to me.

Thank you for accepting my comments. I eagerly await your response!

Sincerely,

Sincerely,

Martin Johnson

2011-06-24 Schlepp N.pdf

Nancy Schlepp
506 N Lamborn
Helena, MT 59601
406-442-2130

June 24, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

Thank you for accepting my comments on the revised reclamation plans for the Troy mine. In the thirty years this impoundment has been in place, there has been a great amount of solid reliable data to support your preferred alternative, and I would like to say thank you for your acknowledging it.

K1 I would also like to comment on the reclamation using the topsoil that is currently providing habitat for the western toad. Many people have also acknowledged that careful soil management and wildlife can coexist and that this is something that should be applauded, not destroyed.

H1 H2 From what I understand, it isn't going to cost any more to use the borrow or the topsoil that has been set aside, but it may take a bit longer for the borrow to produce the same reclamation goals if used. I would submit to you that saving habitat that is currently being created and allowing a little longer to create more is a win, win.

I believe that whenever we can showcase an active mining operation creating habitat to any species that is struggling we should. If it isn't going to cost any more either way, and our goal is to reclaim the ground to provide erosion controls and wildlife habitat, we should use the borrow material instead.

Thank you for your consideration of my comments.

Respectfully,

Sincerely,

Nancy Schlepp

2011-06-24 Stang B.pdf

Barry Stang
1415 Winne
Helena, MT 59601
406-442-6600

June 24, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

I would like to provide some comments regarding the Troy reclamation revision that is open for public comment.

E7 It seems that the agency has done a very thorough examination of all the data that has been collected over the last 30 years and has made an accurate assessment of the water being discharged. From what I have seen, there is simply going to be clean water flowing out of the adit down to the impoundment, and requiring a water treatment facility will not be required.

E1 One thing that really makes me scratch my head though has to do with the pipeline analysis. Is the existing pipeline in a condition that requires replacement immediately upon the mine being decommissioned? I would suggest leaving the existing pipeline infrastructure in place until it needs replacement, and I can't see the logic in burying it when it does get replaced. Wouldn't it be easier to detect leaks and work on it if it was above ground? Aren't we going to be disturbing much more ground by doing it this way? This just doesn't make a whole lot of sense to me.

Thank you for accepting my comments. I eagerly await your response!

Sincerely,

Barry Stang

Sincerely,

Barry Stang

2011-06-24 Williams E.pdf

Eric Williams
318 Plum Tree Court
Cheney, WA 99004
509-998-0223

June 24, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Montana DEQ and Kootenai National Forest:

Thank you for accepting my comments to the proposed revisions to the Troy Revised Reclamation Plan preferred alternative. I have just a couple of suggestions for you before you make your final determination.

I1 I would like to see the asphalt remain on the main road leading to the mine site. Removing it and returning it to dirt will just create more BMP work trying to mitigate for TMDL's in the watershed. You might require the asphalt to be repaired in places that it needs to be, but I believe it would be a short term investment that will pay long term dividends for the watershed.

H1 I also believe that using the readily available materials that is suitable for growth medium located on the mine to reclaim the tailing impoundment would be the better option. The topsoil that has been saved for that purpose has become great habitat for the western toad, and I believe that using the other material instead will grow the trees and shrubs necessary to ensure proper reclamation.

B1 I also think that breaking up the foundations and burying the concrete onsite would be just fine rather than digging them up, breaking them up and burying them somewhere else. It's just concrete and won't impact water quality any more than the rip rap along the Bull Trout stream at the bottom of the mountain.

E1 Requiring the company to bury the pipeline when it could just be replaced with another above ground line doesn't make sense either. It seems that if you are serious about water quality and TMDL impacts, you wouldn't want to be disturbing an entire hillside to bury the line not to mention disturbing the ground and the advanced reclamation down the road if the line were to need replacement or repair. Leaving the pipeline above ground and next to the road with asphalt on it makes the most sense in my opinion.

Thanks for your time and consideration.

Sincerely yours,

Sincerely,

Eric Williams

2011-06-25 Harper H.pdf

Holly Harper
PO Box 536
Whitehall, MT 59759
406-287-3862

June 25, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

Thank you for accepting my comments on the revised reclamation plans for the Troy mine. In the thirty years this impoundment has been in place, there has been a great amount of solid reliable data to support your preferred alternative, and I would like to say thank you for your acknowledging it.

K1 I would also like to comment on the reclamation using the topsoil that is currently providing habitat for the western toad. Many people have also acknowledged that careful soil management and wildlife can coexist and that this is something that should be applauded, not destroyed.

H1 From what I understand, it isn't going to cost any more to use the borrow or the topsoil
H2 that has been set aside, but it may take a bit longer for the borrow to produce the same reclamation goals if used. I would submit to you that saving habitat that is currently being created and allowing a little longer to create more is a win, win.

I believe that whenever we can showcase an active mining operation creating habitat to any species that is struggling we should. If it isn't going to cost any more either way, and our goal is to reclaim the ground to provide erosion controls and wildlife habitat, we should use the borrow material instead.

I am from Whitehall, Montana, which is an economically struggling community with the shining positive factor of the Golden Sunlight Mine, and I work for the Whitehall School District. We have a similar story here as in Troy. When mining operations cease or slow, the economic ripple is wide and sometimes the damages to the community are too large to repair. The economy right now is so bad in rural Montana that to threaten the longevity of a well-established mine is to threaten the longevity of the community itself. Please move rapidly to approve the revised reclamation plans for the Troy mine. Thank you for your consideration of my comments.

Respectfully,

Sincerely,

Holly Harper

2011-06-25 McCallS.pdf

Steve McCall
P.O. box 949
Boulder, MT 59632
4064313866

June 25, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

Hello, my name is Steve McCall, I currently work for Golden Sunlight mine near WhiteHall MT. I have been in mining for over thirty years and have seen a lot of changes over the years. These changes have been for the better for everyone and everything involved, I started working at the MT. Tunnels mine in '91, worked there for 16 years and seen the birth of several fawns and calf Elk on reclaimed areas. I also worked at the Basin creek mine located between Basin and Remini and also seen large game animals and water foul flurish and raise there young. I truely love nature and have wittnessed wild life of several species multiply, I truely hope that the decision is in the best interest of ALL. thank you again in advanced, take care. Steve McCall P.O. box 949 Boulder, MT. 59632#406-431-3866

Please accept my comments for the Troy Mine revised reclamation plans that have been submitted to your agency. After reading most of the DEIS, I wanted to applaud the agency and the diligent work that it has done in coming up with its preferred alternative.

E1 I would like to comment on two things that I believe may need changed before the final decision to move forward with your preferred approach is made. One is the pipeline that you are requiring to be buried. I'm no hydrologist, but it just seems silly to be burying a pipeline that may need dug up and replaced later if in fact you are accurate that the water needs to go through the infiltration process at the impoundment. Why tear up the entire hillside when you could just put it above ground next to the road as it is now for easy access in case there is a problem decades down the road?

H1 K1 Another is with regards to the toe ponds that have all the topsoil that is being recommended to cover the impoundment for reclamation. There has been a lot of praise to the company because of the habitat that has been created for the western toad. It would seem like a no brainer that they use the course borrow to reclaim it even if it takes a bit longer to achieve the standards required. How long will it take to replace the habitat for the western toad?

Thanks for your consideration,

Sincerely,

Steve McCall

2011-06-24 ShortenD.pdf

Dave Shorten
Box 135
Jefferson City, MT 59638
406-933-5285

June 25, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Kootenai National Forest and Montana DEQ:

Please accept my comments for the proposed reclamation revision at the Troy mine. I am fully supportive of the Troy mine and the success that it has had with controlling and mitigating environmental impacts while it has been in operation.

With all of the studies that have been done on the rock and all of the monitoring that has proven no impacts should make this an easy decision. Reading through some of the proposed mitigation measures that have been suggested, it obvious that there has been a very in depth analysis of the revision. It also looks like there is a bit of overkill with some of the suggestions.

I1 E1 You want to take the asphalt out and take it down to dirt again? You feel that you need to dig up the entire existing pipeline and replace it with another line that must be buried? The existing pipelines are sufficient to transport the very clean water from the adit down to the impoundment. Why not disturb less ground and ensure further safety precautions on the existing line that has plenty of capacity to get the job done? Isn't our goal to have the least amount of disturbance necessary?

A5 The men and women at the Troy Mine operate a very safe, very productive, environmentally benign operation. We all want proper reclamation plans approved by the regulators and we certainly want proper bond requirements. That said, there are some things that simply aren't necessary, may not benefit the environment and don't make sense. I approve of the preferred alternative as put forth by the agencies but would like to see some modifications made to in the Record of Decision that reflect proper but not excessive reclamation plans.

Please keep these considerations in mind when making your final decisions on the mitigation measures and the final reclamation plan.

Respectfully yours,

I belive in good jobs in Montana.The Troy Mine is a good job.I am now working in Alaska because mineing in montana is hard to do.I would love to work back in Montana and i work with a lot of other people who feel the same.
Please consider the Troy Mine for my sake and many others.
Thank You,
Dave Shorten

Sincerely,

Dave Shorten

2011-06-25 Ware T.pdf

Timothy Ware
2220 Carolina
Butte, MT 59701
4063602020

June 25, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

I would like to comment on the Troy Mine Revised Reclamation Plan Draft EIS.

G3 The Troy Mine has emerged as a shining light in the tough economic picture of northwestern Montana. The mine made it through the dark days of the recession with pay cuts from top to bottom but not one single employee was laid off. The mine, now with ownership that includes the employees themselves through stock options, now underscores the hopeful economic potential of mining for an area that, for a decade, has led the state with catastrophically high unemployment.

Numbers tell the story. Troy Mine now represents over 190 jobs, over $14 million in payroll, over $10 million in goods and services purchased in Montana, over $1.4 million in metal mines taxes for our schools, and over $1.25 in other state and local taxes.

If an incredibly conservative rollover factor of 2 is used to generate an idea of total local impact in this isolated and depressed area, the Troy Mine serves to economically support an additional 380 local jobs in other main street businesses and local government. This is a huge impact on the area.

E7 Thankfully, this economic impact comes with little impact to the environment. In fact, the EIS recognizes this fact when it repeats the conclusions of 30 years of evaluation of water quality that have shown no impacts to the water quality in the mine's area streams. If society wants to have 'green' metals production, Troy Mine is a good source for providing that need.

E1 I generally support the conclusions of the preferred alternative. I have some questions about the reclamation requests in the document â€" specifically as it concerns the water delivery pipeline. It is currently above ground for the vast majority of its route. It has been in use for nearly 30 years and seems to be functioning as needed and desired. Once the mine is no longer operating, this pipe will just carry water. Therefore, I think it is not

E1 in the best interest of the environment to disturb ground for the many miles that would be need to remove the above ground line and install a new line underground the entire way. This just seems to reflect a desire to remove the visual of the pipe â€“ as if it is a negative thing to share with the public of the future.

E2 I, for one, like to see evidence of the ingenuity of man and think that personal opinion about visual qualities should not trump the need to be environmentally sound. Repair and replacement work in the future would be way less disturbing if the pipe was above ground and easy to access. The agency claims that the above ground pipeline would provide a target for vandalism does not square with the local experience of 30 years of that same pipeline's existence without one incident.

Thank you for considering my comment.

Sincerely,

Sincerely,

Timothy Ware

2011-06-25 Yant R.pdf

ralph yant
1226 farrell st
butte, MT 59701
4063100172

June 25, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi:

Please consider my comment on the Troy Mine Revised Reclamation Plan Draft EIS.

G3 The northwestern area of Montana has been in a deep recession for a decade longer than the rest of our nation. Much of this is because of the systematic dismantling of the forestry management system of the United States Forest Service. The resultant collapse of the local economies of the area has been catastrophic. Over 3500 industrial, family wage jobs have been lost in the logging and milling businesses of Lincoln and Sanders Counties. The social ills such as alcoholism, drug addictions, family destructive behaviors, suicides, domestic abuse that follow these types of economic losses are well documented and were tragically predicted.

For the last several years, there has been a growing hope that mineral activity could replace some of the lost jobs and help to lower the unemployment rates of 20% that is found in these two counties. That hope will not be met with reality unless mines like the Troy Mine can stay in business. The economic benefit of nearly 200 jobs that average over $55,000 per year - not counting the benefits packages that includes health insurance, retirement plans and stock options â€" cannot be overstated. The impact the Troy Mine has with $14 million in payroll, $10 million in local purchases of goods and services, $250,000 in property taxes, $1 million in gross proceeds taxes, $1.4 million in metal mines taxes cannot be overstated.

With this economic need as a backdrop to the discussion of the future of the mine, I would like to offer my support for the agency's preferred alternative â€" with some suggestions for necessary changes.

H2 First, I do not think it is in the best interest of the environment to remove the topsoil from the toe of the impoundment area. Although it is true that this soil was once topsoil on the site, it has now been in place of over 30 years and it seems unnecessary and possibly even foolish to disturb the area so close to the water courses that have successfully protected

H2 during mine operation. Surely, in order to grow the trees and other vegetation that is native to the area, the soil from area borrow pits can be utilized with success and without the potential impacts associated with gross disturbance of areas near streams that have already healed up.

I worked in the mining and construction for 45 years and it put food in our bodys and a roof over our heads not to mention the metals in our system for the manufacture of goods. i also visitied the min in 06 and it looked pretty nice up there., these folks do a real nice job keeping it all sooking spiffy.

Thank you for accepting and considering my comment.

Sincerely,
ralph yant

Sincerely,

ralph yant

2011-06-27 Blair F.pdf

Frank Blair
1511 S Stanley Rd
Spokane Valley, WA 99212-3228
509-533-2716

June 27, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Montana DEQ:

I have been in the mineral exploration industry since the summer of 1959 and have experiences all of the changes of the BLM,USFS, various NWState regs and input from local anti-mining groups. In many cases the need for the changes were valid and caused by previous mining ventures. However, in the last 10 years it seems the changes can be classified as \\\"If it aint broke don't fixit\\\". We in the industry, the state and federal regulators, and the environmental groups need to realize that there is a critical need to encourage the mineral industry andif we work together everyone will be happy. The form letter below is a good presentation of what this cooperation will do!

Please accept my recommendations to the proposed Troy reclamation revisions. I believe that requiring the company to tear down the existing pipeline that is in great shape to replace it with another one immediately upon decommissioning of the mine is not a reasonable requirement. An even more unreasonable request would be to require the company to bury the line.

E1

At a minimum, the document should contain a discussion about the actual condition of the pipeline, how long it is expected to last and a much stronger discussion of why the pipeline should be buried.

After decommissioning, the pipeline will be carrying nothing but clean water and could last another fifty years before it needs replaced. Perhaps you could allow the pipeline to stay above ground and require the Company to repair or replace the line if it becomes necessary or to provide data about the condition of the line periodically to the agencies. I hope that the final reclamation plan allows the existing pipeline to be used until it needs replaced and that it is replaced with another in the same place alongside the road for easy monitoring into the future.

Thank you for considering my common sense recommendations and thank you for approving the Troy mine reclamation plans so they can continue to employ the almost two

hundred men and women that depend on it.

Sincerely yours,

Sincerely,

Frank Blair

2011-06-27 Chapman C.pdf

Clint Chapman
832 Court St.
Elko, NV 89801
7757779399

June 27, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi:

Please consider my comment on the Troy Mine Revised Reclamation Plan Draft EIS.

G3 The northwestern area of Montana has been in a deep recession for a decade longer than the rest of our nation. Much of this is because of the systematic dismantling of the forestry management system of the United States Forest Service. The resultant collapse of the local economies of the area has been catastrophic. Over 3500 industrial, family wage jobs have been lost in the logging and milling businesses of Lincoln and Sanders Counties. The social ills such as alcoholism, drug addictions, family destructive behaviors, suicides, domestic abuse that follow these types of economic losses are well documented and were tragically predicted.

For the last several years, there has been a growing hope that mineral activity could replace some of the lost jobs and help to lower the unemployment rates of 20% that is found in these two counties. That hope will not be met with reality unless mines like the Troy Mine can stay in business. The economic benefit of nearly 200 jobs that average over $55,000 per year - not counting the benefits packages that includes health insurance, retirement plans and stock options â€“ cannot be overstated. The impact the Troy Mine has with $14 million in payroll, $10 million in local purchases of goods and services, $250,000 in property taxes, $1 million in gross proceeds taxes, $1.4 million in metal mines taxes cannot be overstated.

With this economic need as a backdrop to the discussion of the future of the mine, I would like to offer my support for the agency's preferred alternative â€“ with some suggestions for necessary changes.

H2 First, I do not think it is in the best interest of the environment to remove the topsoil from the toe of the impoundment area. Although it is true that this soil was once topsoil on the site, it has now been in place of over 30 years and it seems unnecessary and possibly even foolish to disturb the area so close to the water courses that have successfully protected

H2 during mine operation. Surely, in order to grow the trees and other vegetation that is native to the area, the soil from area borrow pits can be utilized with success and without the potential impacts associated with gross disturbance of areas near streams that have already healed up.

Thank you for accepting and considering my comment.

Sincerely,

Sincerely,

Clint Chapman

2011-06-27 Compton M.pdf

Mark Compton
10 N. Post St.
Spokane, MT 99201
509-624-1158

June 27, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi,

As a former resident of Lincoln County, I am writing to support the Troy Mine and provide comment on their Revised Reclamation Plan Draft EIS.

G3 This project is incredibly important to the communities of Lincoln County and our state. The 190 plus jobs are the last industrial, wealth generating jobs in the County. These jobs and the $14,000,000 per year payroll they represent coupled with $20,000,000 per year spent on services â€“ one half of which are purchased in Montana â€“ are huge factors in the local economy. The $1.4 million paid annually on Montana Metal Mines license taxes and the $250,000 paid in property taxes benefits the local, county and state schools $1million paid annually on gross proceeds taxes benefits the State of Montana's bottom line.

None of this would matter if the mine were not environmentally sound. Thankfully, it is â€“ and I applaud the EIS's conclusion, specifically with water impacts, that backs this conclusion.

E1 However, I do have some issues with the EIS and the potential impact on the environmental footprint of the closure requirements. Specifically, I take issues with the need to bond for removal of the pipelines above ground and replace them with lines below ground when the mine is done. The above ground pipelines are not hurting anything. Digging to bury a new line will cause more impacts to the environment than leaving them in place. Further, every time the pipes need work done to them or replaced the impacts will be revisited. When we are doing all we can to disallow the potential of sediment into our streams, it seems inconsistent to require such ground disturbances being repeated in perpetuity.

Thank you for taking my comment.

Sincerely yours,

Sincerely,

Mark Compton

2011-06-27 Dillon J.pdf

Joseph Dillon
60 First Rd
Whitehall, MT 59759
406 287-5757

June 27, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Kootenai National Forest and Montana DEQ:

As a miner and native Montanan, I am fully aware of the impacts mining may have on the environment. I am also aware that mining can and should be done in an environmentally friendly and responsible way.

The mining industry is one of the few industries Montana has to offer. We all can't make a living selling insurance.

Please accept my comments for the proposed reclamation revision at the Troy mine. I am fully supportive of the Troy mine and the success that it has had with controlling and mitigating environmental impacts while it has been in operation.

With all of the studies that have been done on the rock and all of the monitoring that has proven no impacts should make this an easy decision. Reading through some of the proposed mitigation measures that have been suggested, it obvious that there has been a very in depth analysis of the revision. It also looks like there is a bit of overkill with some of the suggestions.

A5 The men and women at the Troy Mine operate a very safe, very productive, environmentally benign operation. We all want proper reclamation plans approved by the regulators and we certainly want proper bond requirements. That said, there are some things that simply aren't necessary, may not benefit the environment and don't make sense. I approve of the preferred alternative as put forth by the agencies but would like to see some modifications made to in the Record of Decision that reflect proper but not excessive reclamation plans.

Please keep these considerations in mind when making your final decisions on the mitigation measures and the final reclamation plan.

Respectfully yours,

Sincerely,

Joseph Dillon

2011-06-27 Ebisch J. pdf

James Ebisch
12108 N. Forker Rd.
Spokane, WA 99217
509-928-6098

June 27, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

Please accept my comments for the Troy Mine revised reclamation plans that have been submitted to your agency. After reading most of the DEIS, I wanted to applaud the agency and the diligent work that it has done in coming up with its preferred alternative.

I would like to comment on two things that I believe may need changed before the final decision to move forward with your preferred approach is made. One is the pipeline that
E1 you are requiring to be buried. I'm no hydrologist, but it just seems silly to be burying a pipeline that may need dug up and replaced later if in fact you are accurate that the water needs to go through the infiltration process at the impoundment. Why tear up the entire hillside when you could just put it above ground next to the road as it is now for easy access in case there is a problem decades down the road? It is much easier to service an
E2 above-ground pipeline, especially as it will be bear-proof. Further, in the unlikely event of leaks, they will be apparent if the pipeline is exposed.

H1 Another is with regards to the toe ponds that have all the topsoil that is being
K1 recommended to cover the impoundment for reclamation. There has been a lot of praise to the company because of the habitat that has been created for the western toad. It would seem like a no brainer that they use the course borrow to reclaim it even if it takes a bit longer to achieve the standards required. How long will it take to replace the habitat for the western toad?

Thanks for your consideration,

Sincerely,

James Ebisch

2011-06-27 Harrington T_JLDC.pdf

Jefferson Local Development Corporation
309 East Legion
Whitehall, MT 59759
406-287-3282

June 27, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

The Jefferson Local Development Corporation has been actively involved in mining operations in Jefferson County and fully understands the importance of reclamation. We appreciate you accepting comments to the proposed revisions to the Troy Revised Reclamation Plan preferred alternative as you decide on the final determination.

I1 It appears leaving the asphalt in place on the main road leading to the mine site, instead of returning it to dirt, may offer less of an impact on future watershed issues and should be reviewed.

H2 Using the existing soil stockpiles that currently have regrowth would cause additional disturbance in the area that may not be required. It appears that adequate alternative soil is available that would meet guidelines as a a suitable growth medium and would accomplish the reclamation goals established for the site. This option seems to be a win-win and should be considered.

B1 It appears the onsite disposal of inert concrete foundations would not have a negative impact to the location and should be considered as an option.

E1 The disposition and plan for the water pipeline seems to require further investigation. It appears several good points are raised for retention of surface water lines that make sense and could make this a viable option with less ground disturbance.

Thank you for seeking comments and input on the proposed reclamation plan. The opportunity to look at alternative courses of action that make sense will ensure the best plan is adopted.

Sincerely yours,

Tom Harrington

Sincerely,

Jefferson Local Development Corporation

2011-06-27 Kaplan P. pdf

Paul Kaplan
780 Vista Blvd
Sparks, NV 89434
775.331.2375

June 27, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

Please accept my comments for the Troy Mine revised reclamation plans that have been submitted to your agency. After reading most of the DEIS, I wanted to applaud the agency and the diligent work that it has done in coming up with its preferred alternative.

Thanks for your consideration,

Sincerely,

Paul Kaplan

2011-06-27 Larsen K.pdf

keith larsen
877 n 8 w
riverton, Wy 82501
307-856-7557

June 27, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Corsi and Ms. Lacklen:

E7 I would like to provide some comments on the revised reclamation plans for the Troy Mine. For the past three decades the water and rock studies have proven that this is one of the most environmentally benign mining operations in the country. The DEQ and the KNF have recognized this fact throughout the document, and I believe it has firm conclusive data to justify its decision.

B2 One thing that I did question while reading the document was the decommissioning plans for the building foundations. As I understand your preferred alternative, you are going to require the concrete foundations to be dug up, broken up, and deposited elsewhere. The justification was that it may create water quality issues if it was just backfilled on site, which seems the most common sense approach. I am failing to understand how digging it up and hauling it down to private property solves the issue of water quality. It might impact water quality up there, but not elsewhere? The logic doesn't work for me.

E1 One other thing that I read that seems illogical is the requirement for the pipeline to be buried. The existing pipeline is in good shape and runs right next to the road for easy access. Why would we bury it and then have to dig it up again if it ever needs replaced or repaired? This doesn't make much sense to me. It seems as though we are actually going to be requiring unneeded disturbance in the future when the goal is to remove or mitigate what impacts we can.

At any rate, please expedite this matter as soon as possible. In my opinion, this process takes way to long and is designed to help people that want to shut down the mining industry. Mining is what made our country strong and I support it wholeheartedly.

Thank you for your time.

Very truly yours,

Sincerely,

keith larsen

2011-06-27 Laughery J. pdf

Jerry Laughery
11 Jefferson Loop
Jefferson City, MT 59638
406-933-5453

June 27, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

I would like to comment on the Troy Mine Revised Reclamation Plan Draft EIS.

G3 The Troy Mine has emerged as a shining light in the tough economic picture of northwestern Montana. The mine made it through the dark days of the recession with pay cuts from top to bottom but not one single employee was laid off. The mine, now with ownership that includes the employees themselves through stock options, now underscores the hopeful economic potential of mining for an area that, for a decade, has led the state with catastrophically high unemployment.

Numbers tell the story. Troy Mine now represents over 190 jobs, over $14 million in payroll, over $10 million in goods and services purchased in Montana, over $1.4 million in metal mines taxes for our schools, and over $1.25 in other state and local taxes.

If an incredibly conservative rollover factor of 2 is used to generate an idea of total local impact in this isolated and depressed area, the Troy Mine serves to economically support an additional 380 local jobs in other main street businesses and local government. This is a huge impact on the area.

E7 Thankfully, this economic impact comes with little impact to the environment. In fact, the EIS recognizes this fact when it repeats the conclusions of 30 years of evaluation of water quality that have shown no impacts to the water quality in the mine's area streams. If society wants to have 'green' metals production, Troy Mine is a good source for providing that need.

E1 I generally support the conclusions of the preferred alternative. I have some questions about the reclamation requests in the document â€“ specifically as it concerns the water delivery pipeline. It is currently above ground for the vast majority of its route. It has been in use for nearly 30 years and seems to be functioning as needed and desired. Once the mine is no longer operating, this pipe will just carry water. Therefore, I think it is not

E1 in the best interest of the environment to disturb ground for the many miles that would be need to remove the above ground line and install a new line underground the entire way. This just seems to reflect a desire to remove the visual of the pipe â€“ as if it is a negative thing to share with the public of the future.

E2 I, for one, like to see evidence of the ingenuity of man and think that personal opinion about visual qualities should not trump the need to be environmentally sound. Repair and replacement work in the future would be way less disturbing if the pipe was above ground and easy to access. The agency claims that the above ground pipeline would provide a target for vandalism does not square with the local experience of 30 years of that same pipeline's existence without one incident.

Thank you for considering my comment.

Sincerely,

Sincerely,

Jerry Laughery

2011 - 06 - 27 Lewis T. pdf

Tom Lewis
PO Box 2053
Richland, Wa 99352

June 27, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

I would like to comment on the Troy Mine Revised Reclamation Plan Draft EIS.

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Thank you for considering my comment.

Sincerely,

Sincerely,

Tom Lewis

2011 - 06 - 27 McClelland K.pdf

Kevin McClelland
922 N Veranda Dr
Coeur d\\\'Alene, ID 83814
2086601154

June 27, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Montana DEQ:

Please accept my recommendations to the proposed Troy reclamation revisions. I believe that requiring the company to tear down the existing pipeline that is in great shape to replace it with another one immediately upon decommissioning of the mine is not a reasonable requirement. An even more unreasonable request would be to require the company to bury the line.

E1 At a minimum, the document should contain a discussion about the actual condition of the pipeline, how long it is expected to last and a much stronger discussion of why the pipeline should be buried.

After decommissioning, the pipeline will be carrying nothing but clean water and could last another fifty years before it needs replaced. Perhaps you could allow the pipeline to stay above ground and require the Company to repair or replace the line if it becomes necessary or to provide data about the condition of the line periodically to the agencies. I hope that the final reclamation plan allows the existing pipeline to be used until it needs replaced and that it is replaced with another in the same place alongside the road for easy monitoring into the future.

Thank you for considering my common sense recommendations and thank you for approving the Troy mine reclamation plans so they can continue to employ the almost two hundred men and women that depend on it.

Sincerely yours,

Sincerely,

Kevin McClelland

2011-06-27-MendenhallS.pdf

Scott Mendenhall
214 Solomon Mtn. Road
Clancy, MT 59634
406-933-5831

June 27, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

As a former 4-term state legislator from a district that contains several hard-rock mines, I'm writing to provide comment on the Troy mine reclamation revision.

Specifically, I support the Agency-Mitigated Alternative, with some modifications, as the final alternative for reclamation. There are three areas of modification that I recommend:

1. Pipelines: I oppose the Agency mitigated alternative on this and support the Troy Mine reclamation plan.

E1 E2 There is little compelling reason (other than being old and purported susceptibility to vandalism) to not utilize the existing above-ground 8-inch lines. From an environmental standpoint, burying a new pipe causes greater surface impacts, especially when it would cross wetlands and drainages. This is also true for any needed maintenance or repairs of the pipeline, ie., it would require surface disturbance and associated increased sentimentation. The testing documentation and inspections show the existing lines to be in good shape and adequate to handle the load. It's also an unnecessary expense to require the company to remove the above ground lines and install an underground.

2. Soil Replacement and Amendment. I oppose the Agency mitigated alternative on this and support the Troy Mine reclamation plan.

K1 H1 The agency alternative requirement that soil salvaged in the tailing pond area be used for reclamation rather than borrow soil will increase the risk of sediment impacts to Lake Creek, and will increase the risk of impacts to western toad habitat.
It would also disturb the existing topsoil piles that are fully revegetated and have become valuable habitat for a variety wildlife. It makes no sense to disturb them.

H2 The agencies conclude that borrow soils would result in successful but slower vegetative recover. The speed of revegetation is not a requirement. They also agree that the proposed

action would meet guidelines and equirements. The Company is required to have a bond in place until the requirements are met and the risk of sediment to Lake Creek and disturbance of plants and animals in the area is not worth the risk.

H3 Also, the requirements for use of organic fertilizer, organic matter addition to soil, mulch, and placement of coarse woody debris on reclaimed sites is unwarranted. There is no discussion of the justification, benefits, rational or authority for requiring the addition of woody debris or mulch. More importantly, there is no discussion of if or why these requirements or the agency alternative would achieve Forest reclamation requirements.

3. Demolition Debris Disposal. I oppose the Agency Mitigated Alternative in this regard and suppport the Troy Mine Reclamation Plan.

B1 B2 On-site burial of non-hazardous demolition waste is a standard practice and the unnecessary cost of hauling these inert materials to an offsite disposal area where they would be similarly buried provides no environmental benefit. Either way, the result is the same, burial of the concrete and rebar, only the location is different. There is no documentation of any risk to water quality from burial of building and foundation materials. This is an unnecessary and unwarranted stipulation with no identified, quantifiable, or significant benefit.

Thank you for the opportunity to comment. I look forward to your response.

Sincerely,

Sincerely,

Scott Mendenhall

2011-06-27 Mullaney M.pdf

Michael Mullaney
93 Vandolah Road
Three Forks, MT 59752
406-285-4970

June 27, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Hello:

Thank you for allowing me to comment on the proposed revisions to the Troy reclamation plans. I believe that the DEQ's proposed alternative is the best action to take, though I think there needs to be some minor tweaks made before the final action is taken.

E7 The Troy Mine has a long record of water monitoring and the agency seems to also recognize this by not requiring post closure mechanical water treatment, which I fully support. I also understand that the agency wants the reclamation plan to mitigate as many impacts as they can upon decommissioning of the mine, but there seems to be some contradictions in the proposed action plan.

K1 H2 If we truly want to create wildlife habitat and soil stability at the same time, why are we removing the topsoil berm that is already providing awesome habitat for the western toad? I understand that your analysis showed that it may take a bit longer to achieve your desired ends, but how much longer? The trees and shrubs that are currently surrounding the site are growing just fine in the same soil that would be used instead of the topsoil. I understand that you would want to use the topsoil under other circumstances, but because the Western toad uses the berm I believe there should be a variance made to allow for the borrow to be used instead of the previously stripped topsoil to protect the toad's habitat.

E1 E2 Another glaring contradiction is with burying the pipeline that will need to be monitored for decades according to the EIS. If the existing pipeline that has been there for thirty years needs to be removed after another ten years of use, then are you anticipating removing the pipeline every 40 years or so by digging it back up and burying it again? It makes much more sense to require the Company to replace the pipeline if and when necessary, but leave it above ground next to the road for ease of monitoring and accessing the line for any necessary repair or replacement.

Thank you for considering my comments.

Respectfully,

Sincerely,

Michael Mullaney

2011-06-27 Nelson P.pdf

Patricia Nelson
2379 Gateway Oaks Dr., Suite 200
Sacramento, CA 95833
916-679-8747

June 27, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

I would like to provide some comments regarding the Troy reclamation revision that is open for public comment.

E7 It seems that the agency has done a very thorough examination of all the data that has been collected over the last 30 years and has made an accurate assessment of the water being discharged. From what I have seen, there is simply going to be clean water flowing out of the adit down to the impoundment, and requiring a water treatment facility will not be required.

E1 One thing that really makes me scratch my head though has to do with the pipeline analysis. Is the existing pipeline in a condition that requires replacement immediately upon the mine being decommissioned? I would suggest leaving the existing pipeline infrastructure in place until it needs replacement, and I can't see the logic in burying it when it does get replaced. Wouldn't it be easier to detect leaks and work on it if it was above ground? Aren't we going to be disturbing much more ground by doing it this way? This just doesn't make a whole lot of sense to me.

Thank you for accepting my comments. I eagerly await your response!

Sincerely,
Patricia L. Nelson, R.E.A.

Sincerely,

Patricia Nelson

2011-06-27 Rasmussen J. pdf

James Rasmussen
105 West Kanab Creek Drive
Kanab, UT 84741
435-644-8208

June 27, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi,

I am writing to support the Troy Mine and provide comment on their Revised Reclamation Plan Draft EIS.

G3 This project is incredibly important to the communities of Lincoln County and our state. The 190 plus jobs are the last industrial, wealth generating jobs in the County. These jobs and the $14,000,000 per year payroll they represent coupled with $20,000,000 per year spent on services â€“ one half of which are purchased in Montana â€“ are huge factors in the local economy. The $1.4 million paid annually on Montana Metal Mines license taxes and the $250,000 paid in property taxes benefits the local, county and state schools $1million paid annually on gross proceeds taxes benefits the State of Montana's bottom line.

None of this would matter if the mine were not environmentally sound. Thankfully, it is â€“ and I applaud the EIS's conclusion, specifically with water impacts, that backs this conclusion.

E1 However, I do have some issues with the EIS and the potential impact on the environmental footprint of the closure requirements. Specifically, I take issues with the need to bond for removal of the pipelines above ground and replace them with lines below ground when the mine is done. The above ground pipelines are not hurting anything. Digging to bury a new line will cause more impacts to the environment than leaving them in place. Further, every time the pipes need work done to them or replaced the impacts will be revisited. When we are doing all we can to disallow the potential of sediment into our streams, it seems inconsistent to require such ground disturbances being repeated in perpetuity.

Thank you for taking my comment.

Sincerely yours,

Sincerely,

James Rasmussen

2011-06-27 Stevenson T.pdf

Tracy Stevenson
8263 Pine Springs Cove
Sandy, UT 84093

June 27, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Montana DEQ and Kootenai National Forest:

Thank you for allowing me to comment on the Troy Mine Draft EIS. I am a long term shareholder of Revett Minerals. I support this proposed mine because it will be state of the art technically, it will comply fully with all Federal and State permit requirements and because the economic development will benefit the local community, the State of Monana and the shareholders of Revett Mnerals.

E7 I belive the results of the envrionmental studies clearly indicate thatte project will not have a significant impact on ground or surface waters. The attenuation study that was done while the mine was closed and additional studies conducted recently support my conclusion. The rock characterization studies all show little to no potential for ARD or metal releases. These deposits are some of the most environmentally benign metal systems in the world.

After thirty years of this impoundment being in place with no significant impacts to water, it is clear that the decision of the agency will have solid, reliable data documenting the lack of impacts and substantial evidence to support its decision to permit the mine and its proposed reclamation plans.

G3 This operation is very important to the socio-economic wellbeing of Lincoln and Sanders counties. There are over 185 men and women working at this operation and over three million dollars a month of real wealth being distributed into Montana's economy through vendors, payroll, and taxes.

G1 The importance of this operation in two counties that represent the highest unemployment numbers in the state is without question. There will be no significant impacts to the environment by approving this mine's reclamation plans.

Respectfully,

Sincerely,

Tracy Stevenson

2011-06-27 Stevers G.pdf

Gail Stevers
15811 W. Willynwood Ln
Nine Mile Falls, WA 99026
509-466-5709

June 27, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Hello:

Thank you for allowing me to comment on the proposed revisions to the Troy reclamation plans. I believe that the DEQ's proposed alternative is the best action to take, though I think there needs to be some minor tweaks made before the final action is taken.

E7 The Troy Mine has a long record of water monitoring and the agency seems to also recognize this by not requiring post closure mechanical water treatment, which I fully support. I also understand that the agency wants the reclamation plan to mitigate as many impacts as they can upon decommissioning of the mine, but there seems to be some contradictions in the proposed action plan.

K1 H2 If we truly want to create wildlife habitat and soil stability at the same time, why are we removing the topsoil berm that is already providing awesome habitat for the western toad? I understand that your analysis showed that it may take a bit longer to achieve your desired ends, but how much longer? The trees and shrubs that are currently surrounding the site are growing just fine in the same soil that would be used instead of the topsoil. I understand that you would want to use the topsoil under other circumstances, but because the Western toad uses the berm I believe there should be a variance made to allow for the borrow to be used instead of the previously stripped topsoil to protect the toad's habitat.

E1 E2 Another glaring contradiction is with burying the pipeline that will need to be monitored for decades according to the EIS. If the existing pipeline that has been there for thirty years needs to be removed after another ten years of use, then are you anticipating removing the pipeline every 40 years or so by digging it back up and burying it again? It makes much more sense to require the Company to replace the pipeline if and when necessary, but leave it above ground next to the road for ease of monitoring and accessing the line for any necessary repair or replacement.

Thank you for considering my comments.

Respectfully,

Sincerely,

Gail Stevers

2011-06-27 Viegut S.pdf

Scott Viegut
PO Box 9
Hot Springs, MT 59845
4065446401

June 27, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi,

I am writing to support the Troy Mine and provide comment on their Revised Reclamation Plan Draft EIS.

G3 This project is incredibly important to the communities of Lincoln County and our state. The 190 plus jobs are the last industrial, wealth generating jobs in the County. These jobs and the $14,000,000 per year payroll they represent coupled with $20,000,000 per year spent on services â€“ one half of which are purchased in Montana â€“ are huge factors in the local economy. The $1.4 million paid annually on Montana Metal Mines license taxes and the $250,000 paid in property taxes benefits the local, county and state schools $1million paid annually on gross proceeds taxes benefits the State of Montana's bottom line.

None of this would matter if the mine were not environmentally sound. Thankfully, it is â€“ and I applaud the EIS's conclusion, specifically with water impacts, that backs this conclusion.

E1 However, I do have some issues with the EIS and the potential impact on the environmental footprint of the closure requirements. Specifically, I take issues with the need to bond for removal of the pipelines above ground and replace them with lines below ground when the mine is done. The above ground pipelines are not hurting anything. Digging to bury a new line will cause more impacts to the environment than leaving them in place. Further, every time the pipes need work done to them or replaced the impacts will be revisited. When we are doing all we can to disallow the potential of sediment into our streams, it seems inconsistent to require such ground disturbances being repeated in perpetuity.

Thank you for taking my comment.

Sincerely yours,

Sincerely,

Scott Viegut

2011-06-27 Walt T.pdf

Taylor Walt
P.O. Box 62
Clayton, ID 83227
208-838-3576

June 27, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Montana DEQ and Kootenai National Forest:

E7 Thank you for allowing me to comment on the Troy Mine Draft EIS. I believe that all of the past and current studies of the impoundment clearly indicate that it will not have a significant impact on ground or surface waters. The attenuation study that was done while the mine was closed and additional studies conducted recently support my conclusion. The rock characterization studies all show little to no potential for ARD or metal releases. These deposits are some of the most environmentally benign metal systems in the world.

After thirty years of this impoundment being in place with no significant impacts to water, it is clear that the decision of the agency will have solid, reliable data documenting the lack of impacts and substantial evidence to support its decision to permit the mine and its proposed reclamation plans.

G3 This operation is very important to the socio-economic wellbeing of Lincoln and Sanders counties. There are over 185 men and women working at this operation and over three million dollars a month of real wealth being distributed into Montana's economy through vendors, payroll, and taxes.

G1 The importance of this operation in two counties that represent the highest unemployment numbers in the state is without question. There will be no significant impacts to the environment by approving this mine's reclamation plans.

Respectfully, Maintenance Supt. Thompson Creek Mine. Clayton, Idaho

Sincerely,

Taylor Walt

2011-06-27 Watson Da.pdf

David Watson
3037 Rohrer Drive
Lafayette, CA 94549

June 27, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

I would like to comment on the Troy Mine Revised Reclamation Plan Draft EIS. I am a mining engineer with over 40 years of experience. I believe our Nation needs raw materials to build a strong economy and to provide JOBS.

The Troy Mine has emerged as a shining light in the tough economic picture of northwestern Montana. The mine made it through the dark days of the recession with pay cuts from top to bottom but not one single employee was laid off. The mine, now with ownership that includes the employees themselves through stock options, now underscores the hopeful economic potential of mining for an area that, for a decade, has led the state with catastrophically high unemployment.

G3

Numbers tell the story. Troy Mine now represents over 190 jobs, over $14 million in payroll, over $10 million in goods and services purchased in Montana, over $1.4 million in metal mines taxes for our schools, and over $1.25 in other state and local taxes.

If an incredibly conservative rollover factor of 2 is used to generate an idea of total local impact in this isolated and depressed area, the Troy Mine serves to economically support an additional 380 local jobs in other main street businesses and local government. This is a huge impact on the area.

Thankfully, this economic impact comes with little impact to the environment. In fact, the EIS recognizes this fact when it repeats the conclusions of 30 years of evaluation of water quality that have shown no impacts to the water quality in the mine's area streams. If society wants to have 'green' metals production, Troy Mine is a good source for providing that need.

E7

I generally support the conclusions of the preferred alternative. I have some questions about the reclamation requests in the document â€“ specifically as it concerns the water delivery pipeline. It is currently above ground for the vast majority of its route. It has

E1

E1 been in use for nearly 30 years and seems to be functioning as needed and desired. Once the mine is no longer operating, this pipe will just carry water. Therefore, I think it is not in the best interest of the environment to disturb ground for the many miles that would be need to remove the above ground line and install a new line underground the entire way. This just seems to reflect a desire to remove the visual of the pipe â€“ as if it is a negative thing to share with the public of the future.

E2 I, for one, like to see evidence of the ingenuity of man and think that personal opinion about visual qualities should not trump the need to be environmentally sound. Repair and replacement work in the future would be way less disturbing if the pipe was above ground and easy to access. The agency claims that the above ground pipeline would provide a target for vandalism does not square with the local experience of 30 years of that same pipeline's existence without one incident.

Thank you for considering my comment.

Sincerely,

Sincerely,

David Watson

2011-06-27 Watson Do.pdf
(page 1)

Troy Mine Revised Reclamation Plan
Draft Environmental Impact Statement

If you would like to provide written comments, you may use this form today and drop it in the comment box at the registration table. You can also take this form home and mail it later to either Emily Corsi (DEQ) or Bobbie Lacklen (USDA Forest Service) at the addresses below. Comments may be faxed to (406) 283-7709 (KNF) or 406-444-4386 (DEQ Director's Office), or hand-delivered to the KNF Supervisor's Office and DEQ Director's Office between the hours of 8:00 a.m. and 4:30 p.m. Written comments must be postmarked by the Postal Service, e-mailed, faxed, or otherwise submitted by 11:59 pm on July 5, 2011.

Bobbie Lacklen
Kootenai National Forest
31374 U.S. Highway 2
Libby, MT 59923-3022
TroyMineReclamation@fs.fed.us

Emily Corsi
Montana Department of Environmental Qual
P.O. Box 200901
Helena, MT 59620-0901
DEQTroyMine@mt.gov

RECEIVED
JUN 27 2011
DEQ
DIRECTOR'S OFFICE

Name/Organization: DOUGLAS WATSON

Address: PO BOX 1133, TROY, MT 59935-1133

E-mail: doug@troyland.net **Phone:**

Comments: Please see letter dated June 24, 2011 attached. DW

2011_06-27 Watson Do.pdf
(page 2)

June 24, 2011

Emily Corsi
Montana DEQ
PO Box 200901
Helena, MT 59620-0901

Bobbie Lacklen
Kootenai National Forest
31374 US Highway 2
Libby, MT 59923-3022

Ms Corsi and Ms Lacklen,

I attended the June 6 public meeting at Troy High School regarding the Troy Mine Revised Reclamation Plan. I reviewed the three options which were posted on the boards in the back of the meeting room and heard one of you review those proposals during the outset of the meeting.

While I understand your interest in assuring that the reclamation has minimal impact to the environment, I must agree with several of the speakers including our State Senator – Mr. Chas Vincent.

H2 H1 C4

First, unless you have studies to the contrary, you should permit the Troy Mine ("Mine") to follow their plan to cover the reclaimed areas with pit-run and other immediately available products which were demonstrated to foster healthy trees and vegetation. If you have evidence that this study was flawed or if you possess other studies on this type of recovered area that demonstrate that plants cannot grow as reported, please make that evidence available to the public before you deny the Mine's request. The agency alternative in the DEIS indicates that that top soil salvaged in the tailing pond area be used for reclamation rather than borrow soil. I am concerned that use of the toe pond salvaged top soil will result with the following: 1) it would more than likely increase long term risk of sediment impacts to Lake Creek, 2) it will impact documented western toad habitat and 3) it will result in the same reclamation success outcome (return of similar forest vegetation to that before the Mine) as using the borrow soil. According to Mine Representatives the existing topsoil piles are fully revegetated with a thick growth of grass, alders, brush and coniferous trees. The potential impacts to neighbors from dust during soil replacement is higher with the fine grained soils than with the borrow soil. I concur with the Troy Mine request that the agencies to reconsider their decision to require use of the salvaged soil.

E2 Next, there is no need to bury the existing water/slurry lines. They are not an eyesore to the local population and pose no health and safety risk if left alone. In fact, it seems apparent to me that the disturbance to the existing road when digging deep ditches and burying your proposed new tailing line will have a far better chance of causing soil sediment to enter the creek than there would be if left alone. Further, it is my

E3 understanding that the Troy mine waters during the 11 year temporary shut-down quickly reached drinking quality standards without any treatment. The risk of future contamination from ground disturbance to bury a line seems unnecessary when the existing lines are carrying waters meeting groundwater standards." Again, if you have evidence that shows this to be untrue in a location like this with similar ore and waste byproducts, please present this evidence to the public before forcing your changes upon the Mine.

B1 I have no concern about the Mine leaving the old concrete foundations in place upon termination of activities. If they create an unacceptable eyesore (and I do not agree that they will) simply require them to be covered with pit run – borrow material and planted. Digging them up and re-burying the concrete in another location accomplishes nothing of value.

I1 Finally, the requirement to completely remove the existing paved road is also of no real value. Currently there are a number of paved road remnants in the area, mostly from former logging activities. The pavement is easier to ride upon than the surface of many local gravel roads. Erosion appears to be less than I see along the edges of most dirt or gravel roads. The process of removing the road is simply a waste of funds. If the ultimate plan is to close the roadway to motorized public use, that plan should be articulated to the public now.

We can all agree that mining practices have changed dramatically over the past fifty years. Some of this positive change was the result of increased regulations; the other key part is due to companies taking a stand for environmental stewardship.

Please seriously consider my thoughts and those of other area citizens before imposing additional unnecessary requirements upon the Troy Mine which has done a very good job of taking care of the property during its operations over the past few years.

Sincerely,

Douglas E. Watson
PO Box 1133
Troy, MT 59935-1133
doug@troyland.net

2011-06-27 Welsh J. pdf

From: John Welsh
To: DEQ Troy Mine; TroyMineReclamation@fs.fed.us
Subject: Attn: Troy Mine Revised Reclamation Plan
Date: Monday, June 27, 2011 12:50:44 PM

Ladies, Gentlemen, and Others:
We think mineral production is good. We pay taxes. We suggest you approve the Revised Reclamation Plan for the Troy Mine and let us continue to be productive contributors to our great country. Perhaps you should encourage others to mine so that our great country does not become the property of foreign countries who hold our debt.
Regards,
John D. Welsh, P.E.

2011-06-28 Axe D. pdf

david axe
6093 Kootenai River Rd.
Libby, MT 59923
4062939203

June 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi:

Please accept my following comments for the proposed reclamation plan revisions at the Troy mine. I fully support the mine and their desire to continue operating under the Company Proposed Action.

E7 K1 With thirty years of documented analysis and several studies completed during the impoundments history showing no environmental impacts to water or wildlife this plan should be approved.

D1 We as a society have very few examples where we actually extract mineral resources from deposits such as these that are so benign and have no long lasting negative impacts to the environment. I have seen firsthand the impoundment and the abundance of existing wildlife that cohabitates it. The fisheries have had zero negative impacts from this impoundment and the attenuation study done while the mine was dormant clearly illustrates what to expect when this operation is decommissioned.

G3 Between now and then, allowing this permit to move forward will allow for the mine to continue operating in a responsible manner. The contribution of millions of dollars every month into the local and state economy will continue and the 190 employees and their families will have continued job security.
The eviromental issue are not a problem. The problem is these jobs are needed in this community. And speedy approval is needed. Not like the red tape the Libby mine is going through. Again this community needs this mine and the libby creek mine as well.

I urge the agencies to approve this plan as soon as possible and thank you for allowing me to comment.

Sincerely,

Sincerely,

david axe

2011-06-28 Beito A.pdf

Arlyne M. Beito
408 Valley of the Moon Rd
Troy, MT 59935
406-295-4170

June 28, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Kootenai National Forest and Montana DEQ:

Thank you for accepting the following comments on the revised reclamation plan for the Troy mine. I would like to focus my comments on the DEIS to the pipeline and impoundment mitigation recommendations. In general, I support the reclamation plan but there are areas that don't make a great deal of sense to me and that I find contradictory or unnecessary.

E1 Why would you want to dig up and disturb more ground if you were going to decommission the existing water pipeline and replace it with a new one for adit discharges? Aren't we trying to minimize TMDL impacts in the watershed? Why not just make safety precautions or improvements to the existing pipeline that has more than adequate capacity and seems to be working just fine?

If you did require replacement, why would you want it buried when it would be much more difficult to monitor in the future? Why would you want to disturb ground to bury it originally and perhaps again to repair or replace the line when it is completely unnecessary?

K1 Wouldn't using the toe pond stockpiled top soils for reclamation impact the western toad that currently has great habitat there now? Why not just use the coarse borrow material east of the impoundment instead? The DIES indicates that this could be just as successful in achieving reclamation goals and criteria. Are the wood based organic amendments that

H3 add 1,100 lbs of nitrogen per acre for the mill and impoundment really necessary? What is mycorrhizal fungi and why is it needed for reclamation at the mill? Why are the agencies requiring organic versus chemical fertilizer for reclamation in general?

B1 When reclamation occurs, the non-hazardous material should be relocated back into the mine and then the adit should be sealed shut. Lastly, there is no reason to tear out the

I1 access road and other surrounding roads. Just leave them alone and it will be just fine.

Thank you for listening and I look forward to seeing the final reclamation plan include

some further modifications to address some of the areas I have outlined above.

Respectfully,

Sincerely,

Arlyne M. Beito

2011-06-28 Brothers J.pdf

Josh Brothers
35984 u.s. hwy 2
libby, MT 59923
4062915124

June 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Montana DEQ and Kootenai National Forest:

E7 Thank you for allowing me to comment on the Troy Mine Draft EIS. I believe that all of the past and current studies of the impoundment clearly indicate that it will not have a significant impact on ground or surface waters. The attenuation study that was done while the mine was closed and additional studies conducted recently support my conclusion. The rock characterization studies all show little to no potential for ARD or metal releases. These deposits are some of the most environmentally benign metal systems in the world.

After thirty years of this impoundment being in place with no significant impacts to water, it is clear that the decision of the agency will have solid, reliable data documenting the lack of impacts and substantial evidence to support its decision to permit the mine and its proposed reclamation plans.

G3 This operation is very important to the socio-economic wellbeing of Lincoln and Sanders counties. There are over 185 men and women working at this operation and over three million dollars a month of real wealth being distributed into Montana's economy through vendors, payroll, and taxes.

G1 The importance of this operation in two counties that represent the highest unemployment numbers in the state is without question. There will be no significant impacts to the environment by approving this mine's reclamation plans.

Respectfully,

Sincerely,

Josh Brothers

2011-06-28 Brown D.pdf

Doris Brown
721 Flower Creek Road
Libby, MT 59923
(406)293-4663

June 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Montana DEQ and Kootenai National Forest:

E7 Thank you for allowing me to comment on the Troy Mine Draft EIS. I believe that all of the past and current studies of the impoundment clearly indicate that it will not have a significant impact on ground or surface waters. The attenuation study that was done while the mine was closed and additional studies conducted recently support my conclusion. The rock characterization studies all show little to no potential for ARD or metal releases. These deposits are some of the most environmentally benign metal systems in the world.

After thirty years of this impoundment being in place with no significant impacts to water, it is clear that the decision of the agency will have solid, reliable data documenting the lack of impacts and substantial evidence to support its decision to permit the mine and its proposed reclamation plans.

G3 This operation is very important to the socio-economic wellbeing of Lincoln and Sanders counties. There are over 185 men and women working at this operation and over three million dollars a month of real wealth being distributed into Montana's economy through vendors, payroll, and taxes.

G1 The importance of this operation in two counties that represent the highest unemployment numbers in the state is without question. There will be no significant impacts to the environment by approving this mine's reclamation plans.

Respectfully,

Sincerely,

Doris Brown

2011-06-28 Cohan W.pdf

William Cohan
2293 Broadway
Grand JUnction, CO 81507
970 254 0128

June 28, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Corsi and Ms. Lacklen:

E7 I would like to provide some comments on the revised reclamation plans for the Troy Mine. For the past three decades the water and rock studies have proven that this is one of the most environmentally benign mining operations in the country. The DEQ and the KNF have recognized this fact throughout the document, and I believe it has firm conclusive data to justify its decision.

B2 One thing that I did question while reading the document was the decommissioning plans for the building foundations. As I understand your preferred alternative, you are going to require the concrete foundations to be dug up, broken up, and deposited elsewhere. The justification was that it may create water quality issues if it was just backfilled on site, which seems the most common sense approach. I am failing to understand how digging it up and hauling it down to private property solves the issue of water quality. It might impact water quality up there, but not elsewhere? The logic doesn't work for me. In addtion, what is the potential for waterquality distubance from an inert material such as concrete? Have either the KNF or DEQ any valid and documented scientific evidence at their disposal that establishes tyhe potential of adverse water quality impacts from buried reinforced concrete. If so they are obligated to divulge that information to the public. Burying demolished reiforced concrete material on site has long been a recognized and approved method for site reclamation at many projects other than mining related.

E1 One other thing that I read that seems illogical is the requirement for the pipeline to be buried. The existing pipeline is in good shape and runs right next to the road for easy access. Why would we bury it and then have to dig it up again if it ever needs replaced or repaired? This doesn't make much sense to me. It seems as though we are actually going to be requiring unneeded disturbance in the future when the goal is to remove or mitigate what impacts we can.

Thank you for your time.

Very truly yours, W T Cohan, P.Eng.

Sincerely,

William Cohan

2011 - 06 - 28 Endicott Sand R. pdf

From: steve endicott
To: TroyMineReclamation@fs.fed.us
Subject: Mine Reclamation
Date: 06/28/2011 05:00 PM

We tried in vain to give our comments through Firefox on the web. So, we will send them by email.
We are now retired here. Steve grew up in Libby. We are happy that the Troy Mine is in operation. We have not worked at the mine or had any relatives who work or worked at the mine. We believe that some of the plans for reclamation are excessive and unnecessary and would jeopardize the future of the mine.
Thank you, Steve and Ruth Ann Endicott

G2

2011-06-28 Facer D. pdf

Dennis Facer
367 Sunny Meadow Court
Afton,, WY 83110
208.761.3149

June 28, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Kootenai National Forest and Montana DEQ:

Thank you for accepting the following comments on the revised reclamation plan for the Troy mine.

I have been involved for 35 years with mining in SE Idaho where we mine phosphate for fertilizer production. I am very familiar with reclamation technics.

I would like to focus my comments on the DEIS to the pipeline and impoundment mitigation recommendations. In general, I support the reclamation plan but there are areas that don't make a great deal of sense to me and that I find contradictory or unnecessary.

E1 Why would you want to dig up and disturb more ground if you were going to decommission the existing water pipeline and replace it with a new one for adit discharges? Aren't we trying to minimize TMDL impacts in the watershed? Why not just make safety precautions or improvements to the existing pipeline that has more than adequate capacity and seems to be working just fine?

If you did require replacement, why would you want it buried when it would be much more difficult to monitor in the future? Why would you want to disturb ground to bury it originally and perhaps again to repair or replace the line when it is completely unnecessary?

K1 Wouldn't using the toe pond stockpiled top soils for reclamation impact the western toad that currently has great habitat there now? Why not just use the coarse borrow material east of the impoundment instead? The DIES indicates that this could be just as successful in achieving reclamation goals and criteria.

H3 Wood based organic amendments that add 1,100 lbs of nitrogen per acre for the mill is excessive and not necessary for successful reclamation. I have seen numerous examples of great reclamation without this excessive application of wood organics.

H3 I disagree with the agencies requiring organic versus chemical fertilizer for reclamation. Again, i work in the mining industry and have utilized \\\"regular\\\" chemical fertilizer for successful reclamation. This is my business, and regular fertilizers are very save and much for effective when applied properly. The soils can be tested and the proper amounts of N,P,K and other trace nutrients applied.

Thank you for listening and I look forward to seeing the final reclamation plan include some further modifications to address some of the areas I have outlined above.

Respectfully,
Dennis Facer
Director Mine Development
J.R. Simplot Company.

Sincerely,

Dennis Facer

2011-06-28 Hill L.pdf

Louis Hill
1315 Red Fox Road
Arden Hills, MN 55112
651-717-4074

June 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Montana DEQ and Kootenai National Forest:

Thank you for accepting my comments to the proposed revisions to the Troy Revised Reclamation Plan preferred alternative. I have just a couple of suggestions for you before you make your final determination. I am making these suggestions to keep the costs down.

I1 I would like to see the asphalt remain on the main road leading to the mine site. Removing it and returning it to dirt will just create more BMP work trying to mitigate for TMDL's in the watershed. You might require the asphalt to be repaired in places that it needs to be, but I believe it would be a short term investment that will pay long term dividends for the watershed.

H1 I also believe that using the readily available materials that is suitable for growth medium located on the mine to reclaim the tailing impoundment would be the better option. The topsoil that has been saved for that purpose has become great habitat for the western toad, and I believe that using the other material instead will grow the trees and shrubs necessary to ensure proper reclamation.

B1 I also think that breaking up the foundations and burying the concrete onsite would be just fine rather than digging them up, breaking them up and burying them somewhere else. It's just concrete and won't impact water quality any more than the rip rap along the Bull Trout stream at the bottom of the mountain.

E1 Requiring the company to bury the pipeline when it could just be replaced with another above ground line doesn't make sense either. It seems that if you are serious about water quality and TMDL impacts, you wouldn't want to be disturbing an entire hillside to bury the line not to mention disturbing the ground and the advanced reclamation down the road if the line were to need replacement or repair. Leaving the pipeline above ground and next to the road with asphalt on it makes the most sense in my opinion.

Thanks for your time and consideration.

Sincerely yours,

Sincerely,

Louis Hill

2011-06-28 LangdykeS.pdf

Steven Langedyke
1218 Bailey Cr Cir
Soda Springs, ID 83276

June 28, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

I would like to comment on the Troy Mine Revised Reclamation Plan Draft EIS.

G3 The Troy Mine has emerged as a shining light in the tough economic picture of northwestern Montana. The mine made it through the dark days of the recession with pay cuts from top to bottom but not one single employee was laid off. The mine, now with ownership that includes the employees themselves through stock options, now underscores the hopeful economic potential of mining for an area that, for a decade, has led the state with catastrophically high unemployment.

Numbers tell the story. Troy Mine now represents over 190 jobs, over $14 million in payroll, over $10 million in goods and services purchased in Montana, over $1.4 million in metal mines taxes for our schools, and over $1.25 in other state and local taxes.

If an incredibly conservative rollover factor of 2 is used to generate an idea of total local impact in this isolated and depressed area, the Troy Mine serves to economically support an additional 380 local jobs in other main street businesses and local government. This is a huge impact on the area.

E7 Thankfully, this economic impact comes with little impact to the environment. In fact, the EIS recognizes this fact when it repeats the conclusions of 30 years of evaluation of water quality that have shown no impacts to the water quality in the mine's area streams. If society wants to have 'green' metals production, Troy Mine is a good source for providing that need.

E1 I generally support the conclusions of the preferred alternative. I have some questions about the reclamation requests in the document â€“ specifically as it concerns the water delivery pipeline. It is currently above ground for the vast majority of its route. It has been in use for nearly 30 years and seems to be functioning as needed and desired. Once the mine is no longer operating, this pipe will just carry water. Therefore, I think it is not

E1 in the best interest of the environment to disturb ground for the many miles that would be need to remove the above ground line and install a new line underground the entire way. This just seems to reflect a desire to remove the visual of the pipe â€“ as if it is a negative thing to share with the public of the future.

E2 I, for one, like to see evidence of the ingenuity of man and think that personal opinion about visual qualities should not trump the need to be environmentally sound. Repair and replacement work in the future would be way less disturbing if the pipe was above ground and easy to access. The agency claims that the above ground pipeline would provide a target for vandalism does not square with the local experience of 30 years of that same pipeline's existence without one incident.

Thank you for considering my comment.

Sincerely,

Sincerely,

Steven Langedyke

2011-06-28 MastelT-JLDC.pdf

From: Mastel, Tara
To: DEQ Troy Mine; TroyMineReclamation@fs.fed.us
Subject: Attn: Troy Mine Revised Reclamation Plan
Date: Tuesday, June 28, 2011 9:31:59 AM

Hello,

I support the development of the Troy mine. The draft EIS shows a responsible plan for reclamation. The jobs are sorely needed in the area and the state would benefit as well.

Thank you for considering my comment.

Tara Mastel
Jefferson Local Development Corporation
P.O. Box 1079
Whitehall MT, 59759
406.287.3282 Office
406.461.7843 Cell

2011-06-28 mcCanse R.pdf

Roberta McCanse
270 Indian Pipe Rd
Libby, MT 59923
8168684172

June 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi:

Please accept my following comments for the proposed reclamation plan revisions at the Troy mine. As someone who lives surrounded by Forest Service land these issues are of particular concern to me.

With reference to the Executive Summary, Proposed Action â€" ES.6.2.1 Water Management

E8 I do not see any estimate of how long it will take to remediate nitrogen and copper in decant ponds to a level that is compatible with, and does not foul, local streams and lakes.

E10 Further, how do we know that runoff from the toe ponds is safe for irrigation? If nitrogen is in this water so is copper.

E8 Why is there no plan for reclaiming nitrogen and copper from this discharge water rather than simply discharging it into ponds that no matter how well constructed will still pose a threat to surface and ground water supplies in the event of the extreme weather conditions that climate change is precipitating.

With reference to Executive Summary, Proposed Action -ES.6.2.2 Reclamation -

H2 J2 E10 Borrow sites, if they must be used, must be identified in order to minimize the transport of noxious weeds to areas of revegetation. Sources of irrigation water must also be identified and tested.

H3 J2 Why must such poor soils be used? Chemical fertilizers endanger the environment and only benefit those who profit from their manufacture. Certainly organic amendments are to be preferred. More attention should be paid to continued efforts to control noxious weeds. These will continue to flourish regardless of the purity of the seeds used for revegetation.

J2 Reclamation should include the replanting of native trees as well as grasses. Second growth that develops naturally is usually of poorer quality.

B1 With regard to infrastructure, all of the building materials, asphalt, and all desolation materials, should be removed completely from the site. To leave them buried simply invites future exposure and disrespects the natural beauty of the area. Roads left in place pose environmental hazzards as do the many people would not hesitate to use motorized vehicles to despoil this area.

With reference to Executive Summary, ES.6.3 Agency-Mitigated Alternative â€"

I heartily support the alternatives proposed here, especially regarding adit closure, long term monitoring, and the installation of automatic leak detection and emergency overflow systems. This is our water that is at risk. Protections proposed cannot be considered extreme.

With reference to Executive Summary, ES.6.3.2 Reclamation

Again, organic amendments are much to be preferred over chemical fertilizer. Professional monitoring of tailings should be a moral given. Reclamation bond should be increased to cover circumstances conveniently not considered by Troy Mining.

E6 The use of non-mineralized rock for the construction of water channels appears to be another needed environmental safeguard.

I3 With regard to infrastructure, certainly the reuse of asphalt as a component of gravel for our roads is to be encouraged. Again, per my statement above, to leave construction trash in place insults the natural beauty of our environment.

With reference to Executive Summary, ES. 7 Environmental Consequences

It is obvious that the Agency-Mitigated Alternative is more protective of our environment. I therefore support all safeguards they propose, especially the professional monitoring for extended periods of time and the construction of new pipelines. Certainly roads that are unneeded by the Forest Services should be properly removed. Hunters and other who wish to enjoy the area would still be allowed to do this on foot.

Sincerely,

Roberta McCanse

2011-06-28 Morris D.pdf

Dwight Morris
102 Schoolhouse Lk Rd
Troy, MT 59935
406-295-7221

June 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Hello:

Thank you for allowing me to comment on the proposed revisions to the Troy reclamation plans. I believe that the DEQ's proposed alternative is the best action to take, though I think there needs to be some minor tweaks made before the final action is taken.

E7 The Troy Mine has a long record of water monitoring and the agency seems to also recognize this by not requiring post closure mechanical water treatment, which I fully support. I also understand that the agency wants the reclamation plan to mitigate as many impacts as they can upon decommissioning of the mine, but there seems to be some contradictions in the proposed action plan.

K1 H2 If we truly want to create wildlife habitat and soil stability at the same time, why are we removing the topsoil berm that is already providing awesome habitat for the western toad? I understand that your analysis showed that it may take a bit longer to achieve your desired ends, but how much longer? The trees and shrubs that are currently surrounding the site are growing just fine in the same soil that would be used instead of the topsoil. I understand that you would want to use the topsoil under other circumstances, but because the Western toad uses the berm I believe there should be a variance made to allow for the borrow to be used instead of the previously stripped topsoil to protect the toad's habitat.

E1 E2 Another glaring contradiction is with burying the pipeline that will need to be monitored for decades according to the EIS. If the existing pipeline that has been there for thirty years needs to be removed after another ten years of use, then are you anticipating removing the pipeline every 40 years or so by digging it back up and burying it again? It makes much more sense to require the Company to replace the pipeline if and when necessary, but leave it above ground next to the road for ease of monitoring and accessing the line for any necessary repair or replacement.

Thank you for considering my comments.

Respectfully,

Sincerely,

Dwight Morris

2011-06-28 Nicholl B.pdf

Bert Nicholl
P.O. Box 382
Alberton., MT 59820
406-531-6832

June 28, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

Thank you for accepting my comments on the revised reclamation plans for the Troy mine. In the thirty years this impoundment has been in place, there has been a great amount of solid reliable data to support your preferred alternative, and I would like to say thank you for your acknowledging it.

K1 I would also like to comment on the reclamation using the topsoil that is currently providing habitat for the western toad. Many people have also acknowledged that careful soil management and wildlife can coexist and that this is something that should be applauded, not destroyed.

H1 H2 From what I understand, it isn't going to cost any more to use the borrow or the topsoil that has been set aside, but it may take a bit longer for the borrow to produce the same reclamation goals if used. I would submit to you that saving habitat that is currently being created and allowing a little longer to create more is a win, win.

I believe that whenever we can showcase an active mining operation creating habitat to any species that is struggling we should. If it isn't going to cost any more either way, and our goal is to reclaim the ground to provide erosion controls and wildlife habitat, we should use the borrow material instead.

I am employed by Western States Equipment Company. I support mining and drilling in our state. We need more jobs in Montana.
Thank you for your consideration of my comments.

Respectfully,

Sincerely,

Bert Nicholl

2011-06-28 Pauley L. pdf

Lenny Pauley
304 Spencer Rd.
Libby, MT 59923
406-283-1448

June 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Kootenai National Forest and Montana DEQ:

Thank you for accepting the following comments on the revised reclamation plan for the Troy mine. I would like to focus my comments on the DEIS to the pipeline and impoundment mitigation recommendations. In general, I support the reclamation plan but there are areas that don't make a great deal of sense to me and that I find contradictory or unnecessary.

G1 I work at a Local hardware store that provides services for the Troy Mine, if the mine closes for any length of time could cause the lose of jobs in our business due to the lose of a 195 mining jobs. It works fine now why mess with it leave alone.

E1 Why would you want to dig up and disturb more ground if you were going to decommission the existing water pipeline and replace it with a new one for adit discharges? Aren't we trying to minimize TMDL impacts in the watershed? Why not just make safety precautions or improvements to the existing pipeline that has more than adequate capacity and seems to be working just fine?

If you did require replacement, why would you want it bouried when it would be much more difficult to monitor in the future? Why would you want to disturb ground to bury it originally and perhaps again to repair or replace the line when it is completely unnecessary?

K1 H3 Wouldn't using the toe pond stockpiled top soils for reclamation impact the western toad that currently has great habitat there now? Why not just use the coarse borrow material east of the impoundment instead? The DIES indicates that this could be just as successful in achieving reclamation goals and criteria. Are the wood based organic amendments that add 1,100 lbs of nitrogen per acre for the mill and impoundment really necessary? What is mycorrhizal fungi and why is it needed for reclamation at the mill? Why are the agencies requiring organic versus chemical fertilizer for reclamation in general?

Thank you for listening and I look forward to seeing the final reclamation plan include

some further modifications to address some of the areas I have outlined above.

Respectfully,

Sincerely,

Lenny Pauley

2011-06-28 PerryC.pdf

Carol Perry
777 hwy 237
Afton, Wy 83110
208-873-3750

June 28, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

Thank you for accepting my comments on the revised reclamation plans for the Troy mine. In the thirty years this impoundment has been in place, there has been a great amount of solid reliable data to support your preferred alternative, and I would like to say thank you for your acknowledging it.

K1 I would also like to comment on the reclamation using the topsoil that is currently providing habitat for the western toad. Many people have also acknowledged that careful soil management and wildlife can coexist and that this is something that should be applauded, not destroyed.

H1 H2 From what I understand, it isn't going to cost any more to use the borrow or the topsoil that has been set aside, but it may take a bit longer for the borrow to produce the same reclamation goals if used. I would submit to you that saving habitat that is currently being created and allowing a little longer to create more is a win, win.

I believe that whenever we can showcase an active mining operation creating habitat to any species that is struggling we should. If it isn't going to cost any more either way, and our goal is to reclaim the ground to provide erosion controls and wildlife habitat, we should use the borrow material instead.

Thank you for your consideration of my comments.

Respectfully,

Sincerely,

Carol Perry

2011-06-28 Pickering C.pdf

CHARLES PICKERING
488 TERRACE VIEW
LIBBY, MT 59923
406-293-5594

June 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi:

Please consider my comment on the Troy Mine Revised Reclamation Plan Draft EIS.

G3

The northwestern area of Montana has been in a deep recession for a decade longer than the rest of our nation. Much of this is because of the systematic dismantling of the forestry management system of the United States Forest Service. The resultant collapse of the local economies of the area has been catastrophic. Over 3500 industrial, family wage jobs have been lost in the logging and milling businesses of Lincoln and Sanders Counties. The social ills such as alcoholism, drug addictions, family destructive behaviors, suicides, domestic abuse that follow these types of economic losses are well documented and were tragically predicted.

For the last several years, there has been a growing hope that mineral activity could replace some of the lost jobs and help to lower the unemployment rates of 20% that is found in these two counties. That hope will not be met with reality unless mines like the Troy Mine can stay in business. The economic benefit of nearly 200 jobs that average over $55,000 per year - not counting the benefits packages that includes health insurance, retirement plans and stock options â€" cannot be overstated. The impact the Troy Mine has with $14 million in payroll, $10 million in local purchases of goods and services, $250,000 in property taxes, $1 million in gross proceeds taxes, $1.4 million in metal mines taxes cannot be overstated.

With this economic need as a backdrop to the discussion of the future of the mine, I would like to offer my support for the agency's preferred alternative â€" with some suggestions for necessary changes.

H2

First, I do not think it is in the best interest of the environment to remove the topsoil from the toe of the impoundment area. Although it is true that this soil was once topsoil on the site, it has now been in place of over 30 years and it seems unnecessary and possibly even foolish to disturb the area so close to the water courses that have successfully protected

H2 during mine operation. Surely, in order to grow the trees and other vegetation that is native to the area, the soil from area borrow pits can be utilized with success and without the potential impacts associated with gross disturbance of areas near streams that have already healed up.

G1 This mine has given valuable employment to an area that needs it and has not caused any harm to the forest, air, animals or vegetation around or streams if the powers that be would check. We NEED this source of employment for our area!!!

Thank you for accepting and considering my comment.

Sincerely,
Charles and Jane Pickering

Sincerely,

CHARLES PICKERING

2011-06-28 RossN.pdf

Nicholas Ross
475 E. Greg St., Ste. 119
Sparks, NV 89431
(775) 200-9878

June 28, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

I would like to comment on the Troy Mine Revised Reclamation Plan Draft EIS.

G3 The Troy Mine has emerged as a shining light in the tough economic picture of northwestern Montana. The mine made it through the dark days of the recession with pay cuts from top to bottom but not one single employee was laid off. The mine, now with ownership that includes the employees themselves through stock options, now underscores the hopeful economic potential of mining for an area that, for a decade, has led the state with catastrophically high unemployment.

Numbers tell the story. Troy Mine now represents over 190 jobs, over $14 million in payroll, over $10 million in goods and services purchased in Montana, over $1.4 million in metal mines taxes for our schools, and over $1.25 in other state and local taxes.

If an incredibly conservative rollover factor of 2 is used to generate an idea of total local impact in this isolated and depressed area, the Troy Mine serves to economically support an additional 380 local jobs in other main street businesses and local government. This is a huge impact on the area.

E7 Thankfully, this economic impact comes with little impact to the environment. In fact, the EIS recognizes this fact when it repeats the conclusions of 30 years of evaluation of water quality that have shown no impacts to the water quality in the mine's area streams. If society wants to have 'green' metals production, Troy Mine is a good source for providing that need.

E1 I generally support the conclusions of the preferred alternative. I have some questions about the reclamation requests in the document â€“ specifically as it concerns the water delivery pipeline. It is currently above ground for the vast majority of its route. It has been in use for nearly 30 years and seems to be functioning as needed and desired. Once the mine is no longer operating, this pipe will just carry water. Therefore, I think it is not

E1 in the best interest of the environment to disturb ground for the many miles that would be need to remove the above ground line and install a new line underground the entire way. This just seems to reflect a desire to remove the visual of the pipe â€“ as if it is a negative thing to share with the public of the future.

E2 I, for one, like to see evidence of the ingenuity of man and think that personal opinion about visual qualities should not trump the need to be environmentally sound. Repair and replacement work in the future would be way less disturbing if the pipe was above ground and easy to access. The agency claims that the above ground pipeline would provide a target for vandalism does not square with the local experience of 30 years of that same pipeline's existence without one incident.

Thank you for considering my comment.

Sincerely,

Sincerely,

Nicholas Ross

2011-06-28 Selle B.pdf

Brady Selle
235 Hummingbird Ln
Troy, MT 59935
406-295-4229

June 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi:

Please consider my comment on the Troy Mine Revised Reclamation Plan Draft EIS.

I came to Troy 9 years ago as the Superintendent of Schools at a time when the mine was not in operation. Since then I have seen the economic impact in our area. I can not imagine what this community would have been like without the Troy Mine. They have been wonderful partners in many aspects of our community.

More importantly, I have spent all 9 years living and playing beside Lake Creek. The creek is a wonderful drainage that is clean, clear and a great fishery. Who would ever know that a mine existed toward the beginning of creek. I believe that the mine personnel have been great stewards of the land and water.

Due to this confidence and past history, I feel that the mine workers and managment are very capable of reclaiming the mine in a practical and effective manner.

B1 The plan containes some very sound and necessary components. I believe that it is totally necessary to cap or cover all of the tailing areas as well as demolishing all buildings. It does seem to go a bit to far in requiring the mine to tear up all of the asphalt and cement and haul it away. If you are going to bury it somewhere, why not on the mine site where no one will even know that it existed.

I know that the mine has done well in the past and I have full confidence in their ability to clean up after themselves when they are done.

Thank you for accepting and considering my comment.
Sincerely,

Sincerely,

Brady Selle

2011-06-28 SipolsR.pdf

Reinis Sipols
7 Wesley Drive
West Milford, NJ 07480
914 282 1450

June 28, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi,

I am writing to support the Troy Mine and provide comment on their Revised Reclamation Plan Draft EIS.

G3 This project is incredibly important to the communities of Lincoln County and our state. The 190 plus jobs are the last industrial, wealth generating jobs in the County. These jobs and the $14,000,000 per year payroll they represent coupled with $20,000,000 per year spent on services â€" one half of which are purchased in Montana â€" are huge factors in the local economy. The $1.4 million paid annually on Montana Metal Mines license taxes and the $250,000 paid in property taxes benefits the local, county and state schools $1million paid annually on gross proceeds taxes benefits the State of Montana's bottom line.

None of this would matter if the mine were not environmentally sound. Thankfully, it is â€" and I applaud the EIS's conclusion, specifically with water impacts, that backs this conclusion.

E1 However, I do have some issues with the EIS and the potential impact on the environmental footprint of the closure requirements. Specifically, I take issues with the need to bond for removal of the pipelines above ground and replace them with lines below ground when the mine is done. The above ground pipelines are not hurting anything. Digging to bury a new line will cause more impacts to the environment than leaving them in place. Further, every time the pipes need work done to them or replaced the impacts will be revisited. When we are doing all we can to disallow the potential of sediment into our streams, it seems inconsistent to require such ground disturbances being repeated in perpetuity.

Thank you for taking my comment.

Sincerely yours,

Sincerely,

Reinis Sipols

2011-06-28 StoorJ.pdf

Jim Stoor
3878 Wayan Loop
Wayan, ID 83285
208-574-2574

June 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:
My name is Jim Stoor and I am a Miner in the state of Idaho. I have been in mining for 19 years now and have seen a huge change in how mining operations handle their mining practices and their reclamation. I can say that I have worked in the Phosphate patches of Idaho for most of my mining career and have seen many changes. I see the mining industry working together to return the areas in which they mine back to its original state or as close to as humanly possible. When I started out in mining this was not always the case, but today I see that happening with most of the mines in this area and the mines in Nevada where I worked. As I have read the impact statements and the proposal that have been offered by all parties I can truly say that each side has tried to work with each other in order to protect the environment. The issue that I take is that the Troy Mine is probably being asked to take steps that are not based on fact but on someones own determination.

A5 Troy Mine has had to raise their bonds for reclamation that probably well exceeds the cost but shows good faith in the practices that they believe in. The following is part of a form letter that is being summitted, but that I totally would put my support behind. I know that I am not a local person, but when it comes to mining it affects us all whether you work in Montana, Idaho or wherever. Allow the history of the mine to dictate the future mining and reclamation practices.

G3 The Troy Mine Reclamation plans needs to be approved and permitted for several reasons. The operation is a huge asset to northwest Montana and provides over 190 good paying family wage jobs in an area that has the highest unemployment in the state.

For over thirty years the mine has been depositing its tailings in the impoundment and there has not been any significant impact to the areas streams or wildlife.

E7 Several studies have been done that confirm this and I believe that allowing them to amend their reclamation plan to continue operating is a no brainer. It seems that both the USFS and the DEQ has done a thorough job of analyzing the revised reclamation plans, though there seems to be some recommendations that would actually create more disturbance than should be necessary.

E1
E2

Removing the water pipeline that is buried below the surface (if it is decided that it needs to be replaced) seems impractical as it wouldn't hurt anything to just leave it and remove the pipeline that is above ground. Completely burying a new pipeline (which I'm not convinced is even needed) seems to contradict the desire of all parties to ensure that the lines can be monitored and that there is ability to quickly detect any leakage or break in the line and just as quickly get necessary repairs made while disturbing the least ground or water resources as possible.

That being said, I'm confident the agency will listen to those that have more experience than I in this area and arrive at common sense mitigations while approving this reclamation permit. But I would like to go on record as supporting the preferred alternative with some modifications to the requirements for the pipeline.

Thank you for your time,

Jim Stoor
Mill Relief Coordinator
JR Simplot
Smoky Canyon Mine

Sincerely,

Jim Stoor

2011-06-28 StrykerC.pdf

Chester Stryker
80 Ring Loop RD.,
Troy, MT 59935
406-295-9511

June 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

I would like to comment on the Troy Mine Revised Reclamation Plan Draft EIS.

G3 The Troy Mine has emerged as a shining light in the tough economic picture of northwestern Montana. The mine made it through the dark days of the recession with pay cuts from top to bottom but not one single employee was laid off. The mine, now with ownership that includes the employees themselves through stock options, now underscores the hopeful economic potential of mining for an area that, for a decade, has led the state with catastrophically high unemployment.

Numbers tell the story. Troy Mine now represents over 190 jobs, over $14 million in payroll, over $10 million in goods and services purchased in Montana, over $1.4 million in metal mines taxes for our schools, and over $1.25 in other state and local taxes.

If an incredibly conservative rollover factor of 2 is used to generate an idea of total local impact in this isolated and depressed area, the Troy Mine serves to economically support an additional 380 local jobs in other main street businesses and local government. This is a huge impact on the area.

E7 Thankfully, this economic impact comes with little impact to the environment. In fact, the EIS recognizes this fact when it repeats the conclusions of 30 years of evaluation of water quality that have shown no impacts to the water quality in the mine's area streams. If society wants to have 'green' metals production, Troy Mine is a good source for providing that need.

E1 I generally support the conclusions of the preferred alternative. I have some questions about the reclamation requests in the document â€“ specifically as it concerns the water delivery pipeline. It is currently above ground for the vast majority of its route. It has been in use for nearly 30 years and seems to be functioning as needed and desired. Once the mine is no longer operating, this pipe will just carry water. Therefore, I think it is not

E1 in the best interest of the environment to disturb ground for the many miles that would be need to remove the above ground line and install a new line underground the entire way. This just seems to reflect a desire to remove the visual of the pipe â€“ as if it is a negative thing to share with the public of the future.

E2 I, for one, like to see evidence of the ingenuity of man and think that personal opinion about visual qualities should not trump the need to be environmentally sound. Repair and replacement work in the future would be way less disturbing if the pipe was above ground and easy to access. The agency claims that the above ground pipeline would provide a target for vandalism does not square with the local experience of 30 years of that same pipeline's existence without one incident.

Thank you for considering my comment. Keep this mine and get the other mines OPEN !!!

Sincerely,
Chester Stryker

Sincerely,

Chester Stryker

2011-06-28 Weisenbach J. pdf

Jon Weisenbach
351 Rustic Ave.
Libby, MT 59923-2926
4062932193

June 28, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

Please accept my comments for the Troy Mine revised reclamation plans that have been submitted to your agency. After reading most of the DEIS, I wanted to applaud the agency and the diligent work that it has done in coming up with its preferred alternative.

E1 I would like to comment on two things that I believe may need changed before the final decision to move forward with your preferred approach is made. One is the pipeline that you are requiring to be buried. I'm no hydrologist, but it just seems silly to be burying a pipeline that may need dug up and replaced later if in fact you are accurate that the water needs to go through the infiltration process at the impoundment. Why tear up the entire hillside when you could just put it above ground next to the road as it is now for easy access in case there is a problem decades down the road?

H1
K1 Another is with regards to the toe ponds that have all the topsoil that is being recommended to cover the impoundment for reclamation. There has been a lot of praise to the company because of the habitat that has been created for the western toad. It would seem like a no brainer that they use the course borrow to reclaim it even if it takes a bit longer to achieve the standards required. How long will it take to replace the habitat for the western toad?

Thanks for your consideration,

Sincerely,

Jon Weisenbach

2011-06-29 Ahearnk.pdf

From: Ken Ahearn
To: DEQ Troy Mine; TroyMineReclamation@fs.fed.us
Subject: Attn: Troy Mine Revised Reclamation Plan
Date: Wednesday, June 29, 2011 9:27:09 AM

Ken Ahearn
416 Strand Ave
Missoula, MT 59801
406-207-3449

June 29, 2011

Dear Kootenai National Forest and Montana DEQ:

I have personally visited the mine site and have recreated in the area for the last 20 years. I fully appreciate the job being done by the people responsible for the operation of the Troy Mine and entrust them to understand what is best for this area. I have copied the following statement from the Mining Association website simply because I agree with their proposal. I strongly support mining in Montana and would like to see the most common sense approach implemented.

Please accept my comments for the proposed reclamation revision at the Troy mine. I am fully supportive of the Troy mine and the success that it has had with controlling and mitigating environmental impacts while it has been in operation.

With all of the studies that have been done on the rock and all of the monitoring that has proven no impacts should make this an easy decision. Reading through some of the proposed mitigation measures that have been suggested, it obvious that there has been a very in depth analysis of the revision. It also looks like there is a bit of overkill with some of the suggestions.

I1
E1

You want to take the asphalt out and take it down to dirt again? You feel that you need to dig up the entire existing pipeline and replace it with another line that must be buried? The existing pipelines are sufficient to transport the very clean water from the adit down to the impoundment. Why not disturb less ground and ensure further safety precautions on the existing line that has plenty of capacity to get the job done? Isn't our goal to have the least amount of disturbance necessary?

A5

The men and women at the Troy Mine operate a very safe, very productive, environmentally benign operation. We all want proper reclamation plans approved by the regulators and we certainly want proper bond requirements. That said, there are some things that simply aren't necessary, may not benefit the environment and don't make sense. I approve of the preferred alternative as put forth by the agencies but would like to see some modifications made to in the Record of Decision that reflect proper but not excessive reclamation plans.

Please keep these considerations in mind when making your final decisions on the mitigation measures and the final reclamation plan.

Respectfully yours,

Ken Ahearn

Ken Ahearn
Parts Supervisor
Western States Equipment-Missoula
406-721-4050
kenahearn@wseco.com

2011-06-29 Bowe L. pdf

Lori Bowe
6318 Kootenai River Road
Libby, MT 59923
(406) 293-7156

June 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Bobbie and Emily,

Thank you for your diligent role in the Draft Environmental Impact Statement for the Troy Mine Revised Reclamation Plan.

This project is incredibly important to the communities of Lincoln County and our state. The Troy Mine's wages, taxes, and consumption of local goods and services benefits our schools, as well as the local and state economy. I am pleased to see that all parties involved in the EIS are taking careful consideration of good stewardship practices that will ensure that the benefits of the mine do not outweigh the cost.

I have some suggestions reguarding the EIS and the potential impact on the environmental footprint of the closure requirements. Specifically, I wish to address the pipelines, acess road, fill for the tailings area, and demolition debris disposal.

E2 A pipeline leak either above or below ground is undesireable; with careful monitoring to detect leaks, the existing above ground pipelines will mean faster leak detection and repair, easier access, and less disturbance than burying pipeline. If sensors could be installed in the above ground line, that would be wise. If the effectiveness of the decant ponds would be compromised by stormwater, burming the ponds is wise also.

I1 The access road to the mine could be beneficial to keep in place for facilitating any necessary repairs (not to mention it is a scenic drive for people who are interested in seeing the area).

B1 As long as the site is properly filled and revegetated, burying concrete, rebar, and other materials that will not cause toxic decomposition products on site will save fuel and landfill space with very minimal disturbance to the Kootenai National Forest.

I appreciate the time you have taken to consider my comments. I trust you will come up with a great solution!

Sincerely yours,

Sincerely,

Lori Bowe

2011-06-29 HammonsJ.pdf

Jim Hammons
PO Box 1030
Troy, MT 59935
406-295-5590

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Montana DEQ:

My name is Jim Hammons and I live in Troy. I have been a city councilman and Mayor here in Troy and I have seen firsthand the social and economic disasters that have happened to the Troy, Libby area due to the restrictions and litigation imposed on the natural resource based economy here in Lincoln County.

No one wants to see the environmental disaster of past mining in Montana. But we also don't want to put such stringent restrictions on mining and logging that we drive this companies out of the country to places where there are no environmental laws to protect the environment.

There has got to be middle ground. The pendulum is swinging too far to the side of the extremist and obstructionist.

Please accept my recommendations to the proposed Troy reclamation revisions. I believe that requiring the company to tear down the existing pipeline that is in great shape to replace it with another one immediately upon decommissioning of the mine is not a reasonable requirement. An even more unreasonable request would be to require the company to bury the line.

E1

At a minimum, the document should contain a discussion about the actual condition of the pipeline, how long it is expected to last and a much stronger discussion of why the pipeline should be buried.

After decommissioning, the pipeline will be carrying nothing but clean water and could last another fifty years before it needs replaced. Perhaps you could allow the pipeline to stay above ground and require the Company to repair or replace the line if it becomes necessary or to provide data about the condition of the line periodically to the agencies. I hope that the final reclamation plan allows the existing pipeline to be used until it needs replaced and that it is replaced with another in the same place alongside the road for easy

monitoring into the future.

Thank you for considering my common sense recommendations and thank you for approving the Troy mine reclamation plans so they can continue to employ the almost two hundred men and women that depend on it.

Sincerely yours,

Sincerely,

Jim Hammons

2011-06-29 HartungH.pdf

hank hartung
130 piney rd.
troy, MT 59935
406-291-4888

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Montana DEQ and Kootenai National Forest:

E7 Thank you for allowing me to comment on the Troy Mine Draft EIS. I believe that all of the past and current studies of the impoundment clearly indicate that it will not have a significant impact on ground or surface waters. The attenuation study that was done while the mine was closed and additional studies conducted recently support my conclusion. The rock characterization studies all show little to no potential for ARD or metal releases. These deposits are some of the most environmentally benign metal systems in the world.

After thirty years of this impoundment being in place with no significant impacts to water, it is clear that the decision of the agency will have solid, reliable data documenting the lack of impacts and substantial evidence to support its decision to permit the mine and its proposed reclamation plans.

G3 This operation is very important to the socio-economic wellbeing of Lincoln and Sanders counties. There are over 185 men and women working at this operation and over three million dollars a month of real wealth being distributed into Montana's economy through vendors, payroll, and taxes.

G1 The importance of this operation in two counties that represent the highest unemployment numbers in the state is without question. There will be no significant impacts to the environment by approving this mine's reclamation plans.

Respectfully,

Sincerely,

hank hartung

2011-06-29 Holcomb K. pdf

Karyn Holcomb
2323 Snowshoe Rd.
Libby, MT 59923
293-3318

June 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Kootenai National Forest and Montana DEQ:

Please accept my comments for the proposed reclamation revision at the Troy mine. I am fully supportive of the Troy mine and the success that it has had with controlling and mitigating environmental impacts while it has been in operation.

With all of the studies that have been done on the rock and all of the monitoring that has proven no impacts should make this an easy decision. Reading through some of the proposed mitigation measures that have been suggested, it obvious that there has been a very in depth analysis of the revision. It also looks like there is a bit of overkill with some of the suggestions.

I1
E1

You want to take the asphalt out and take it down to dirt again? You feel that you need to dig up the entire existing pipeline and replace it with another line that must be buried? The existing pipelines are sufficient to transport the very clean water from the adit down to the impoundment. Why not disturb less ground and ensure further safety precautions on the existing line that has plenty of capacity to get the job done? Isn't our goal to have the least amount of disturbance necessary?

A5

The men and women at the Troy Mine operate a very safe, very productive, environmentally benign operation. We all want proper reclamation plans approved by the regulators and we certainly want proper bond requirements. That said, there are some things that simply aren't necessary, may not benefit the environment and don't make sense. I approve of the preferred alternative as put forth by the agencies but would like to see some modifications made to in the Record of Decision that reflect proper but not excessive reclamation plans.

Please keep these considerations in mind when making your final decisions on the mitigation measures and the final reclamation plan.

Respectfully yours,

Sincerely,

Karyn Holcomb

2011-06-29 Matthews J.pdf

jay matthews
1130 Idaho ave
libby, MT 59923

June 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Kootenai National Forest and Montana DEQ:

Please accept my comments for the proposed reclamation revision at the Troy mine. I am fully supportive of the Troy mine and the success that it has had with controlling and mitigating environmental impacts while it has been in operation.

With all of the studies that have been done on the rock and all of the monitoring that has proven no impacts should make this an easy decision. Reading through some of the proposed mitigation measures that have been suggested, it obvious that there has been a very in depth analysis of the revision. It also looks like there is a bit of overkill with some of the suggestions.

I1
E1

You want to take the asphalt out and take it down to dirt again? You feel that you need to dig up the entire existing pipeline and replace it with another line that must be buried? The existing pipelines are sufficient to transport the very clean water from the adit down to the impoundment. Why not disturb less ground and ensure further safety precautions on the existing line that has plenty of capacity to get the job done? Isn't our goal to have the least amount of disturbance necessary?

A5

The men and women at the Troy Mine operate a very safe, very productive, environmentally benign operation. We all want proper reclamation plans approved by the regulators and we certainly want proper bond requirements. That said, there are some things that simply aren't necessary, may not benefit the environment and don't make sense. I approve of the preferred alternative as put forth by the agencies but would like to see some modifications made to in the Record of Decision that reflect proper but not excessive reclamation plans.

Please keep these considerations in mind when making your final decisions on the mitigation measures and the final reclamation plan.

I feel its time to get on with it, yes the mining industy, in the past has had a reputation of

\\\" rape and run \\\" when it comes to clean up and accountabilty. This mining group seems more than willing to do the right thing. The more time that is spent hand wringing and squinting accross the table at each other is just going to increase the cost. lets not jeopordise the few good jobs that remain in this county with needless costs. It's the same old song, people that need to make the dissision won't for fear of there job could is on the line.

Respectfully yours,
Jay D. Matthews

Sincerely,

jay matthews

2011-06-29 moore B. pdf

Bob Moore
1402 Nevada Ave
Libby, MT 59923
406-293-7380

June 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

Thank you for accepting my comments on the revised reclamation plans for the Troy mine. In the thirty years this impoundment has been in place, there has been a great amount of solid reliable data to support your preferred alternative, and I would like to say thank you for your acknowledging it.

K1 I would also like to comment on the reclamation using the topsoil that is currently providing habitat for the western toad. Many people have also acknowledged that careful soil management and wildlife can coexist and that this is something that should be applauded, not destroyed.

H1 H2 From what I understand, it isn't going to cost any more to use the borrow or the topsoil that has been set aside, but it may take a bit longer for the borrow to produce the same reclamation goals if used. I would submit to you that saving habitat that is currently being created and allowing a little longer to create more is a win, win.

I believe that whenever we can showcase an active mining operation creating habitat to any species that is struggling we should. If it isn't going to cost any more either way, and our goal is to reclaim the ground to provide erosion controls and wildlife habitat, we should use the borrow material instead. Remember the old adage: \\\"If it aint broke don't try and fix it\\\". You have to use common sense and not just say \\\" Rules are Rules.

Respectfully,

Sincerely,

Bob Moore

2011-06-29 Watson F. pdf

Fred Watson
7804 Millicent Way
Shreveport, LA 71105

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

G3 The Troy Mine Reclamation plans needs to be approved and permitted for several reasons. The operation is a huge asset to northwest Montana and provides over 190 good paying family wage jobs in an area that has the highest unemployment in the state.

For over thirty years the mine has been depositing its tailings in the impoundment and there has not been any significant impact to the areas streams or wildlife.

E7 K2 Several studies have been done that confirm this and I believe that allowing them to amend their reclamation plan to continue operating is a no brainer. It seems that both the USFS and the DEQ has done a thorough job of analyzing the revised reclamation plans, though there seems to be some recommendations that would actually create more disturbance than should be necessary.

E1 E2 Removing the water pipeline that is buried below the surface (if it is decided that it needs to be replaced) seems impractical as it wouldn't hurt anything to just leave it and remove the pipeline that is above ground. Completely burying a new pipeline (which I'm not convinced is even needed) seems to contradict the desire of all parties to ensure that the lines can be monitored and that there is ability to quickly detect any leakage or break in the line and just as quickly get necessary repairs made while disturbing the least ground or water resources as possible.

That being said, I'm confident the agency will listen to those that have more experience than I in this area and arrive at common sense mitigations while approving this reclamation permit. But I would like to go on record as supporting the preferred alternative with some modifications to the requirements for the pipeline.

Thank you for your time,

Sincerely,

Fred Watson

2011-06-29 WilkinsB.pdf

brian wilkins
221 mahoney rd
libby, MT 59923
4062935929

June 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Kootenai National Forest and Montana DEQ:

Thank you for accepting the following comments on the revised reclamation plan for the Troy mine. I would like to focus my comments on the DEIS to the pipeline and impoundment mitigation recommendations. In general, I support the reclamation plan but there are areas that don't make a great deal of sense to me and that I find contradictory or unnecessary.

E1 Why would you want to dig up and disturb more ground if you were going to decommission the existing water pipeline and replace it with a new one for adit discharges? Aren't we trying to mimimize TMDL impacts in the watershed? Why not just make safety precautions or improvements to the existing pipeline that has more than adequate capacity and seems to be working just fine?

If you did require replacement, why would you want it buried when it would be much more difficult to monitor in the future? Why would you want to disturb ground to bury it originally and perhaps again to repair or replace the line when it is completely unnecessary?

K1 H3 Wouldn't using the toe pond stockpiled top soils for reclamation impact the western toad that currently has great habitat there now? Why not just use the coarse borrow material east of the impoundment instead? The DIES indicates that this could be just as successful in achieving reclamation goals and criteria. Are the wood based organic amendments that add 1,100 lbs of nitrogen per acre for the mill and impoundment really necessary? What is mycorrhizal fungi and why is it needed for reclamation at the mill? Why are the agencies requiring organic versus chemical fertilizer for reclamation in general?

Thank you for listening and I look forward to seeing the final reclamation plan include some further modifications to address some of the areas I have outlined above.

Respectfully,

Sincerely,

brian wilkins

2011-06-30 Bowman L. pdf

Larry Bowman
12242 Bull Lake Road
Troy, MT 59935
(406) 295-5122

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

G1 To whom it may concern. I support the Troy Mine. It has been the best employer in Lincoln county for the last 30+ years. It has proven over and over again to be environmentally sound with no impact on the water quality or wildlife. The benefits to the comunities in northwest Montana are huge. I believe that the citizens of northwest Montana are tired of all the enviromentalist lawsuits that have been filed to harrass and slow down this project and others in Montana. The economy demands that we have these jobs and the benefits to help the people who are trying to make a living here, not moving in to live in their summer homes. Thank-you.

Sincerely,

Larry Bowman

2011-06-30 Briggs M. pdf

Mark Briggs
81 Daly RD
Whitehall, MT 59759
4062872027

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Montana DEQ and Kootenai National Forest:

I work at Golden Sunlight and I appriciate you taking the time to read this letter.

Thank you for accepting my comments to the proposed revisions to the Troy Revised Reclamation Plan preferred alternative. I have just a couple of suggestions for you before you make your final determination.

I1 I would like to see the asphalt remain on the main road leading to the mine site. Removing it and returning it to dirt will just create more BMP work trying to mitigate for TMDL's in the watershed. You might require the asphalt to be repaired in places that it needs to be, but I believe it would be a short term investment that will pay long term dividends for the watershed.

H1 I also believe that using the readily available materials that is suitable for growth medium located on the mine to reclaim the tailing impoundment would be the better option. The topsoil that has been saved for that purpose has become great habitat for the western toad, and I believe that using the other material instead will grow the trees and shrubs necessary to ensure proper reclamation.

B1 I also think that breaking up the foundations and burying the concrete onsite would be just fine rather than digging them up, breaking them up and burying them somewhere else. It's just concrete and won't impact water quality any more than the rip rap along the Bull Trout stream at the bottom of the mountain.

E1 Requiring the company to bury the pipeline when it could just be replaced with another above ground line doesn't make sense either. It seems that if you are serious about water quality and TMDL impacts, you wouldn't want to be disturbing an entire hillside to bury the line not to mention disturbing the ground and the advanced reclamation down the road if the line were to need replacement or repair. Leaving the pipeline above ground and next to the road with asphalt on it makes the most sense in my opinion.

Thanks for your time and consideration.

Sincerely yours,

Sincerely,

Mark Briggs

2011-06-30 Chewing B. pdf

Bud Chewning
193 Farm to Market Road
Libby, MT 59923
406-293-3601

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

I would like to provide some comments regarding the Troy reclamation revision that is open for public comment.

E7 It seems that the agency has done a very thorough examination of all the data that has been collected over the last 30 years and has made an accurate assessment of the water being discharged. From what I have seen, there is simply going to be clean water flowing out of the adit down to the impoundment, and requiring a water treatment facility will not be required.

E1 One thing that really makes me scratch my head though has to do with the pipeline analysis. Is the existing pipeline in a condition that requires replacement immediately upon the mine being decommissioned? I would suggest leaving the existing pipeline infrastructure in place until it needs replacement, and I can't see the logic in burying it when it does get replaced. Wouldn't it be easier to detect leaks and work on it if it was above ground? Aren't we going to be disturbing much more ground by doing it this way? This just doesn't make a whole lot of sense to me.

Thank you for accepting my comments. I eagerly await your response!

Sincerely,

Sincerely,

Bud Chewning

2011-06-30 Clements G. pdf

George Clements
PO Box 813
Whitehall, MT 59759
406-287-3906

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Hello:

Thank you for allowing me to comment on the proposed revisions to the Troy reclamation plans. I believe that the DEQ's proposed alternative is the best action to take, though I think there needs to be some minor tweaks made before the final action is taken.

E7 The Troy Mine has a long record of water monitoring and the agency seems to also recognize this by not requiring post closure mechanical water treatment, which I fully support. I also understand that the agency wants the reclamation plan to mitigate as many impacts as they can upon decommissioning of the mine, but there seems to be some contradictions in the proposed action plan.

K1 H2 If we truly want to create wildlife habitat and soil stability at the same time, why are we removing the topsoil berm that is already providing awesome habitat for the western toad? I understand that your analysis showed that it may take a bit longer to achieve your desired ends, but how much longer? The trees and shrubs that are currently surrounding the site are growing just fine in the same soil that would be used instead of the topsoil. I understand that you would want to use the topsoil under other circumstances, but because the Western toad uses the berm I believe there should be a variance made to allow for the borrow to be used instead of the previously stripped topsoil to protect the toad's habitat.

E1 E2 Another glaring contradiction is with burying the pipeline that will need to be monitored for decades according to the EIS. If the existing pipeline that has been there for thirty years needs to be removed after another ten years of use, then are you anticipating removing the pipeline every 40 years or so by digging it back up and burying it again? It makes much more sense to require the Company to replace the pipeline if and when necessary, but leave it above ground next to the road for ease of monitoring and accessing the line for any necessary repair or replacement.

Thank you for considering my comments.

Respectfully,

Sincerely,

George Clements

2011-06-30 CloughR.pdf

Robert Clough
1120 Mt. Ave
Libby, MT 59923
293-5257

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

RDear Ms. Corsi and Ms. Lacklen:

Thank you for the opportunity to comment on the proposed revisions to the Troy reclamation plans. I would like to give my support for the preferred alternative as selected by the agencies, but would like to see some modifications to it.

I1 I don't understand why you would be taking the asphalt off of the road and returning the road surface to dirt. Wouldn't this create more BMP work to ensure that TMDLs are as low as possible? The current road needs some repair, but the costs of those repairs would be virtually insignificant compared to the long term work and maintenance you would be avoiding by doing so. I would imagine as this is a Forest Service road that it will also have I2 a gate on it not far from the tailings impoundment, which would allow the asphalt to have a very good life span for continued access for monitoring of the pipelines carrying water from the adit.

E2 This brings me to my next issue with the preferred alternative. I don't understand why you want to require the Company to bury the pipeline underground when it could be monitored and accessed easily if it was left above ground and next to the road. Putting strict monitoring requirements on the existing line until it truly needs replaced and making them bond to replace it with an above ground line seems like the most common sense approach that will have the least impact to the watershed long term.

Please consider my suggestions before making your final decision.

Sincerely, Robert Clough

Sincerely,

Robert Clough

2011-06-30 Davis S. pdf

Emily Corsi
Montana Department of Environmental Quality
P.O. Box 200901
Helena, Montana 59620-0901

June 30, 2011

Project Coordinator,

This comment is in regard to a Troy Mine flier which arrived in my mail box.

My main concern is an apparent attempt to ram through something as a large employer, raising questions that can not be researched and acted upon by the July 5, 2011 deadline.

I request that a print copy of the EIS and all issues being considered be sent to me at the address below and the comment period extended long enough to provide the evaluation and comment time needed.

A1

The Community is struggling to attract economic investment from sources who resist being stuck with the irresponsibility of W.R. Grace, Montanore and I need to make sure Troy Mine is not another stack on the pile.

People in a news story found themselves responsible for the toxic mess quick covered on property sold to them as their home so, in that vein and as it stands now, I say: Yes, it makes perfect sense to hold the cream skimmers liable for their messes.

Thank you.

Stanley H. Davis
3264 Iron Creek Road (mail)
559 Copper Mountain Road (residence)
Troy, Montana 59935

RECEIVED

JUL 05 2011

DEQ
DIRECTOR'S OFFICE

2011-06-30 Dibble A. pdf

Al Dibble
475 Northwood Ave
Libby, MT 59923
406-293-3434

July 1, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Kootenai National Forest and Montana DEQ:

G1 It seems to me that the Troy mine has been a great part of Lincoln County. They have provided safe employment to a significant number of workers, paying good wages, and seem to be a responsible guardian of the environment. I would hate to see what would happen if they were to shut down. I saw what happened in Libby when the National Forests were (in effect) shut down. The economy collapsed and the forests suffered from additional fires!

Please accept my comments for the proposed reclamation revision at the Troy mine. I am fully supportive of the Troy mine and the success that it has had with controlling and mitigating environmental impacts while it has been in operation.

With all of the studies that have been done on the rock and all of the monitoring that has proven no impacts should make this an easy decision. Reading through some of the proposed mitigation measures that have been suggested, it obvious that there has been a very in depth analysis of the revision. It also looks like there is a bit of overkill with some of the suggestions.

I1 E1 You want to take the asphalt out and take it down to dirt again? You feel that you need to dig up the entire existing pipeline and replace it with another line that must be buried? The existing pipelines are sufficient to transport the very clean water from the adit down to the impoundment. Why not disturb less ground and ensure further safety precautions on the existing line that has plenty of capacity to get the job done? Isn't our goal to have the least amount of disturbance necessary?

A5 The men and women at the Troy Mine operate a very safe, very productive, environmentally benign operation. We all want proper reclamation plans approved by the regulators and we certainly want proper bond requirements. That said, there are some

things that simply aren't necessary, may not benefit the environment and don't make sense. I approve of the preferred alternative as put forth by the agencies but would like to see some modifications made to in the Record of Decision that reflect proper but not excessive reclamation plans.

Please keep these considerations in mind when making your final decisions on the mitigation measures and the final reclamation plan.

Respectfully yours,

Al Dibble

Sincerely,

Al Dibble

2011-06-30 Dimock T. pdf

Tim Dimock
207 Circle Dr
Bozeman, MT 59715
406-491-1071

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Corsi and Ms. Lacklen:

Thank you for the opportunity to comment on the proposed revisions to the Troy reclamation plans. I would like to give my support for the preferred alternative as selected by the agencies, but would like to see some modifications to it.

I1 I don't understand why you would be taking the asphalt off of the road and returning the road surface to dirt. Wouldn't this create more BMP work to ensure that TMDLs are as low as possible? The current road needs some repair, but the costs of those repairs would be virtually insignificant compared to the long term work and maintenance you would be
I2 avoiding by doing so. I would imagine as this is a Forest Service road that it will also have a gate on it not far from the tailings impoundment, which would allow the asphalt to have a very good life span for continued access for monitoring of the pipelines carrying water from the adit.

This brings me to my next issue with the preferred alternative. I don't understand why you
E2 want to require the Company to bury the pipeline underground when it could be monitored and accessed easily if it was left above ground and next to the road. Putting strict monitoring requirements on the existing line until it truly needs replaced and making them bond to replace it with an above ground line seems like the most common sense approach that will have the least impact to the watershed long term.

As a President of the Montana Mining Association, I have had many dealings with the management from Troy mines, and would like to say that they are very proffessional and make managing their impact on the environment a priority.

Please consider my suggestions before expeditiously making your final decision.

Sincerely,

Sincerely,

Tim Dimock

2011-06-30 Erickson L. pdf

Montana DEQ and Kootenai National Forest:

Thank you for accepting my comments to the proposed revisions to the Troy Revised Reclamation Plan preferred alternative. I have just a couple of suggestions for you before you make your final determination.

I1 I would like to see the asphalt remain on the main road leading to the mine site. Removing it and returning it to dirt will just create more BMP work trying to mitigate for TMDL's in the watershed. You might require the asphalt to be repaired in places that it needs to be, but I believe it would be a short term investment that will pay long term dividends for the watershed.

H1 I also believe that using the readily available materials that is suitable for growth medium located on the mine to reclaim the tailing impoundment would be the better option. The topsoil that has been saved for that purpose has become great habitat for the western toad, and I believe that using the other material instead will grow the trees and shrubs necessary to ensure proper reclamation.

B1 I also think that breaking up the foundations and burying the concrete onsite would be just fine rather than digging them up, breaking them up and burying them somewhere else. It's just concrete and won't impact water quality any more than the rip rap along the Bull Trout stream at the bottom of the mountain.

E1 Requiring the company to bury the pipeline when it could just be replaced with another above ground line doesn't make sense either. It seems that if you are serious about water quality and TMDL impacts, you wouldn't want to be disturbing an entire hillside to bury the line not to mention disturbing the ground and the advanced reclamation down the road if the line were to need replacement or repair. Leaving the pipeline above ground and next to the road with asphalt on it makes the most sense in my opinion.

Thanks for your time and consideration.

Sincerely yours,

Lawanda M. Erickson
44 Halo Drive
Troy, MT 59935

Please respond

RECEIVED
JUN 30 2011
DEQ
DIRECTOR'S OFFICE

2011-06-30 Henderson R.pdf

Rick Henderson
1006 Hwy 55
Whitehall, MT 59759
406-287-2063

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

I would like to comment on the Troy Mine Revised Reclamation Plan Draft EIS.

G3

The Troy Mine has emerged as a shining light in the tough economic picture of northwestern Montana. The mine made it through the dark days of the recession with pay cuts from top to bottom but not one single employee was laid off. The mine, now with ownership that includes the employees themselves through stock options, now underscores the hopeful economic potential of mining for an area that, for a decade, has led the state with catastrophically high unemployment.

Numbers tell the story. Troy Mine now represents over 190 jobs, over $14 million in payroll, over $10 million in goods and services purchased in Montana, over $1.4 million in metal mines taxes for our schools, and over $1.25 in other state and local taxes.

If an incredibly conservative rollover factor of 2 is used to generate an idea of total local impact in this isolated and depressed area, the Troy Mine serves to economically support an additional 380 local jobs in other main street businesses and local government. This is a huge impact on the area.

E7

Thankfully, this economic impact comes with little impact to the environment. In fact, the EIS recognizes this fact when it repeats the conclusions of 30 years of evaluation of water quality that have shown no impacts to the water quality in the mine's area streams. If society wants to have 'green' metals production, Troy Mine is a good source for providing that need.

E1

I generally support the conclusions of the preferred alternative. I have some questions about the reclamation requests in the document â€“ specifically as it concerns the water delivery pipeline. It is currently above ground for the vast majority of its route. It has been in use for nearly 30 years and seems to be functioning as needed and desired. Once the mine is no longer operating, this pipe will just carry water. Therefore, I think it is not

E1 in the best interest of the environment to disturb ground for the many miles that would be need to remove the above ground line and install a new line underground the entire way. This just seems to reflect a desire to remove the visual of the pipe â€“ as if it is a negative thing to share with the public of the future.

E2 I, for one, like to see evidence of the ingenuity of man and think that personal opinion about visual qualities should not trump the need to be environmentally sound. Repair and replacement work in the future would be way less disturbing if the pipe was above ground and easy to access. The agency claims that the above ground pipeline would provide a target for vandalism does not square with the local experience of 30 years of that same pipeline's existence without one incident.

Thank you for considering my comment.

Sincerely,

Sincerely,

Rick Henderson

2011-06-30 HurdB.pdf

Bernard Hurd
2381 Nordic Loop
Whitefish, MT 59937
406-892-1778

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Lady's and Gentlemen of the MDEQ and KNF

I am a third generation native born Montana resident. With two additional generations added by my family. My Grand folks homesteaded on Lake Creek back in the 1910's. The Bull Lake, Spar Lake, Stanley Creek, and Lake Creek area is very important to me. I would not want it not taken care of.
I have also become close to the mine sight with their support toward the area. The Troy officers and employees are very respectful and show great concern regarding all aspects of land use and its environment. They are closer to the ground and conditions and believe that certain action changes to the decommission process could be better for all. It is my pleasure that the Troy Mine and DEQ evaluate legitimate changes with less stress on the wildlife habitat and soil stability.
My family and I appreciate your consideration of my comments.

Regards,

Bernard G. Hurd--CEO
Northwest Parts and Equipment
5460 Hwy 2 West
Columbia Falls, MT 59912

Sincerely,

Bernard Hurd

2011-06-30 Keehn S.pdf

sheri keehn
po 62
grover, wy 83122
307-887-1742

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Corsi and Ms. Lacklen:

Thank you for the opportunity to comment on the proposed revisions to the Troy reclamation plans. I would like to give my support for the preferred alternative as selected by the agencies, but would like to see some modifications to it.

I1 I don't understand why you would be taking the asphalt off of the road and returning the road surface to dirt. Wouldn't this create more BMP work to ensure that TMDLs are as low as possible? The current road needs some repair, but the costs of those repairs would be virtually insignificant compared to the long term work and maintenance you would be avoiding by doing so. I would imagine as this is a Forest Service road that it will also have I2 a gate on it not far from the tailings impoundment, which would allow the asphalt to have a very good life span for continued access for monitoring of the pipelines carrying water from the adit.

E2 This brings me to my next issue with the preferred alternative. I don't understand why you want to require the Company to bury the pipeline underground when it could be monitored and accessed easily if it was left above ground and next to the road. Putting strict monitoring requirements on the existing line until it truly needs replaced and making them bond to replace it with an above ground line seems like the most common sense approach that will have the least impact to the watershed long term.

Please consider my suggestions before making your final decision.

Sincerely,

Sincerely,

sheri keehn

2011-06-30 Kendall J. pdf

Julie Kendall
247 Libby Creek Rd.
Libby, MT 59923
406-293-6698

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

I would like to provide some comments regarding the Troy reclamation revision that is open for public comment.

E7 It seems that the agency has done a very thorough examination of all the data that has been collected over the last 30 years and has made an accurate assessment of the water being discharged. From what I have seen, there is simply going to be clean water flowing out of the adit down to the impoundment, and requiring a water treatment facility will not be required.

E1 One thing that really makes me scratch my head though has to do with the pipeline analysis. Is the existing pipeline in a condition that requires replacement immediately upon the mine being decommissioned? I would suggest leaving the existing pipeline infrastructure in place until it needs replacement, and I can't see the logic in burying it when it does get replaced. Wouldn't it be easier to detect leaks and work on it if it was above ground? Aren't we going to be disturbing much more ground by doing it this way? This just doesn't make a whole lot of sense to me.

Thank you for accepting my comments. I eagerly await your response!

Sincerely,

Julie Kendall

Sincerely,

Julie Kendall

2011-06-30 KetchumR.pdf

Rudy Ketchum
1251 Caledonia Street
Butte, MT 59701
406-723-2500

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Kootenai National Forest and Montana DEQ:

Please accept my comments for the proposed reclamation revision at the Troy mine. I am fully supportive of the Troy mine and the success that it has had with controlling and mitigating environmental impacts while it has been in operation.

With all of the studies that have been done on the rock and all of the monitoring that has proven no impacts should make this an easy decision. Reading through some of the proposed mitigation measures that have been suggested, it obvious that there has been a very in depth analysis of the revision. It also looks like there is a bit of overkill with some of the suggestions.

I1
E1

You want to take the asphalt out and take it down to dirt again? You feel that you need to dig up the entire existing pipeline and replace it with another line that must be buried? The existing pipelines are sufficient to transport the very clean water from the adit down to the impoundment. Why not disturb less ground and ensure further safety precautions on the existing line that has plenty of capacity to get the job done? Isn't our goal to have the least amount of disturbance necessary?

A5

The men and women at the Troy Mine operate a very safe, very productive, environmentally benign operation. We all want proper reclamation plans approved by the regulators and we certainly want proper bond requirements. That said, there are some things that simply aren't necessary, may not benefit the environment and don't make sense. I approve of the preferred alternative as put forth by the agencies but would like to see some modifications made to in the Record of Decision that reflect proper but not excessive reclamation plans.

Please keep these considerations in mind when making your final decisions on the mitigation measures and the final reclamation plan.

Respectfully yours,

Rudy Ketchum

Sincerely,

Rudy Ketchum

2011-06-30 Lanz V. pdf

Vanessa Lanz
1126 Cruiser Lane, Unit F
Belgrade, MT 59714
406-924-6542

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Montana DEQ:

Please accept my recommendations to the proposed Troy reclamation revisions. I believe that requiring the company to tear down the existing pipeline that is in great shape to replace it with another one immediately upon decommissioning of the mine is not a reasonable requirement. An even more unreasonable request would be to require the company to bury the line.

E1 At a minimum, the document should contain a discussion about the actual condition of the pipeline, how long it is expected to last and a much stronger discussion of why the pipeline should be buried.

After decommissioning, the pipeline will be carrying nothing but clean water and could last another fifty years before it needs replaced. Perhaps you could allow the pipeline to stay above ground and require the Company to repair or replace the line if it becomes necessary or to provide data about the condition of the line periodically to the agencies. I hope that the final reclamation plan allows the existing pipeline to be used until it needs replaced and that it is replaced with another in the same place alongside the road for easy monitoring into the future.

Thank you for considering my common sense recommendations and thank you for approving the Troy mine reclamation plans so they can continue to employ the almost two hundred men and women that depend on it.

Sincerely yours,

Sincerely,

Vanessa Lanz

2011-06-30 Lingel S. pdf

Sharon Lingel
236 Hummingbird Lane
Troy, MT 59935
295-9453

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

Please accept my comments for the Troy Mine revised reclamation plans that have been submitted to your agency. After reading most of the DEIS, I wanted to applaud the agency and the diligent work that it has done in coming up with its preferred alternative.

E1 I would like to comment on two things that I believe may need changed before the final decision to move forward with your preferred approach is made. One is the pipeline that you are requiring to be buried. I'm no hydrologist, but it just seems silly to be burying a pipeline that may need dug up and replaced later if in fact you are accurate that the water needs to go through the infiltration process at the impoundment. Why tear up the entire hillside when you could just put it above ground next to the road as it is now for easy access in case there is a problem decades down the road?

H1 K1 Another is with regards to the toe ponds that have all the topsoil that is being recommended to cover the impoundment for reclamation. There has been a lot of praise to the company because of the habitat that has been created for the western toad. It would seem like a no brainer that they use the course borrow to reclaim it even if it takes a bit longer to achieve the standards required. How long will it take to replace the habitat for the western toad?

Thanks for your consideration,

Sincerely,

Sharon Lingel

2011-06-30 MoeH.pdf

Harry Moe
812 W. Balsam
Libby, MT 59923
406-293-4870

July 1, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi:

Please consider my comment on the Troy Mine Revised Reclamation Plan Draft EIS.

G3 The northwestern area of Montana has been in a deep recession for a decade longer than the rest of our nation. Much of this is because of the systematic dismantling of the forestry management system of the United States Forest Service. The resultant collapse of the local economies of the area has been catastrophic. Over 3500 industrial, family wage jobs have been lost in the logging and milling businesses of Lincoln and Sanders Counties. The social ills such as alcoholism, drug addictions, family destructive behaviors, suicides, domestic abuse that follow these types of economic losses are well documented and were tragically predicted.

For the last several years, there has been a growing hope that mineral activity could replace some of the lost jobs and help to lower the unemployment rates of 20% that is found in these two counties. That hope will not be met with reality unless mines like the Troy Mine can stay in business. The economic benefit of nearly 200 jobs that average over $55,000 per year - not counting the benefits packages that includes health insurance, retirement plans and stock options â€" cannot be overstated. The impact the Troy Mine has with $14 million in payroll, $10 million in local purchases of goods and services, $250,000 in property taxes, $1 million in gross proceeds taxes, $1.4 million in metal mines taxes cannot be overstated.

With this economic need as a backdrop to the discussion of the future of the mine, I would like to offer my support for the agency's preferred alternative â€" with some suggestions for necessary changes.

H2 First, I do not think it is in the best interest of the environment to remove the topsoil from the toe of the impoundment area. Although it is true that this soil was once topsoil on the site, it has now been in place of over 30 years and it seems unnecessary and possibly even foolish to disturb the area so close to the water courses that have successfully protected

H2 during mine operation. Surely, in order to grow the trees and other vegetation that is native to the area, the soil from area borrow pits can be utilized with success and without the potential impacts associated with gross disturbance of areas near streams that have already healed up.

Thank you for accepting and considering my comment.

Sincerely,
Harry Moe

Sincerely,

Harry Moe

2011-06-30 moodrym.pdf

Mike Moodry
1806 Haggin Ave
Anaconda, MT 59711
406-287-2044

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Kootenai National Forest and Montana DEQ:

I am currently employed by Barrick Inc's Golden Sunlight mine. I've worked in the mining industry most of my adult life and owe much of the good fortune I've attained to the mining industry. I feel it is in Montana's best interest to support mining and other natural resource jobs in our beautiful state.

Thank you for accepting the following comments on the revised reclamation plan for the Troy mine. I would like to focus my comments on the DEIS to the pipeline and impoundment mitigation recommendations. In general, I support the reclamation plan but there are areas that don't make a great deal of sense to me and that I find contradictory or unnecessary.

E1 Why would you want to dig up and disturb more ground if you were going to decommission the existing water pipeline and replace it with a new one for adit discharges? Aren't we trying to minimize TMDL impacts in the watershed? Why not just make safety precautions or improvements to the existing pipeline that has more than adequate capacity and seems to be working just fine?

If you did require replacement, why would you want it buried when it would be much more difficult to monitor in the future? Why would you want to disturb ground to bury it originally and perhaps again to repair or replace the line when it is completely unnecessary?

K1 H3 Wouldn't using the toe pond stockpiled top soils for reclamation impact the western toad that currently has great habitat there now? Why not just use the coarse borrow material east of the impoundment instead? The DIES indicates that this could be just as successful in achieving reclamation goals and criteria. Are the wood based organic amendments that add 1,100 lbs of nitrogen per acre for the mill and impoundment really necessary? What is mycorrhizal fungi and why is it needed for reclamation at the mill? Why are the agencies requiring organic versus chemical fertilizer for reclamation in general?

Thank you for listening and I look forward to seeing the final reclamation plan include some further modifications to address some of the areas I have outlined above.

Respectfully,

Sincerely,

Mike Moodry

2011-06-30 mortensen C.pdf

Clint Mortensen
125 saddle ln
Butte, MT 59701
4064986177

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Montana DEQ and Kootenai National Forest:

Thank you for accepting my comments to the proposed revisions to the Troy Revised Reclamation Plan preferred alternative. I have just a couple of suggestions for you before you make your final determination.

I1 I would like to see the asphalt remain on the main road leading to the mine site. Removing it and returning it to dirt will just create more BMP work trying to mitigate for TMDL's in the watershed. You might require the asphalt to be repaired in places that it needs to be, but I believe it would be a short term investment that will pay long term dividends for the watershed.

H1 I also believe that using the readily available materials that is suitable for growth medium located on the mine to reclaim the tailing impoundment would be the better option. The topsoil that has been saved for that purpose has become great habitat for the western toad, and I believe that using the other material instead will grow the trees and shrubs necessary to ensure proper reclamation.

B1 I also think that breaking up the foundations and burying the concrete onsite would be just fine rather than digging them up, breaking them up and burying them somewhere else. It's just concrete and won't impact water quality any more than the rip rap along the Bull Trout stream at the bottom of the mountain.

E1 Requiring the company to bury the pipeline when it could just be replaced with another above ground line doesn't make sense either. It seems that if you are serious about water quality and TMDL impacts, you wouldn't want to be disturbing an entire hillside to bury the line not to mention disturbing the ground and the advanced reclamation down the road if the line were to need replacement or repair. Leaving the pipeline above ground and next to the road with asphalt on it makes the most sense in my opinion.

Thanks for your time and consideration.

Sincerely yours,

Sincerely,

Clint Mortensen

2011-06-30 Oedewaldt C. pdf

Carol Oedewaldt
34338 US Hwy 2
Libby, MT 59923
406-293-5326

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Montana DEQ and Kootenai National Forest:
I believe that the Troy Mine is a valuable asset to Lincoln County and Montana. I have visited the mine and was impressed with the work they are doing. They are genuinely concerned about the environment and their working conditions. Please allow them to continue their work. They have proven themselves.

E7 Thank you for allowing me to comment on the Troy Mine Draft EIS. I believe that all of the past and current studies of the impoundment clearly indicate that it will not have a significant impact on ground or surface waters. The attenuation study that was done while the mine was closed and additional studies conducted recently support my conclusion. The rock characterization studies all show little to no potential for ARD or metal releases. These deposits are some of the most environmentally benign metal systems in the world.

After thirty years of this impoundment being in place with no significant impacts to water, it is clear that the decision of the agency will have solid, reliable data documenting the lack of impacts and substantial evidence to support its decision to permit the mine and its proposed reclamation plans.

G3 This operation is very important to the socio-economic wellbeing of Lincoln and Sanders counties. There are over 185 men and women working at this operation and over three million dollars a month of real wealth being distributed into Montana's economy through vendors, payroll, and taxes.

G1 We need the jobs in northwest Montana. Please keep them here. The importance of this operation in two counties that represent the highest unemployment numbers in the state is without question. There will be no significant impacts to the environment by approving this mine's reclamation plans.

Sincerely,
Carol Oedewaldt

2011-06-30 Owens M-and-Anderson M.pdf

From:	CoonAdoor@aol.com
To:	DEQ Troy Mine; TroyMineReclamation@fs.fed.us
Subject:	Attn: Troy Mine Revised Reclamation Plan
Date:	Thursday, June 30, 2011 7:21:37 PM

To Whom It May Concern:

As requested by all parties involved, I am submitting a short comment regarding the requirements to be followed by the Troy Mine. My wife and I live in the Yaak area and are full-time residents in this area and the state of Montana.

As everyone knows, this is nothing new and the Troy Mine appears to have complied in their responsibilities to the community, federal and state governments. As an outsider, it amazes me to see the amount of changes placed on the Troy Mine over the years to "do the right thing", and watch them adapt to the (sometimes whims) of the many participating groups involved. Some common sense would a long way in protecting all. We as nation need what the Troy Mine, and other business', provide. To go over-board on any business' rule requirements is a travesty in our way of life.

We feel the Troy Mine has succeeded in following the red-tape on this matter. Thank you for your time and consideration.

R/S
Michael Owens
Monica Anderson

2011-06-30 PhillipsT. pdf

Tom Phillips
6330 Dawn Drive
Belgrade, MT 59714
406-388-1072

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Corsi and Ms. Lacklen:

Thank you for the opportunity to comment on the proposed revisions to the Troy reclamation plans. I would like to give my support for the preferred alternative as selected by the agencies, but would like to see some modifications to it.

I1 I don't understand why you would be taking the asphalt off of the road and returning the road surface to dirt. Wouldn't this create more BMP work to ensure that TMDLs are as low as possible? The current road needs some repair, but the costs of those repairs would be virtually insignificant compared to the long term work and maintenance you would be avoiding by doing so. I would imagine as this is a Forest Service road that it will also have I2 a gate on it not far from the tailings impoundment, which would allow the asphalt to have a very good life span for continued access for monitoring of the pipelines carrying water from the adit.

E2 This brings me to my next issue with the preferred alternative. I don't understand why you want to require the Company to bury the pipeline underground when it could be monitored and accessed easily if it was left above ground and next to the road. Putting strict monitoring requirements on the existing line until it truly needs replaced and making them bond to replace it with an above ground line seems like the most common sense approach that will have the least impact to the watershed long term.

Please consider my suggestions before making your final decision.

Sincerely,

Sincerely,

Tom Phillips

2011-06-30 Rebo8.pdf

steve rebo
582 dome mtn. ave.
libby, MT 59923
406-293-5853

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi:

Please consider my comment on the Troy Mine Revised Reclamation Plan Draft EIS.

G3

The northwestern area of Montana has been in a deep recession for a decade longer than the rest of our nation. Much of this is because of the systematic dismantling of the forestry management system of the United States Forest Service. The resultant collapse of the local economies of the area has been catastrophic. Over 3500 industrial, family wage jobs have been lost in the logging and milling businesses of Lincoln and Sanders Counties. The social ills such as alcoholism, drug addictions, family destructive behaviors, suicides, domestic abuse that follow these types of economic losses are well documented and were tragically predicted.

For the last several years, there has been a growing hope that mineral activity could replace some of the lost jobs and help to lower the unemployment rates of 20% that is found in these two counties. That hope will not be met with reality unless mines like the Troy Mine can stay in business. The economic benefit of nearly 200 jobs that average over $55,000 per year - not counting the benefits packages that includes health insurance, retirement plans and stock options â€“ cannot be overstated. The impact the Troy Mine has with $14 million in payroll, $10 million in local purchases of goods and services, $250,000 in property taxes, $1 million in gross proceeds taxes, $1.4 million in metal mines taxes cannot be overstated.

With this economic need as a backdrop to the discussion of the future of the mine, I would like to offer my support for the agency's preferred alternative â€“ with some suggestions for necessary changes.

H2

First, I do not think it is in the best interest of the environment to remove the topsoil from the toe of the impoundment area. Although it is true that this soil was once topsoil on the site, it has now been in place of over 30 years and it seems unnecessary and possibly even foolish to disturb the area so close to the water courses that have successfully protected

H2 during mine operation. Surely, in order to grow the trees and other vegetation that is native to the area, the soil from area borrow pits can be utilized with success and without the potential impacts associated with gross disturbance of areas near streams that have already healed up.

Thank you for accepting and considering my comment.

Sincerely,
Steve Rebo

Sincerely,

steve rebo

2011-06-30 ScharfD.pdf

Darrell Scharf
P.O. Box 263
Whitehall, MT 59759
406-287-5802

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

I would like to comment on the Troy Mine Revised Reclamation Plan Draft EIS.

G3 The Troy Mine has emerged as a shining light in the tough economic picture of northwestern Montana. The mine made it through the dark days of the recession with pay cuts from top to bottom but not one single employee was laid off. The mine, now with ownership that includes the employees themselves through stock options, now underscores the hopeful economic potential of mining for an area that, for a decade, has led the state with catastrophically high unemployment.

Numbers tell the story. Troy Mine now represents over 190 jobs, over $14 million in payroll, over $10 million in goods and services purchased in Montana, over $1.4 million in metal mines taxes for our schools, and over $1.25 in other state and local taxes.

If an incredibly conservative rollover factor of 2 is used to generate an idea of total local impact in this isolated and depressed area, the Troy Mine serves to economically support an additional 380 local jobs in other main street businesses and local government. This is a huge impact on the area.

E7 Thankfully, this economic impact comes with little impact to the environment. In fact, the EIS recognizes this fact when it repeats the conclusions of 30 years of evaluation of water quality that have shown no impacts to the water quality in the mine's area streams. If society wants to have 'green' metals production, Troy Mine is a good source for providing that need.

I generally support the conclusions of the preferred alternative.

Thank you for considering my comment.

Sincerely,

Sincerely,

Darrell Scharf

2011-06-30 Seeman J. pdf

Judy Seeman
waterfront road
Troy, MT 59935
291-8058

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Kootenai National Forest and Montana DEQ:

Leave things the way they are, why destroy what is already there. A BIG waste of money and time.

Please accept my comments for the proposed reclamation revision at the Troy mine. I am fully supportive of the Troy mine and the success that it has had with controlling and mitigating environmental impacts while it has been in operation.

With all of the studies that have been done on the rock and all of the monitoring that has proven no impacts should make this an easy decision. Reading through some of the proposed mitigation measures that have been suggested, it obvious that there has been a very in depth analysis of the revision. It also looks like there is a bit of overkill with some of the suggestions.

I1
E1

You want to take the asphalt out and take it down to dirt again? You feel that you need to dig up the entire existing pipeline and replace it with another line that must be buried? The existing pipelines are sufficient to transport the very clean water from the adit down to the impoundment. Why not disturb less ground and ensure further safety precautions on the existing line that has plenty of capacity to get the job done? Isn't our goal to have the least amount of disturbance necessary?

A5

The men and women at the Troy Mine operate a very safe, very productive, environmentally benign operation. We all want proper reclamation plans approved by the regulators and we certainly want proper bond requirements. That said, there are some things that simply aren't necessary, may not henefit the environment and don't make sense. I approve of the preferred alternative as put forth by the agencies but would like to see some modifications made to in the Record of Decision that reflect proper but not excessive reclamation plans.

Please keep these considerations in mind when making your final decisions on the

mitigation measures and the final reclamation plan.

Respectfully yours,
Judy Seeman

Sincerely,

Judy Seeman

2011-06-30 Sholey F. pdf

Frank Sholey
5 Whitetail Dr
Whitehall, MT 59759
406-498-6946

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Montana DEQ:

Please accept my recommendations to the proposed Troy reclamation revisions. I believe that requiring the company to tear down the existing pipeline that is in great shape to replace it with another one immediately upon decommissioning of the mine is not a reasonable requirement. An even more unreasonable request would be to require the company to bury the line.

E1 At a minimum, the document should contain a discussion about the actual condition of the pipeline, how long it is expected to last and a much stronger discussion of why the pipeline should be buried.

After decommissioning, the pipeline will be carrying nothing but clean water and could last another fifty years before it needs replaced. Perhaps you could allow the pipeline to stay above ground and require the Company to repair or replace the line if it becomes necessary or to provide data about the condition of the line periodically to the agencies. I hope that the final reclamation plan allows the existing pipeline to be used until it needs replaced and that it is replaced with another in the same place alongside the road for easy monitoring into the future.

Thank you for considering my common sense recommendations and thank you for approving the Troy mine reclamation plans so they can continue to employ the almost two hundred men and women that depend on it.

Sincerely yours,

Sincerely,

Frank Sholey

2011-06-30 Slatter S.pdf

Seth Slatter
253 Mt Hwy 2 East
Whitehall, MT 59759

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

G3 The Troy Mine Reclamation plans needs to be approved and permitted for several reasons. The operation is a huge asset to northwest Montana and provides over 190 good paying family wage jobs in an area that has the highest unemployment in the state.

For over thirty years the mine has been depositing its tailings in the impoundment and there has not been any significant impact to the areas streams or wildlife.

E7
K2 Several studies have been done that confirm this and I believe that allowing them to amend their reclamation plan to continue operating is a no brainer. It seems that both the USFS and the DEQ has done a thorough job of analyzing the revised reclamation plans, though there seems to be some recommendations that would actually create more disturbance than should be necessary.

E1
E2 Removing the water pipeline that is buried below the surface (if it is decided that it needs to be replaced) seems impractical as it wouldn't hurt anything to just leave it and remove the pipeline that is above ground. Completely burying a new pipeline (which I'm not convinced is even needed) seems to contradict the desire of all parties to ensure that the lines can be monitored and that there is ability to quickly detect any leakage or break in the line and just as quickly get necessary repairs made while disturbing the least ground or water resources as possible.

That being said, I'm confident the agency will listen to those that have more experience than I in this area and arrive at common sense mitigations while approving this reclamation permit. But I would like to go on record as supporting the preferred alternative with some modifications to the requirements for the pipeline.

Thank you for your time,

Sincerely,

Seth Slatter

2011-06-30 Stolpk.pdf

Kelly Stolp
PO Box 1281
Boulder, MT 59632
406-490-3533

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Kootenai National Forest and Montana DEQ:

As the Safety and Security Director for a Gold Mine I am totally in suport of the Troy Mine. Mining is important to the State of Montana.
Please accept my comments for the proposed reclamation revision at the Troy mine. I am fully supportive of the Troy mine and the success that it has had with controlling and mitigating environmental impacts while it has been in operation.

With all of the studies that have been done on the rock and all of the monitoring that has proven no impacts should make this an easy decision. Reading through some of the proposed mitigation measures that have been suggested, it obvious that there has been a very in depth analysis of the revision. It also looks like there is a bit of overkill with some of the suggestions.

I1
E1

You want to take the asphalt out and take it down to dirt again? You feel that you need to dig up the entire existing pipeline and replace it with another line that must be buried? The existing pipelines are sufficient to transport the very clean water from the adit down to the impoundment. Why not disturb less ground and ensure further safety precautions on the existing line that has plenty of capacity to get the job done? Isn't our goal to have the least amount of disturbance necessary?

A5

The men and women at the Troy Mine operate a very safe, very productive, environmentally benign operation. We all want proper reclamation plans approved by the regulators and we certainly want proper bond requirements. That said, there are some things that simply aren't necessary, may not benefit the environment and don't make sense. I approve of the preferred alternative as put forth by the agencies but would like to see some modifications made to in the Record of Decision that reflect proper but not excessive reclamation plans.

Please keep these considerations in mind when making your final decisions on the mitigation measures and the final reclamation plan.

Respectfully yours,

Sincerely,

Kelly Stolp

2011-06-30 Thompson M.pdf

Mark Thompson
400 Stagecoach Rd
Butte, MT 59701
406-782-5731

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Montana DEQ and Kootenai National Forest:

Thank you for accepting my comments to the proposed revisions to the Troy Revised Reclamation Plan preferred alternative. I have just a couple of suggestions for you before you make your final determination.

I1 I would like to see the asphalt remain on the main road leading to the mine site. Removing it and returning it to dirt will just create more BMP work trying to mitigate for TMDL's in the watershed. You might require the asphalt to be repaired in places that it needs to be, but I believe it would be a short term investment that will pay long term dividends for the watershed.

H1 I also believe that using the readily available materials that is suitable for growth medium located on the mine to reclaim the tailing impoundment would be the better option. The topsoil that has been saved for that purpose has become great habitat for the western toad, and I believe that using the other material instead will grow the trees and shrubs necessary to ensure proper reclamation.

B1 I also think that breaking up the foundations and burying the concrete onsite would be just fine rather than digging them up, breaking them up and burying them somewhere else. It's just concrete and won't impact water quality any more than the rip rap along the Bull Trout stream at the bottom of the mountain.

E1 Requiring the company to bury the pipeline when it could just be replaced with another above ground line doesn't make sense either. It seems that if you are serious about water quality and TMDL impacts, you wouldn't want to be disturbing an entire hillside to bury the line not to mention disturbing the ground and the advanced reclamation down the road if the line were to need replacement or repair. Leaving the pipeline above ground and next to the road with asphalt on it makes the most sense in my opinion.

Thanks for your time and consideration.

Sincerely yours,

Sincerely,

Mark Thompson

2011-06-30 Tuohimaa .R.pdf

Ron Tuohimaa
PO Box 238
Three Forks, Montana 59752-0238

Montana Department of Environmental Quality

Reference: Troy Mine Revised Reclamation Plan Draft EIS - File Code: 2810/1950.

To Whom it May Concern:

G3 The current unemployment rate of Troy Montana is 11.3%, significantly higher than the current, but stagnant, national average. The typical household income in this town is only 50% of the median household income of the United States.

While it is true that the Troy Mine has an impeccable record relative to safety, environmental accord and quality and on that alone the Troy Mine's Revised Reclamation Plan Draft EIS should be approved, I would like to comment on the one factor that never seems to have any implicit value in these matters – human life and liberties.

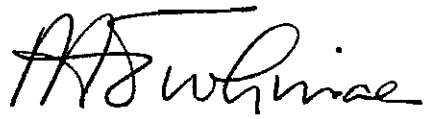
It is high time to put an intrinsic value on human dignity. It is the moment to realistically diminish the significance of the chants, demonstrations, imprudence and arrogance of extreme environmental factions.

Natural resource extractors, and the industries that subsist because of them, all over this nation, are experiencing a denial for normal existence and livelihoods because of the moral corruption, irresponsible implications and intimidation tactics instituted by these organizations.

The entire State of Montana, through deception by environmental groups, has suffered a great deal of decline in economic growth. All the while, these groups maintain a larger-than-life 'donate' button on their website with never a care or concern for the livelihoods they continue to destroy.

I beseech you to continue to give the people of Troy their dignity and self-esteem.

Yours truly,



Ron Tuohimaa

2011-06-30 WesleyF.pdf

fred wesley
667 shalom dr
libby, MT 59923
406. 293.5690

June 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Kootenai National Forest and Montana DEQ:

Please accept my comments for the proposed reclamation revision at the Troy mine. I am fully supportive of the Troy mine and the success that it has had with controlling and mitigating environmental impacts while it has been in operation.

With all of the studies that have been done on the rock and all of the monitoring that has proven no impacts should make this an easy decision. Reading through some of the proposed mitigation measures that have been suggested, it obvious that there has been a very in depth analysis of the revision. It also looks like there is a bit of overkill with some of the suggestions.

I1
E1

You want to take the asphalt out and take it down to dirt again? You feel that you need to dig up the entire existing pipeline and replace it with another line that must be buried? The existing pipelines are sufficient to transport the very clean water from the adit down to the impoundment. Why not disturb less ground and ensure further safety precautions on the existing line that has plenty of capacity to get the job done? Isn't our goal to have the least amount of disturbance necessary?

A5

The men and women at the Troy Mine operate a very safe, very productive, environmentally benign operation. We all want proper reclamation plans approved by the regulators and we certainly want proper bond requirements. That said, there are some things that simply aren't necessary, may not benefit the environment and don't make sense. I approve of the preferred alternative as put forth by the agencies but would like to see some modifications made to in the Record of Decision that reflect proper but not excessive reclamation plans.

Please keep these considerations in mind when making your final decisions on the mitigation measures and the final reclamation plan.

Respectfully yours,

Sincerely,

fred wesley

2011-07-01 Erickson3.pdf

Dear Kootenai National Forest and Montana DEQ:

Please accept my comments for the proposed reclamation revision at the Troy mine. I am fully supportive of the Troy mine and the success that it has had with controlling and mitigating environmental impacts while it has been in operation.

With all of the studies that have been done on the rock and all of the monitoring that has proven no impacts should make this an easy decision. Reading through some of the proposed mitigation measures that have been suggested, it obvious that there has been a very in depth analysis of the revision. It also looks like there is a bit of overkill with some of the suggestions.

I1 E1 You want to take the asphalt out and take it down to dirt again? You feel that you need to dig up the entire existing pipeline and replace it with another line that must be buried? The existing pipelines are sufficient to transport the very clean water from the adit down to the impoundment. Why not disturb less ground and ensure further safety precautions on the existing line that has plenty of capacity to get the job done? Isn't our goal to have the least amount of disturbance necessary?

A5 The men and women at the Troy Mine operate a very safe, very productive, environmentally benign operation. We all want proper reclamation plans approved by the regulators and we certainly want proper bond requirements. That said, there are some things that simply aren't necessary, may not benefit the environment and don't make sense. I approve of the preferred alternative as put forth by the agencies but would like to see some modifications made to in the Record of Decision that reflect proper but not excessive reclamation plans.

Please keep these considerations in mind when making your final decisions on the mitigation measures and the final reclamation plan.

Respectfully yours,

Steven Erickson
44 Halo Drive
Troy, MT 59935

RECEIVED
JUL 01 2011
DEQ
DIRECTOR'S OFFICE

2011-07-01 Farmer L. pdf

Lacie Farmer
1382 Kootenai River Road
Libby, MT 59923
406.293.7430

July 1, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Corsi and Ms. Lacklen:

My name is Lacie Farmer and I am a Libby public school teacher. I live and work in Libby, and the Troy Mine is a vital part of our economy. Many families of mine are employed at the mine, and we need these jobs to keep our schools up and running. I hear that there is a reclamation plan that you are offering comments on. I am in full support of the reclamation plan, but I believe there are a few alterations that can be done that are more cost effective and safe for the environment.

E1 First off, I have visited the Troy mine and seen the piping along the road that leads to the tailings. I have heard you have proposed to bury these lines. Why do they need to be buried and replaced if they are working fine now? I would think that ease of access would be easier for the mine if something did need replaced. If you put in place a bond asking them to replace and monitor the pipeline, that would allow for ease of access and a common sense approach.

I1 Secondly, please consider NOT taking off the asphalt and making it a dirt road. I would think this would make the air quality worse in this area, and our area is already boxed in enough with bad air quality as is. Asphalt would be easy to maintain and repair as it is already there.

Thank you for taking the time to listen to my support and concern about the proposed plan.

Sincerely,

Sincerely,

Lacie Farmer

2011-07-01 FreeburyD.pdf

dan freebury
228 white ave
libby, MT 59923
406-293-8944

July 1, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Montana DEQ and Kootenai National Forest:

Thank you for allowing me to comment on the Troy Mine Draft EIS. I believe that all of the past and current studies of the impoundment clearly indicate that it will not have a significant impact on ground or surface waters. The attenuation study that was done whileDear Montana DEQ and Kootenai National Forest:

Thank you for allowing me to comment on the Troy Mine Draft EIS. I believe that all of the past and current studies of the impoundment clearly indicate that it will not have a significant impact on ground or surface waters. The attenuation study that was done while the mine was closed and additional studies conducted recently support my conclusion. The
E7 rock characterization studies all show little to no potential for ARD or metal releases. These deposits are some of the most environmentally benign metal systems in the world.

After thirty years of this impoundment being in place with no significant impacts to water, it is clear that the decision of the agency will have solid, reliable data documenting the lack of impacts and substantial evidence to support its decision to permit the mine and its proposed reclamation plans.

G3 This operation is very important to the socio-economic wellbeing of Lincoln and Sanders counties. There are over 185 men and women working at this operation and over three million dollars a month of real wealth being distributed into Montana's economy through vendors, payroll, and taxes.

G1 The importance of this operation in two counties that represent the highest unemployment numbers in the state is without question. There will be no significant impacts to the environment by approving this mine's reclamation plans.

Respectfully,Dan Freebury
i'm retired and i feel the mine should be opened we need the jobs here and i don't feel the enviroment is being hurt keep it open please the mine was closed and additional studies

conducted recently support my conclusion. The rock characterization studies all show little to no potential for ARD or metal releases. These deposits are some of the most environmentally benign metal systems in the world.

After thirty years of this impoundment being in place with no significant impacts to water, it is clear that the decision of the agency will have solid, reliable data documenting the lack of impacts and substantial evidence to support its decision to permit the mine and its proposed reclamation plans.

This operation is very important to the socio-economic wellbeing of Lincoln and Sanders counties. There are over 185 men and women working at this operation and over three million dollars a month of real wealth being distributed into Montana's economy through vendors, payroll, and taxes.

The importance of this operation in two counties that represent the highest unemployment numbers in the state is without question. There will be no significant impacts to the environment by approving this mine's reclamation plans.

Respectfully,

Sincerely,

dan freebury

2011-07-01 Haugen M. pdf

milo haugen
111 michelle lane
libby, MT 59923
406-293-6786

July 2, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

cc Montana DEQ and Kootenai National Forest:

Thank you for accepting my comments to the proposed revisions to the Troy Revised Reclamation Plan preferred alternative. I have just a couple of suggestions for you before you make your final determination.

I have worked for 46 years in the construction industry, with about half of the years in the reclamation aspect of the industry.

I have supervised mine recamation projects in four different states. I believe I have some hands on knowledge of what will work in the field and what won't. Some things look good on paper but actually create great problems down the road. The reclamation process should be done in a practical long term solution approach.

I1 I would like to see the asphalt remain on the main road leading to the mine site. Removing it and returning it to dirt will just create more BMP work trying to mitigate for TMDL's in the watershed. You might require the asphalt to be repaired in places that it needs to be, but I believe it would be a short term investment that will pay long term dividends for the watershed.

H1 I also believe that using the readily available materials that is suitable for growth medium located on the mine to reclaim the tailing impoundment would be the better option. The topsoil that has been saved for that purpose has become great habitat for the western toad, and I believe that using the other material instead will grow the trees and shrubs necessary to ensure proper reclamation.

B1 I also think that breaking up the foundations and burying the concrete onsite would be just fine rather than digging them up, breaking them up and burying them somewhere else. It's just concrete and won't impact water quality any more than the rip rap along the Bull Trout stream at the bottom of the mountain.

E1 Requiring the company to bury the pipeline when it could just be replaced with another above ground line doesn't make sense either. It seems that if you are serious about water quality and TMDL impacts, you wouldn't want to be disturbing an entire hillside to bury the line not to mention disturbing the ground and the advanced reclamation down the road if the line were to need replacement or repair. Leaving the pipeline above ground and next to the road with asphalt on it makes the most sense in my opinion.

Thanks for your time and consideration.

Sincerely yours,

Sincerely,

milo haugen

2011-07-01 Heinert R. pdf

Ralph Heinert
PO Box 577
Libby, MT 59923

July 1, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Montana DEQ and Kootenai National Forest:

E7 Thank you for allowing me to comment on the Troy Mine Draft EIS. I have personally visited this mine and viewed the underground operations, the disposal sites and how the tailings pond are being managed. It is apparent to me that all of the past and current studies of the impoundment clearly indicate that it will not have a significant impact on ground or surface waters. The attenuation study that was completed while the mine was closed and with the additional studies conducted recently support my conclusion. The rock characterization studies all show little to no potential for ARD or metal releases. As your own scientific data indicates, these deposits are some of the most environmentally benign metal systems in the world.

After thirty years of this impoundment being in place with no significant impacts to water, it is clear that the agency has solid, reliable data documenting the absense of any adverse impacts and substantial evidence to support a decision to re-permit the mine and its proposed reclamation plans.

B1 It also makes common sense to dispose of the the materials on site after the mine has completed its lifespan and to disturb the site as little as possible during reclamation where the scars of activity have already healed themselves through time, revegitation, etc.

G3 As to the social/economic impact, this operation is very important to the well-being of Lincoln and Sanders counties. There are 185 or more men and women working at this operation with nearly 40 million dollars per year in real dollars being distributed into Montana's economy through vendors, payroll, and taxes.

It is easy to see how important this operation is to the well-being of the two counties and communities in the area where they currently represent some of the highest unemployment numbers in the state. The loss of these mining jobs and subsequent revenue would without question increase an already very bad employment situation.

Considering that there will be no significant impacts to the environment by approving this mine's reclamation plans, and operations, I would emplore you approve the plans without any further delay.

Sincerely,

Sincerely,

Ralph Heinert

2011-07-01 McGlassonJ.pdf

James McGlasson
324 White Ave
Libby, MT 59923
4062932552

July 1, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

As a member of the Libby community, I am very concerned with the welfare of the people in our area. This welfare has been negatively impacted by distant decision makers with no understanding of the impact of their decisions or the science of forest maintenance. Are the forests to be used or ignored to the harm of the community and to the forest itself?

Responsible uses of the forests reduce the fire danger, provide employment for the community, and reduce our trade imbalance while maintaining the quality of the environment for the native animals of the forest.

Wolves and grizzly bears were not eliminated from the environment because of roads or lumber harvest. They were purposely eliminated because of their perceived danger to life and livestock. There will be a price to coexist with them but the price currently imposed is unnecessary and out of reason.

A current and very important issue is the impediments placed on the completion of the EIS for the Troy and Montanore mines. I appeal to you as a decision maker on these issues to responsibly remove the irresponsible arguments holding up the approval for these projects.

Sincerely,

James McGlasson

2011-07-01 McGlassonL.pdf

FS R1
RECEIVED
JUN 5 - 2011
REGIONAL FORESTER

7/1/2011

Dear Leslie,

As a significant decision maker in affairs affecting our community, I ask for your consideration and action regarding my concerns.
I am a "Libbyite," from Libby MT, a community being ordained to die by decisions and indecisions of various corporate, environmentalist and numerous inter-government agencies.

Libby is surrounded by God-given riches designed for the well being of our community and nation - forests of timber as far as the eye can see & beyond,
mountains filled with precious metals, lakes and streams for fishing & hunting, an intelligent workforce proven capable of harvesting these resources using sound stewardship.
Yet we sit here with no work because we are not allowed to touch it, 75% of the land owned and controlled by the government, and telling us what we can or can't do with our own property.

After persevering for many years, and expending all resources, many businesses have had to shut down, or move elsewhere. The rest of us are feeling strangled with all options being forbidden. We can't even have a splash pad for children in our city park (using water fit for drinking) without cost prohibitive legalities. The "powers that be" do not acknowledge our situation in these terms, but it is the reality.

The Montanore Mine project has spent more money on satisfying the environmental concerns for the grizzly bear than our new hospital would cost. Animals are considered more important than people. It is also disturbing that because environmentalists will not accept smelting operations in this country, all mining products must be shipped overseas - as tho that solves anything but ensuring our demise thru higher costs, and the prosperity of our competition in other nations.

Both the Montanore and Troy mines are repeatedly being required to satisfy additional requirements, a continually rising bar, that stops progression indefinitely, while our taxes pay for their obstructionism and dysfunction.

Many of these requirements are seen by local experts as made by "book learner authorities" with no practical_hands-on experience or thinking whatsoever. I'm sure you have access to these requirements and no need for me to repeat them here.

I am asking and praying for you to be a voice for common sense in decisions that will allow these mines to start producing, and save not only our community but our country. Our country desperately needs your sensible intervening leadership in these matters, as well as other areas of influence.

Sincerely,

Laura E McGlasson

Laura E McGlasson
324 White Ave
Libby MT 59923
406-293-2552
lmcg@frontier.com

2011-07-01 NichollsJ.pdf

joe nicholls
617 waterloo rd
whitehall, MT 59759
(406)498-3773

July 1, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Corsi and Ms. Lacklen:

Thank you for the opportunity to comment on the proposed revisions to the Troy reclamation plans. I would like to give my support for the preferred alternative as selected by the agencies, but would like to see some modifications to it.

I1 I don't understand why you would be taking the asphalt off of the road and returning the road surface to dirt. Wouldn't this create more BMP work to ensure that TMDLs are as low as possible? The current road needs some repair, but the costs of those repairs would be virtually insignificant compared to the long term work and maintenance you would be avoiding by doing so. I would imagine as this is a Forest Service road that it will also have
I2 a gate on it not far from the tailings impoundment, which would allow the asphalt to have a very good life span for continued access for monitoring of the pipelines carrying water from the adit.

E2 This brings me to my next issue with the preferred alternative. I don't understand why you want to require the Company to bury the pipeline underground when it could be monitored and accessed easily if it was left above ground and next to the road. Putting strict monitoring requirements on the existing line until it truly needs replaced and making them bond to replace it with an above ground line seems like the most common sense approach that will have the least impact to the watershed long term.

Please consider my suggestions before making your final decision.

Sincerely,

Sincerely,

joe nicholls

2011-07-01 Oman T. pdf

Timothy Oman
8615 Pheasant Drive
Missoula, MT 59808
406-543-5877

July 1, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

Thank you for accepting my comments on the revised reclamation plans for the Troy mine. In the thirty years this impoundment has been in place, there has been a great amount of solid reliable data to support your preferred alternative, and I would like to say thank you for your acknowledging it.

K1 I would also like to comment on the reclamation using the topsoil that is currently providing habitat for the western toad. Many people have also acknowledged that careful soil management and wildlife can coexist and that this is something that should be applauded, not destroyed.

H1 H2 From what I understand, it isn't going to cost any more to use the borrow or the topsoil that has been set aside, but it may take a bit longer for the borrow to produce the same reclamation goals if used. I would submit to you that saving habitat that is currently being created and allowing a little longer to create more is a win, win.

I believe that whenever we can showcase an active mining operation creating habitat to any species that is struggling we should. If it isn't going to cost any more either way, and our goal is to reclaim the ground to provide erosion controls and wildlife habitat, we should use the borrow material instead.

I have lived in Montana all but 5 years of my life and I am 56 years old this year. I have seen a lot of good jobs leave this state not to mention that when this happens the state loses a lot of revenue, and good people. How do we stop this? We need to let projects like this one and others continue because they intend to follow the rules. Let us open up the resources of this state responsibly so we can all continue to live well here and not just subsist. It is not popular opinion that should dictate to us what we do, especially when it is from out of state people, but is up to us Montanans to do so. In closing, I say belp the people of Montana stay here.

Thank you, Respectfully Tim Oman

2011-07-01 Schwab S. pdf

Steve SCHWAB
PO BOX 73
WHITHEHALL, MT 59759
406.287.3465

July 1, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Hello:

Thank you for allowing me to comment on the proposed revisions to the Troy reclamation plans. I believe that the DEQ's proposed alternative is the best action to take, though I think there needs to be some minor tweaks made before the final action is taken.

E7 The Troy Mine has a long record of water monitoring and the agency seems to also recognize this by not requiring post closure mechanical water treatment, which I fully support. I also understand that the agency wants the reclamation plan to mitigate as many impacts as they can upon decommissioning of the mine, but there seems to be some contradictions in the proposed action plan.

K1 H2 If we truly want to create wildlife habitat and soil stability at the same time, why are we removing the topsoil berm that is already providing awesome habitat for the western toad? I understand that your analysis showed that it may take a bit longer to achieve your desired ends, but how much longer? The trees and shrubs that are currently surrounding the site are growing just fine in the same soil that would be used instead of the topsoil. I understand that you would want to use the topsoil under other circumstances, but because the Western toad uses the berm I believe there should be a variance made to allow for the borrow to be used instead of the previously stripped topsoil to protect the toad's habitat.

E1 E2 Another glaring contradiction is with burying the pipeline that will need to be monitored for decades according to the EIS. If the existing pipeline that has been there for thirty years needs to be removed after another ten years of use, then are you anticipating removing the pipeline every 40 years or so by digging it back up and burying it again? It makes much more sense to require the Company to replace the pipeline if and when necessary, but leave it above ground next to the road for ease of monitoring and accessing the line for any necessary repair or replacement.

Thank you for considering my comments.

Respectfully,

Sincerely,

Steve SCHWAB

2011-07-01 weightmanh.pdf

Kerry Weightman
49 capp lane
Whitehall, MT 59759
560-6455

July 1, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

I would like to provide some comments regarding the Troy reclamation revision that is open for public comment.

E7 It seems that the agency has done a very thorough examination of all the data that has been collected over the last 30 years and has made an accurate assessment of the water being discharged. From what I have seen, there is simply going to be clean water flowing out of the adit down to the impoundment, and requiring a water treatment facility will not be required.

E1 One thing that really makes me scratch my head though has to do with the pipeline analysis. Is the existing pipeline in a condition that requires replacement immediately upon the mine being decommissioned? I would suggest leaving the existing pipeline infrastructure in place until it needs replacement, and I can't see the logic in burying it when it does get replaced. Wouldn't it be easier to detect leaks and work on it if it was above ground? Aren't we going to be disturbing much more ground by doing it this way? This just doesn't make a whole lot of sense to me.
Let's keep some common sense in this process.
Thank you for accepting my comments. I eagerly await your response!

Sincerely,Kerry Weightman

Sincerely,

Kerry Weightman

2011-07-02 BennettD.pdf

Donald Bennett
904 E. Missoula Ave.
Troy, MT 59935

July 2, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

Thank you for accepting my comments on the revised reclamation plans for the Troy mine. In the thirty years this impoundment has been in place, there has been a great amount of solid reliable data to support your preferred alternative, and I would like to say thank you for your acknowledging it.

K1 I would also like to comment on the reclamation using the topsoil that is currently providing habitat for the western toad. Many people have also acknowledged that careful soil management and wildlife can coexist and that this is something that should be applauded, not destroyed.

H1 H2 From what I understand, it isn't going to cost any more to use the borrow or the topsoil that has been set aside, but it may take a bit longer for the borrow to produce the same reclamation goals if used. I would submit to you that saving habitat that is currently being created and allowing a little longer to create more is a win, win.

I believe that whenever we can showcase an active mining operation creating habitat to any species that is struggling we should. If it isn't going to cost any more either way, and our goal is to reclaim the ground to provide erosion controls and wildlife habitat, we should use the borrow material instead.

Thank you for your consideration of my comments.

Respectfully,

Sincerely,

Donald Bennett

2011-07-02 GuthrieG.pdf

Garman Guthrie
797 Northwood Avenue
Libby, MT 59923
406 293 3877

July 2, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Montana DEQ and Kootenai National Forest:

It is beyond understanding how the environtmalists can come up with their idiotic nonsense with no thought or compassion for the 195 or so family jobs involved. I'm sure a lot of this nonsense comes from people out of the large eastern cities who have never had to struggle to support their families as a lot of us Montanians have.

Let's knock off this nonsense and let the workers keep making an honest living to support their families and help struggling Lincoln County get back on its feet.

E7 Thank you for allowing me to comment on the Troy Mine Draft EIS. I believe that all of the past and current studies of the impoundment clearly indicate that it will not have a significant impact on ground or surface waters. The attenuation study that was done while the mine was closed and additional studies conducted recently support my conclusion. The rock characterization studies all show little to no potential for ARD or metal releases. These deposits are some of the most environmentally benign metal systems in the world.

After thirty years of this impoundment being in place with no significant impacts to water, it is clear that the decision of the agency will have solid, reliable data documenting the lack of impacts and substantial evidence to support its decision to permit the mine and its proposed reclamation plans.

G3 This operation is very important to the socio-economic wellbeing of Lincoln and Sanders counties. There are over 185 men and women working at this operation and over three million dollars a month of real wealth being distributed into Montana's economy through vendors, payroll, and taxes.

G1 The importance of this operation in two counties that represent the highest unemployment numbers in the state is without question. There will be no significant impacts to the environment by approving this mine's reclamation plans.

Respectfully,

Garman V. Guthrie

Sincerely,

Garman Guthrie

2011-07-02 Habeck D. pdf

E. Dianne Habeck
72 Ave. C
Libby, MT 59923
406--293-2246

July 2, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Montana DEQ and Kootenai National Forest:

Thank you for accepting my comments to the proposed revisions to the Troy Revised Reclamation Plan preferred alternative. I have just a couple of suggestions for you before you make your final determination.

I1 I would like to see the asphalt remain on the main road leading to the mine site. Removing it and returning it to dirt will just create more BMP work trying to mitigate for TMDL's in the watershed. You might require the asphalt to be repaired in places that it needs to be, but I believe it would be a short term investment that will pay long term dividends for the watershed.

H1 I also believe that using the readily available materials that is suitable for growth medium located on the mine to reclaim the tailing impoundment would be the better option. The topsoil that has been saved for that purpose has become great habitat for the western toad, and I believe that using the other material instead will grow the trees and shrubs necessary to ensure proper reclamation.

B1 I also think that breaking up the foundations and burying the concrete onsite would be just fine rather than digging them up, breaking them up and burying them somewhere else. It's just concrete and won't impact water quality any more than the rip rap along the Bull Trout stream at the bottom of the mountain.

E1 Requiring the company to bury the pipeline when it could just be replaced with another above ground line doesn't make sense either. It seems that if you are serious about water quality and TMDL impacts, you wouldn't want to be disturbing an entire hillside to bury the line not to mention disturbing the ground and the advanced reclamation down the road if the line were to need replacement or repair. Leaving the pipeline above ground and next to the road with asphalt on it makes the most sense in my opinion.

Thanks for your time and consideration.

Please take into consideration the importance of this mine in our community as you plan its future. We need jobs, not unnecessary regulations that would cost the mining company millions of dollars that could go to workers to feed their families.

Sincerely yours,

Sincerely,

E. Dianne Habeck

2011-07-02 James C. pdf

Connor James James
421 Dome Mountain Ave.
Libby, MT 93950
831 402 7122

July 3, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

I believe this would be a great idea, it would bring jobs and substantially help the economy in this area, please do the right thing and help families who are in need of jobs and support your local neighbor. Thank you for taking the time to read these many comments

I would like to provide some comments regarding the Troy reclamation revision that is open for public comment.

E7 It seems that the agency has done a very thorough examination of all the data that has been collected over the last 30 years and has made an accurate assessment of the water being discharged. From what I have seen, there is simply going to be clean water flowing out of the adit down to the impoundment, and requiring a water treatment facility will not be required.

E1 One thing that really makes me scratch my head though has to do with the pipeline analysis. Is the existing pipeline in a condition that requires replacement immediately upon the mine being decommissioned? I would suggest leaving the existing pipeline infrastructure in place until it needs replacement, and I can't see the logic in burying it when it does get replaced. Wouldn't it be easier to detect leaks and work on it if it was above ground? Aren't we going to be disturbing much more ground by doing it this way? This just doesn't make a whole lot of sense to me.

Thank you for accepting my comments. I eagerly await your response!

Sincerely,

Sincerely,

Connor James James

2011-07-02 McMenamin J.pdf

John McMenamin
32 Halo Ct.
Troy, MT 59935
406 295 9079

July 2, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

Thank you for accepting my comments on the revised reclamation plans for the Troy mine. In the thirty years this impoundment has been in place, there has been a great amount of solid reliable data to support your preferred alternative, and I would like to say thank you for your acknowledging it.

K1 I would also like to comment on the reclamation using the topsoil that is currently providing habitat for the western toad. Many people have also acknowledged that careful soil management and wildlife can coexist and that this is something that should be applauded, not destroyed.

H1 H2 From what I understand, it isn't going to cost any more to use the borrow or the topsoil that has been set aside, but it may take a bit longer for the borrow to produce the same reclamation goals if used. I would submit to you that saving habitat that is currently being created and allowing a little longer to create more is a win, win.

I believe that whenever we can showcase an active mining operation creating habitat to any species that is struggling we should. If it isn't going to cost any more either way, and our goal is to reclaim the ground to provide erosion controls and wildlife habitat, we should use the borrow material instead.

Thank you for your consideration of my comments.

Respectfully,
John McMenamin

Sincerely,

John McMenamin

2011-07-02 RileyC.pdf

Chuck Riley
P O Box 522
Libby, MT 59923

July 2, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

I would like to comment on the Troy Mine Revised Reclamation Plan Draft EIS.

G3 The Troy Mine has emerged as a shining light in the tough economic picture of northwestern Montana. The mine made it through the dark days of the recession with pay cuts from top to bottom but not one single employee was laid off. The mine, now with ownership that includes the employees themselves through stock options, now underscores the hopeful economic potential of mining for an area that, for a decade, has led the state with catastrophically high unemployment.

Numbers tell the story. Troy Mine now represents over 190 jobs, over $14 million in payroll, over $10 million in goods and services purchased in Montana, over $1.4 million in metal mines taxes for our schools, and over $1.25 in other state and local taxes.

If an incredibly conservative rollover factor of 2 is used to generate an idea of total local impact in this isolated and depressed area, the Troy Mine serves to economically support an additional 380 local jobs in other main street businesses and local government. This is a huge impact on the area.

E7 Thankfully, this economic impact comes with little impact to the environment. In fact, the EIS recognizes this fact when it repeats the conclusions of 30 years of evaluation of water quality that have shown no impacts to the water quality in the mine's area streams. If society wants to have 'green' metals production, Troy Mine is a good source for providing that need.

E1 I generally support the conclusions of the preferred alternative. I have some questions about the reclamation requests in the document â€“ specifically as it concerns the water delivery pipeline. It is currently above ground for the vast majority of its route. It has been in use for nearly 30 years and seems to be functioning as needed and desired. Once the mine is no longer operating, this pipe will just carry water. Therefore, I think it is not

E1 in the best interest of the environment to disturb ground for the many miles that would be need to remove the above ground line and install a new line underground the entire way. This just seems to reflect a desire to remove the visual of the pipe â€“ as if it is a negative thing to share with the public of the future.

E2 I, for one, like to see evidence of the ingenuity of man and think that personal opinion about visual qualities should not trump the need to be environmentally sound. Repair and replacement work in the future would be way less disturbing if the pipe was above ground and easy to access. The agency claims that the above ground pipeline would provide a target for vandalism does not square with the local experience of 30 years of that same pipeline's existence without one incident.

Thank you for considering my comment.

Sincerely,

Sincerely,

Chuck Riley

2011-07-02 Snyder C.pdf

colleen Snyder
PO Box 248
Libby, MT 59923
406-293-7422

July 2, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi:

Please consider my comment on the Troy Mine Revised Reclamation Plan Draft EIS.

G3

The northwestern area of Montana has been in a deep recession for a decade longer than the rest of our nation. Much of this is because of the systematic dismantling of the forestry management system of the United States Forest Service. The resultant collapse of the local economies of the area has been catastrophic. Over 3500 industrial, family wage jobs have been lost in the logging and milling businesses of Lincoln and Sanders Counties. The social ills such as alcoholism, drug addictions, family destructive behaviors, suicides, domestic abuse that follow these types of economic losses are well documented and were tragically predicted.

For the last several years, there has been a growing hope that mineral activity could replace some of the lost jobs and help to lower the unemployment rates of 20% that is found in these two counties. That hope will not be met with reality unless mines like the Troy Mine can stay in business. The economic benefit of nearly 200 jobs that average over $55,000 per year - not counting the benefits packages that includes health insurance, retirement plans and stock options â€" cannot be overstated. The impact the Troy Mine has with $14 million in payroll, $10 million in local purchases of goods and services, $250,000 in property taxes, $1 million in gross proceeds taxes, $1.4 million in metal mines taxes cannot be overstated.

With this economic need as a backdrop to the discussion of the future of the mine, I would like to offer my support for the agency's preferred alternative â€" with some suggestions for necessary changes.

H2

First, I do not think it is in the best interest of the environment to remove the topsoil from the toe of the impoundment area. Although it is true that this soil was once topsoil on the site, it has now been in place of over 30 years and it seems unnecessary and possibly even foolish to disturb the area so close to the water courses that have successfully protected

H2 during mine operation. Surely, in order to grow the trees and other vegetation that is native to the area, the soil from area borrow pits can be utilized with success and without the potential impacts associated with gross disturbance of areas near streams that have already healed up.

Thank you for accepting and considering my comment.

Sincerely,

Sincerely,

colleen Snyder

2011-07-02 Snyder D. pdf

Dan Snyder
PO box 248
Libby, MT 59923
406-293-7422

July 2, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

Please accept my comments for the Troy Mine revised reclamation plans that have been submitted to your agency. After reading most of the DEIS, I wanted to applaud the agency and the diligent work that it has done in coming up with its preferred alternative.

E1 I would like to comment on two things that I believe may need changed before the final decision to move forward with your preferred approach is made. One is the pipeline that you are requiring to be buried. I'm no hydrologist, but it just seems silly to be burying a pipeline that may need dug up and replaced later if in fact you are accurate that the water needs to go through the infiltration process at the impoundment. Why tear up the entire hillside when you could just put it above ground next to the road as it is now for easy access in case there is a problem decades down the road?

H1 K1 Another is with regards to the toe ponds that have all the topsoil that is being recommended to cover the impoundment for reclamation. There has been a lot of praise to the company because of the habitat that has been created for the western toad. It would seem like a no brainer that they use the course borrow to reclaim it even if it takes a bit longer to achieve the standards required. How long will it take to replace the habitat for the western toad?

Thanks for your consideration,

Sincerely,

Dan Snyder

2011-07-02 Spell J. pdf

JoAnn Spell
904 E. Missoula
Troy, MT 59935

July 2, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Kootenai National Forest and Montana DEQ:

Please accept my comments for the proposed reclamation revision at the Troy mine. I am fully supportive of the Troy mine and the success that it has had with controlling and mitigating environmental impacts while it has been in operation.

With all of the studies that have been done on the rock and all of the monitoring that has proven no impacts should make this an easy decision. Reading through some of the proposed mitigation measures that have been suggested, it obvious that there has been a very in depth analysis of the revision. It also looks like there is a bit of overkill with some of the suggestions.

I1 E1 You want to take the asphalt out and take it down to dirt again? You feel that you need to dig up the entire existing pipeline and replace it with another line that must be buried? The existing pipelines are sufficient to transport the very clean water from the adit down to the impoundment. Why not disturb less ground and ensure further safety precautions on the existing line that has plenty of capacity to get the job done? Isn't our goal to have the least amount of disturbance necessary?

A5 The men and women at the Troy Mine operate a very safe, very productive, environmentally benign operation. We all want proper reclamation plans approved by the regulators and we certainly want proper bond requirements. That said, there are some things that simply aren't necessary, may not benefit the environment and don't make sense. I approve of the preferred alternative as put forth by the agencies but would like to see some modifications made to in the Record of Decision that reflect proper but not excessive reclamation plans.

Please keep these considerations in mind when making your final decisions on the mitigation measures and the final reclamation plan.

Respectfully yours,

Sincerely,

JoAnn Spell

2011-07-02 SpellR.pdf

Ronald Spell
904 E. Missoula Ave.
Troy, MT 59935

July 2, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

I would like to provide some comments regarding the Troy reclamation revision that is open for public comment.

E7 It seems that the agency has done a very thorough examination of all the data that has been collected over the last 30 years and has made an accurate assessment of the water being discharged. From what I have seen, there is simply going to be clean water flowing out of the adit down to the impoundment, and requiring a water treatment facility will not be required.

E1 One thing that really makes me scratch my head though has to do with the pipeline analysis. Is the existing pipeline in a condition that requires replacement immediately upon the mine being decommissioned? I would suggest leaving the existing pipeline infrastructure in place until it needs replacement, and I can't see the logic in burying it when it does get replaced. Wouldn't it be easier to detect leaks and work on it if it was above ground? Aren't we going to be disturbing much more ground by doing it this way? This just doesn't make a whole lot of sense to me.

Thank you for accepting my comments. I eagerly await your response!

Sincerely,

Sincerely,

Ronald Spell

2011-07-02 TallmadgeN.pdf

Nancee Tallmadge
PO Box 1073
Troy, MT 59935
4062959969

July 2, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Kootenai National Forest and Montana DEQ:

Thank you for accepting the following comments on the revised reclamation plan for the Troy mine. I would like to focus my comments on the DEIS to the pipeline and impoundment mitigation recommendations. In general, I support the reclamation plan but there are areas that don't make a great deal of sense to me and that I find contradictory or unnecessary.

E1 Why would you want to dig up and disturb more ground if you were going to decommission the existing water pipeline and replace it with a new one for adit discharges? Aren't we trying to minimize TMDL impacts in the watershed? Why not just make safety precautions or improvements to the existing pipeline that has more than adequate capacity and seems to be working just fine?

If you did require replacement, why would you want it buried when it would be much more difficult to monitor in the future? Why would you want to disturb ground to bury it originally and perhaps again to repair or replace the line when it is completely unnecessary?

K1 H3 Wouldn't using the toe pond stockpiled top soils for reclamation impact the western toad that currently has great habitat there now? Why not just use the coarse borrow material east of the impoundment instead? The DIES indicates that this could be just as successful in achieving reclamation goals and criteria. Are the wood based organic amendments that add 1,100 lbs of nitrogen per acre for the mill and impoundment really necessary? What is mycorrhizal fungi and why is it needed for reclamation at the mill? Why are the agencies requiring organic versus chemical fertilizer for reclamation in general?

Thank you for listening and I look forward to seeing the final reclamation plan include some further modifications to address some of the areas I have outlined above.

Respectfully,

Sincerely,

Nancee Tallmadge

2011-07-03 Hesse C. pdf

Chris A. Hesse, P.Eng.
2701 Lake Hollywood Dr.
Los Angeles, CA 90068
323 463-8851

July 3, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Montana DEQ:

Please accept a general comment to the Troy Mine DEIS, which I have not had the opportunity to study in detail.

Some years ago, I was involved in U.S. Borax's near-by copper-silver prospect which is now being developed by Mines Management Inc. I therefore have some knowledge of the area.

I would recommend that MDEQ continue to make all reasonable efforts to allow the mineral deposits of the region to be developed and operated in an environmentally responsible manner, without unnecessary cost-increasing restrictions. The region needs the opportunity for economic growth and employment.

Thank you for for allowing me to comment on this matter.

Sincerely yours,

Sincerely,

Chris A. Hesse, P.Eng.

2011-07-04 BrulandB.pdf

Barry Bruland
2171 Bull Lake Road
Troy, MT 59935
406-291-3684

July 4, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Corsi and Ms. Lacklen:

G3 The Troy Mine employs 195 men and women, but there are also a large number of people that are employed because of the Mine. I do not understand why you people are always
A5 changing the rules. The mine has posted bond moneys accepted by you people in the past. Why do you need more money? Question what happens to the interest on this money.
B1 E1 I1 Also in my opinion it is stupid to destroy the buildings, roads, and pipelines. The forest service is so smart, can't they find another use for this site?
It appears to me that you people do not care about the people of Troy, all you care about is making it harder on the Troy Mine to stay open and make a future for there employee.

Sincerely,

Barry Bruland

2011-07-04 Guisewiter.pdf

Renee Guisewite
P.O. Box 246
Troy, MT 59935
406-295-9948

July 4, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

I would like to comment on the Troy Mine Revised Reclamation Plan Draft EIS.

G3 The Troy Mine has emerged as a shining light in the tough economic picture of northwestern Montana. The mine made it through the dark days of the recession with pay cuts from top to bottom but not one single employee was laid off. The mine, now with ownership that includes the employees themselves through stock options, now underscores the hopeful economic potential of mining for an area that, for a decade, has led the state with catastrophically high unemployment.

Numbers tell the story. Troy Mine now represents over 190 jobs, over $14 million in payroll, over $10 million in goods and services purchased in Montana, over $1.4 million in metal mines taxes for our schools, and over $1.25 in other state and local taxes.

If an incredibly conservative rollover factor of 2 is used to generate an idea of total local impact in this isolated and depressed area, the Troy Mine serves to economically support an additional 380 local jobs in other main street businesses and local government. This is a huge impact on the area.

E7 Thankfully, this economic impact comes with little impact to the environment. In fact, the EIS recognizes this fact when it repeats the conclusions of 30 years of evaluation of water quality that have shown no impacts to the water quality in the mine's area streams. If society wants to have 'green' metals production, Troy Mine is a good source for providing that need.

E1 I generally support the conclusions of the preferred alternative. I have some questions about the reclamation requests in the document â€" specifically as it concerns the water delivery pipeline. It is currently above ground for the vast majority of its route. It has been in use for nearly 30 years and seems to be functioning as needed and desired. Once the mine is no longer operating, this pipe will just carry water. Therefore, I think it is not

E1 in the best interest of the environment to disturb ground for the many miles that would be need to remove the above ground line and install a new line underground the entire way. This just seems to reflect a desire to remove the visual of the pipe â€“ as if it is a negative thing to share with the public of the future.

E2 I, for one, like to see evidence of the ingenuity of man and think that personal opinion about visual qualities should not trump the need to be environmentally sound. Repair and replacement work in the future would be way less disturbing if the pipe was above ground and easy to access. The agency claims that the above ground pipeline would provide a target for vandalism does not square with the local experience of 30 years of that same pipeline's existence without one incident.

In addition, no one could have vocalized my thoughts better than Bruce Vincent. DITTO TO EVERYTHING HE SAID.

Sincerely,

Renee Guisewite

Sincerely,

Renee Guisewite

2011-07-04 MaynardRandJ.pdf

Rusty and Joan Maynard
P.O. Box 371
Troy, MT 59935
295-6506

July 4, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

I would like to comment on the Troy Mine Revised Reclamation Plan Draft EIS.

I am a retired school teacher/pastor living in Troy for 12 years with ties/history/family going back to the 1930's. My wife was raised here in Troy and the Bull Lake area, so we care greatly about the environment and the availability of jobs. We agree with the following letter.

G3 The Troy Mine has emerged as a shining light in the tough economic picture of northwestern Montana. The mine made it through the dark days of the recession with pay cuts from top to bottom but not one single employee was laid off. The mine, now with ownership that includes the employees themselves through stock options, now underscores the hopeful economic potential of mining for an area that, for a decade, has led the state with catastrophically high unemployment.

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Thank you for considering my comment.

Sincerely,

Rusty and Joan Maynard

Sincerely,

Rusty and Joan Maynard

2011-07-04 Rice S. pdf

Sharon Rice
202 Honeysuckle Lane
Libby, MT 59923
406 293-5867

July 4, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

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Thank you for considering my comment.

Sincerely,
Sharon Rice; I am an old lady that has had a bad stroke. I don't know a lot about this, but I have learned that if there is a problem, some do-gooder will report it. In the meantime, our people need the jobs. I really believe that Lincoln County problems should be handled by those who live here.

Sincerely,

Sharon Rice

2011-07-05 Anderson T. pdf

From: Tammy Anderson
To: DEQ Troy Mine
Subject: Troy Mine
Date: Tuesday, July 05, 2011 7:54:36 AM
Attachments: SENDER_EMAILctander@kvis@@net.png

E7

It seems that the agency has done a very thorough examination of all the data that has been collected over the last 30 years and has made an accurate assessment of the water being discharged. From what I have seen, there is simply going to be clean water flowing out of the adit down to the impoundment, and requiring a water treatment facility will not be required.

I also think we need to realize that 'Revett' is a smaller mining company compared to many others that can afford the big bucks ransom this DEIS demands. They mine silver here not gold!

B1

I also find it interesting how the DEQ thought it would be just great to put asbestos contaminated soil at the Troy landfill for a price to city of Troy, yet an inert matter such as remainder of cement buildings etc... Can't be buried on the current mine site. I recall that DEQ's offer of planting and such after the asbestos contaminated soil at the Troy landfill did not include even a tiny fraction of the ridiculous amount of material is being demanded of the Troy mine to replant. I find the double standard ridiculous.

G3
A5

While I understand the effort to prepare this DEIS, I wonder why so little effort is given to a how this impacts a community (or 3) Genesis mine employs 190 people, double that number if you consider a spouse and double it again if we estimate a 2 dependants for each. Now we're closer to 800 people that those 190 paychecks affect. Then we also need to think of the small business owners in these communities that see the trickle down of these paychecks, and we also need to consider the taxes that go into these communities, the metal mines taxes to the school.

As a small business owner I feel the effects of these paychecks to my business and it is my hope that The Troy Mine not throw their hands up in exasperation because of the the very expensive demands of this DEIS and decide that the ore body they would like to go after is simply not worth it.

Thank You for considering my comments.

Sincerely,
Tammy Anderson.

2011-07-05 CarsonM.pdf

MONTY CARSON
691 N 400 W
SALT LAKE CITY, UT 84103
801-363-6736

July 5, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

G3 The Troy Mine Reclamation plans needs to be approved and permitted for several reasons. The operation is a huge asset to northwest Montana and provides over 190 good paying family wage jobs in an area that has the highest unemployment in the state.

For over thirty years the mine has been depositing its tailings in the impoundment and there has not been any significant impact to the areas streams or wildlife.

E7 K2 Several studies have been done that confirm this and I believe that allowing them to amend their reclamation plan to continue operating is a no brainer. It seems that both the USFS and the DEQ has done a thorough job of analyzing the revised reclamation plans, though there seems to be some recommendations that would actually create more disturbance than should be necessary.

E1 E2 Removing the water pipeline that is buried below the surface (if it is decided that it needs to be replaced) seems impractical as it wouldn't hurt anything to just leave it and remove the pipeline that is above ground. Completely burying a new pipeline (which I'm not convinced is even needed) seems to contradict the desire of all parties to ensure that the lines can be monitored and that there is ability to quickly detect any leakage or break in the line and just as quickly get necessary repairs made while disturbing the least ground or water resources as possible.

That being said, I'm confident the agency will listen to those that have more experience than I in this area and arrive at common sense mitigations while approving this reclamation permit. But I would like to go on record as supporting the preferred alternative with some modifications to the requirements for the pipeline.

Thank you for your time,

Sincerely,

MONTY CARSON

2011-07-05 Dolezal L. pdf

Lawrence Dolezal
800 Kilbrennan Lake Road
Troy, MT 59935
406-295-9865

July 6, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

Please accept my comments for the Troy Mine revised reclamation plans that have been submitted to your agency. After reading most of the DEIS, I wanted to applaud the agency and the diligent work that it has done in coming up with its preferred alternative.

E7 In the thirty years this mine and tailings impoundment have been in place significant, solid, reliable data has accumulated to support your preferred alternative. Thank you for acknowledging the supporting data for the preferred alternative that appears to me to be the most logical option before you.

E1 There are a number of key points that stand out to me, and I expect you've heard comments regarding them from many others. I do not understand why an existing pipeline is proposed to be torn out in place of new construction of miles of underground pipeline. The current pipeline has served well. Significant unnecessary ground disturbance may be avoided by retaining the existing pipeline.

B1 I do not understand the reasoning behind the suggestion that it is necessary to haul non-hazardous construction materials off site to be buried rather than burying these inert materials, such as concrete, on site within the mine. It is also illogical to add unnecessary
I1 steps to suggest removing asphalt and disturbing grown-in, healed road surfaces while decommissioning the mine.

K1 I would also like to comment on the reclamation using the topsoil that is currently providing habitat for the western toad. Many people have also acknowledged that careful soil management and wildlife can coexist and that this is something that should be applauded, not destroyed.

H1
H2 From what I understand, it will not cost much more to utilize borrow versus the topsoil that has been set aside, but it may take longer for the borrow to produce the same reclamation goals, if used. It seems that saving habitat that is currently being created and allowing a

K1 little longer to create more is a win-win for all. Why disturb already healed and re-vegetated earth from the toe of the tailings impoundment pond and create more disturbed area when it is unnecessary?

H1 H2 I believe that whenever we can showcase an active mining operation creating habitat to any species that is struggling we should. If it isn't going to cost any more either way, and our goal is to reclaim the ground to provide erosion controls and wildlife habitat, we should use the borrow material instead.

Thank you for your consideration of my comments.

Respectfully,

Sincerely,

Lawrence Dolezal

2011-07-05 Erickson O. pdf

Bobbie Lacklen
Project Coordinator
Kootenai National Forest
31374 US 2
Libby, MT 59923-3022

RECEIVED
JUL 05 2011
DEQ
DIRECTOR'S OFFICE

Ms. Lacklen,

I would like to comment on the Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement (DEIS).

I am a third generation miner. As a youth, I saw raw tailings material and its impact on the South Fork of the Coeur d'Alene River running through my home town in North Idaho. Those days are long gone. The upper South Fork of the CDA River is now clear and clean and mining continues in the Silver Valley. I came to the Kootenai in 1979 and helped start the ASARCO Troy Project. I worked there until the end and beyond. I returned in 2011 as a safety and health consultant. I have seen the worst and in Troy Mine's case the best of what underground mining can be as evidenced by the mine's minimal impact to the environment. I applaud the KNF and the DEQ for recognizing this fact throughout the DEIS, and I believe it has firm conclusive monitoring data to justify its decision.

It stands to reason that any time the earth is disturbed there is a possibility of watershed and wetland degradation and the habitat disturbance of sensitive species, which in the case of the tailings impoundment issue is the western toad. Minimizing soil disturbance whenever possible will be the most prudent course of action during decommissioning and reclamation of the mine site as I am sure you will agree.

B2 I fail to understand the justification for digging up, breaking up and hauling off the concrete building foundations as per the decommissioning plans. If it is the agencies' belief the foundations will impact water quality, then where in Montana or elsewhere in the Great Northwest is it acceptable for it to be buried. Buried concrete and rebar will have no environmental impact on the Stanley Creek and Lake Creek watershed.

E1 E2 On your recent tour of the mine's South Adit (June 9, 2011), I am sure you focused some attention to the water pipeline along the mine road. The tall grasses along the road hide the pipeline in many locations this time of the year and often snow masks the pipeline during the winter months. The existing pipeline has many, many decades of service left in it. It is reasonable to believe the pipeline monitoring, early visual detection of seeps, leaks or breaks, and the ability to facilitate necessary repairs could be done more efficiently and in much less time in its present location than if it were buried. Again, digging up seven and a half miles of ground creates habitat disturbance and allows the possibility of watershed and wetland degradation when there is no foreseeable need. After 30 years, there is no basis for the assumption the pipeline would be subject to vandalism any more so than a live copper conductor power line running adjacent to every road in Lincoln County.

I1 There is no environmental benefit to returning the mine road to a dirt road as it was prior to 1980. It is reasonable to believe there will be a sediment impact on the Stanley Creek and Lake Creek watershed if the pavement is dug up and returned to a dirt road. In addition, dust from vehicular traffic will be greatly increased.

H1
H2
H3

I realize the topsoil forming the toe ponds was intended to cap the tailings impoundment upon reclamation, but that was before it became a well vegetated wildlife habitat and sensitive species habitat for the western toad and a wetland for migratory water fowl. The borrow material on the east side of the impoundment area has been proven to be an excellent alternative to topsoil for returning the area to a natural forest state with the use of fertilizer alone and without woody debris.

There is no significant environmental benefit in hauling off the foundation material, burying a new pipeline, returning the mine road to dirt or using the top soil and woody debris for reclamation of the tailings impoundment. This is an unwarranted justification for increasing the reclamation bond.

Please keep these considerations in mind when making your final decisions on the mitigation measures and the final reclamation plan.

Respectfully,

Owen R. Erickson

Owen R. Erickson

2011-07-05 Hammerschmidt Ed and L. pdf

7/1/11

Ed & Lorraine

TROY • MONTANA

RECEIVED

JUL 05 2011

DEQ
DIRECTOR'S OFFICE

Emily Corsi

WE RECEIVED THE GREEN
MINERS NEED YOUR HELP
FORM. UNFORTUNATELY WE
DO NOT HAVE A COMPUTER
BUT WE WILL DO SUPPORT
ANY PROJECTS THE TROY MINE
COMES UP WITH - TROY
NEEDS THE MINE!

Ed & Lorraine
Hammerschmidt

Ed A. Hammerschmidt
2478 Bull Lake Rd.
Troy, MT 59935

2011-07-05 Johnson R. pdf

Rich Johnson
127 Bench Road
Whitehall, MT 59759
406 287 3716

July 5, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Kootenai National Forest and Montana DEQ:

Please accept my comments for the proposed reclamation revision at the Troy mine. I am fully supportive of the Troy mine and the success that it has had with controlling and mitigating environmental impacts while it has been in operation.

With all of the studies that have been done on the rock and all of the monitoring that has proven no impacts should make this an easy decision. Reading through some of the proposed mitigation measures that have been suggested, it obvious that there has been a very in depth analysis of the revision. It also looks like there is a bit of overkill with some of the suggestions.

I1 E1 You want to take the asphalt out and take it down to dirt again? You feel that you need to dig up the entire existing pipeline and replace it with another line that must be buried? The existing pipelines are sufficient to transport the very clean water from the adit down to the impoundment. Why not disturb less ground and ensure further safety precautions on the existing line that has plenty of capacity to get the job done? Isn't our goal to have the least amount of disturbance necessary?

A5 The men and women at the Troy Mine operate a very safe, very productive, environmentally benign operation. We all want proper reclamation plans approved by the regulators and we certainly want proper bond requirements. That said, there are some things that simply aren't necessary, may not benefit the environment and don't make sense. I approve of the preferred alternative as put forth by the agencies but would like to see some modifications made to in the Record of Decision that reflect proper but not excessive reclamation plans.

Please keep these considerations in mind when making your final decisions on the mitigation measures and the final reclamation plan.

Respectfully yours,

Sincerely,

Rich Johnson

2011-07-05 JonesT. pdf

Tom Jones
93 Whitetail Way
Troy, MT 59935
406-295-0154

July 6, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Corsi and Ms. Lacklen:

E7 I would like to provide some comments on the revised reclamation plans for the Troy Mine. For the past three decades the water and rock studies have proven that this is one of the most environmentally benign mining operations in the country. The DEQ and the KNF have recognized this fact throughout the document, and I believe it has firm conclusive data to justify its decision.

B2 One thing that I did question while reading the document was the decommissioning plans for the building foundations. As I understand your preferred alternative, you are going to require the concrete foundations to be dug up, broken up, and deposited elsewhere. The justification was that it may create water quality issues if it was just backfilled on site, which seems the most common sense approach. I am failing to understand how digging it up and hauling it down to private property solves the issue of water quality. It might impact water quality up there, but not elsewhere? The logic doesn't work for me.

E1 One other thing that I read that seems illogical is the requirement for the pipeline to be buried. The existing pipeline is in good shape and runs right next to the road for easy access. Why would we bury it and then have to dig it up again if it ever needs replaced or repaired? This doesn't make much sense to me. It seems as though we are actually going to be requiring unneeded disturbance in the future when the goal is to remove or mitigate what impacts we can.

Thank you for your time.

Very truly yours,
Tom Jones

Sincerely,

Tom Jones

2011-07-05 Kneller D. pdf

dan kneller
442 woodland hgts. rd.
libby, MT 59923
2933061

July 5, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

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Adding to that note, it seems to me that the government agencies that are trying to make these new rules are not doing it with the environment in mind. Instead, they are trying to make it impossible to do business in this country. If the new rules are implemented it will set a presidency that all new business would be subject to. This only makes it impossible or unrealistic for any new business to look here to locate. This is my home, and a clean environment is very important to me. I need to work preferably here as well. I believe that this can happen but the government needs to be a little more realistic in the rules they try to impose on any one trying to make a living here.

Thank you for your time.

Very truly yours,
Robert D Kneller

Sincerely,

dan kneller

2011-07-05 ~~Barnes~~ Regh S. pdf

James Regh,Sr
95 Regh Ave
Libby, MT 59923
406-293-6020

July 6, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

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For over thirty years the mine has been depositing its tailings in the impoundment and there has not been any significant impact to the areas streams or wildlife.

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That being said, I'm confident the agency will listen to those that have more experience than I in this area and arrive at common sense mitigations while approving this reclamation permit. But I would like to go on record as supporting the preferred alternative with some modifications to the requirements for the pipeline.

The mine has been a good neighbor for many years and as a contractor who worked on the original construction I know that Asarco and now Genesis are extremely conscious of enviromental concerns. As far as removing the 2 pipelines & replacing with buried pipe I

think the old adage-\\\"if its not broke don't fix it\\\".

Thank you for your time,

Sincerely,

James Regh,Sr

2011-07-05 SmithE.pdf

Edwina Smith
270 Indian Pipe Rd.
Libby, MT 59923
818-728-5429

July 5, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

E1
I1
H3

I oppose the Troy Mine Reclamation plan as inadequate for safeguarding the environment and holding polluters accountable. Specifically, the owners want to use old outdated pipelines instead of replacing them for safety. They don't want to have to remove the roads they cut and restore the land. And they intend to apply chemical fertilizer in replanting instead of the organic type recommended by the EPA. All of this is to save the owners costs while endangering the rest of us and the land.

I understand that people desperately want jobs, but that should not be an excuse for the owners to cut corners. The requirements that the EPA proposes are reasonable and necessary to insure that the land and water of this beautiful area are not poisoned with mine spilloffs and chemicals. People have short memories, it seems. The story of W.R. Grace and the asbestos contamination should give everyone pause to consider what happens when mine owners are not held to stringent regulations, given any leeway and not held stricly accountable for what they do. For once could we learn from history?

I strongly support the EPA impact statement proposals and urge that they be adopted. Please do not let the mine owners exploit the need for jobs to avoid environmentally necessary costs in order to generate extra profits for stockholders.

Thank you for your consideration of these comments.

Sincerely,

Edwina Smith

2011-07-06 Foote A.pdf

Andrew Foote
PO Box 788
Libby, MT 59923
406-291-0498

July 6, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi:

Please consider my comment on the Troy Mine Revised Reclamation Plan Draft EIS.

G3 The mining industry is critical to future jobs in Montana and especially in the NW part. The price of silver has doubled in the past year and will more than likely double if not triple in the next year. The demand is not only increasing from industry such as solar panel manufacturing but also from investment demand as worldwide fiat currencies are becoming more unstable.

The contents of the silver vein in the Troy and Rock Creek area are among the purest in the world as it contains 60% copper and 40% silver. So other minerals that are normally associated with silver mines such as zinc, lead, and tin are not there in the tailings to contaminate the ground.

G3 The northwestern area of Montana has been in a deep recession for a decade longer than the rest of our nation. Much of this is because of the systematic dismantling of the forestry management system of the United States Forest Service. The resultant collapse of the local economies of the area has been catastrophic. Over 3500 industrial, family wage jobs have been lost in the logging and milling businesses of Lincoln and Sanders Counties. The social ills such as alcoholism, drug addictions, family destructive behaviors, suicides, domestic abuse that follow these types of economic losses are well documented and were tragically predicted.

For the last several years, there has been a growing hope that mineral activity could replace some of the lost jobs and help to lower the unemployment rates of 20% that is found in these two counties. That hope will not be met with reality unless mines like the Troy Mine can stay in business. The economic benefit of nearly 200 jobs that average over $55,000 per year - not counting the benefits packages that includes health insurance, retirement plans and stock options â€" cannot be overstated. The impact the Troy Mine has with $14 million in payroll, $10 million in local purchases of goods and services, $250,000 in

property taxes, $1 million in gross proceeds taxes, $1.4 million in metal mines taxes cannot be overstated.

With this economic need as a backdrop to the discussion of the future of the mine, I would like to offer my support for the agency's preferred alternative â€“ with some suggestions for necessary changes.

First, I do not think it is in the best interest of the environment to remove the topsoil from the toe of the impoundment area. Although it is true that this soil was once topsoil on the site, it has now been in place of over 30 years and it seems unnecessary and possibly even foolish to disturb the area so close to the water courses that have successfully protected during mine operation. Surely, in order to grow the trees and other vegetation that is native to the area, the soil from area borrow pits can be utilized with success and without the potential impacts associated with gross disturbance of areas near streams that have already healed up.

Thank you for accepting and considering my comment.

Sincerely,
Andrew Foote

Sincerely,

Andrew Foote

2011-07-06 Hesse C. pdf

From: Chris Hesse
To: Corsi, Emily
Subject: Re: Troy Mine Revised Reclamation Plan
Date: Wednesday, July 06, 2011 12:08:36 PM

Emily:
Sorry, it seems to have gotten lost in the ethernet - I can't retrieve it.
The comment was a general one. In the late 80's I was involved with U.S. Borax during the discovery and early exploration of the copper-silver mineral deposit in the region, which is now being developed by Mines Management Inc. In my capacity I had a chance to observe the economic situation in northwest Montana at that time. My recent comment was to encourage the Department to use every effort to allow the development of any mineral deposits there in an environmentally responsible manner, all else being equal. This is technically possible; the environmental objections raised in the previous EIS of the nearby ASARCO project can be overcome.
Unless things have changed, the region needs all the economic help it can get.
Full disclosure: I am a minor shareholder in Mines Management.
Thanks for the renewed opportunity to comment.
Chris Hesse, P.Eng.

From: "Corsi, Emily" <ECorsi@mt.gov>
To: Chris Hesse <cahesse@att.net>
Sent: Wed, July 6, 2011 7:21:10 AM
Subject: RE: Troy Mine Revised Reclamation Plan

Chris,

Do you have a copy of the letter you wrote? If so, you can send it directly to me, and I can replace it. My e-mail address is ecorsi@mt.gov

Emily W. Corsi
MEPA Coordinator
Montana Department of Environmental Quality
1520 East Sixth Avenue
P.O. Box 200901
Helena, MT 59620-0901
Phone: 406-444-2813
Fax: 406-444-1374
ecorsi@mt.gov

From: Chris Hesse [mailto:cahesse@att.net]
Sent: Tuesday, July 05, 2011 6:15 PM
To: Corsi, Emily
Subject: Re: Troy Mine Revised Reclamation Plan

The "Original Message" is not the letter I wrote. I give up!

From: "Corsi, Emily" <ECorsi@mt.gov>
To: "cahesse@att.net" <cahesse@att.net>
Sent: Tue, July 5, 2011 10:21:38 AM
Subject: RE: Troy Mine Revised Reclamation Plan

Chris,

Thank you for your comment.

Emily W. Corsi
MEPA Coordinator
Montana Department of Environmental Quality
1520 East Sixth Avenue
P.O. Box 200901
Helena, MT 59620-0901
Phone: 406-444-2813
Fax: 406-444-1374
ecorsi@mt.gov

-----Original Message-----
From: cahesse@att.net [mailto:cahesse@att.net]
Sent: Sunday, July 03, 2011 12:32 PM
To: troymine@miningmontana.com
Subject: Troy Mine Revised Reclamation Plan

Hello,
Attached is a letter stating my views on the Troy Mine Revised Reclamation Plan . Thank you for allowing me to submit my comments.

Sincerely,
Chris A. Hesse, P.Eng.

2011-07-06 Miller E. pdf

Elvie Miller
50 Meadowlark Ln
Libby, MT 59923
406-250-7715

July 6, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi:

My name is Elvie Miller, one of the family owners of Meadowlark Log Homes in Libby, Montana. I am writing in support of the Troy Mine in details outlined farther below.

In the industry I am involved in of building log homes, we have been affected by the almost total lack of stewardship of our forest. What has happened to the logging industry resulting in forests that are no longer harvested and managed, is a tragedy that can hardly be fathomed. The rich forests we have here can provide all the wood our company needs and a hundred more companies, but because of so called \\\"environmental\\\" issues, we now must buy our logs from Canada at a far greater cost. It is a burden for us to stay in business and it would not have to be this way. Is this the great American dream- where runaway \\\"environmental\\\" laws rule to supposedly \\\"save\\\" our resources, but it's ok if the people perish? How about some laws to protect their jobs to keep them from starving instead of the wolves, etc?

My personal opinion is that some of these \\\"environmental\\\" laws are actually doing far more harm to the environment than good- restricting the harvesting of resources. I pray for the day when these crimes will come to light and justice will once more rule. We will awake with a shock when our well- intentioned ideas come back to hurt us, such as when massive fires occur due to lack of management and thinning.

With this in mind, please consider doing what's best for the big picture and not merely a politically correct decision such as \\\"restoring\\\" something that is just ok the way it is.

Please consider my comment on the Troy Mine Revised Reclamation Plan Draft EIS.

The northwestern area of Montana has been in a deep recession for a decade longer than the rest of our nation. Much of this is because of the systematic dismantling of the forestry management system of the United States Forest Service. The resultant collapse of the local economies of the area has been catastrophic. Over 3500 industrial, family wage jobs have been lost in the logging and milling businesses of Lincoln and Sanders Counties. The social ills such as alcoholism, drug addictions, family destructive behaviors, suicides, domestic abuse that follow these types of economic losses are well documented and were tragically predicted.

G3

For the last several years, there has been a growing hope that mineral activity could replace some of the lost jobs and help to lower the unemployment rates of 20% that is found in these two counties. That hope will not be met with reality unless mines like the Troy Mine can stay in business. The economic benefit of nearly 200 jobs that average over $55,000 per year - not counting the benefits packages that includes health insurance, retirement plans and stock options â€“ cannot be overstated. The impact the Troy Mine has with $14 million in payroll, $10 million in local purchases of goods and services, $250,000 in property taxes, $1 million in gross proceeds taxes, $1.4 million in metal mines taxes cannot be overstated.

With this economic need as a backdrop to the discussion of the future of the mine, I would like to offer my support for the agency's preferred alternative â€“ with some suggestions for necessary changes.

H2

First, I do not think it is in the best interest of the environment to remove the topsoil from the toe of the impoundment area. Although it is true that this soil was once topsoil on the site, it has now been in place of over 30 years and it seems unnecessary and possibly even foolish to disturb the area so close to the water courses that have successfully protected during mine operation. Surely, in order to grow the trees and other vegetation that is native to the area, the soil from area borrow pits can be utilized with success and without the potential impacts associated with gross disturbance of areas near streams that have already healed up.

Thank you for accepting and considering my comment.

Sincerely,

Elvie Miller
Meadowlark Log Homes

--
Elvie and Rebekah Miller
cell 406 250 7715
home 406 293 9011

Sincerely,

Elvie Miller

2011-07-08 Uphus S. pdf

Sharel Uphus
PO Box 857
Whitehall, MT 59759
406-491-5036

July 8, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Montana DEQ and Kootenai National Forest:

Thank you for accepting my comments to the proposed revisions to the Troy Revised Reclamation Plan preferred alternative. I have just a couple of suggestions for you before you make your final determination.

I1 I would like to see the asphalt remain on the main road leading to the mine site. Removing it and returning it to dirt will just create more BMP work trying to mitigate for TMDL's in the watershed. You might require the asphalt to be repaired in places that it needs to be, but I believe it would be a short term investment that will pay long term dividends for the watershed.

H1 I also believe that using the readily available materials that is suitable for growth medium located on the mine to reclaim the tailing impoundment would be the better option. The topsoil that has been saved for that purpose has become great habitat for the western toad, and I believe that using the other material instead will grow the trees and shrubs necessary to ensure proper reclamation.

B1 I also think that breaking up the foundations and burying the concrete onsite would be just fine rather than digging them up, breaking them up and burying them somewhere else. It's just concrete and won't impact water quality any more than the rip rap along the Bull Trout stream at the bottom of the mountain.

E1 Requiring the company to bury the pipeline when it could just be replaced with another above ground line doesn't make sense either. It seems that if you are serious about water quality and TMDL impacts, you wouldn't want to be disturbing an entire hillside to bury the line not to mention disturbing the ground and the advanced reclamation down the road if the line were to need replacement or repair. Leaving the pipeline above ground and next to the road with asphalt on it makes the most sense in my opinion.

Thanks for your time and consideration.

Sincerely yours,

Sincerely,

Sharel Uphus

2011-07-12 McGillM.pdf

Marc McGill
1309 Airth Ave.
Libby, MT 59923
283-1084

July 12, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi:

Please accept my following comments for the proposed reclamation plan revisions at the Troy mine. I fully support the mine and their desire to continue operating under the Company Proposed Action.

E7 With thirty years of documented analysis and several studies completed during the impoundments history showing no environmental impacts to water or wildlife this plan should be approved.

K1 We as a society have very few examples where we actually extract mineral resources from deposits such as these that are so benign and have no long lasting negative impacts to the environment. I have seen firsthand the impoundment and the abundance of existing wildlife that cohabitates it. The fisheries have had zero negative impacts from this impoundment and the attenuation study done while the mine was dormant clearly illustrates what to expect when this operation is decommissioned.

D1

G3 Between now and then, allowing this permit to move forward will allow for the mine to continue operating in a responsible manner. The contribution of millions of dollars every month into the local and state economy will continue and the 190 employees and their families will have continued job security.

I urge the agencies to approve this plan as soon as possible and thank you for allowing me to comment.

Sincerely,

Sincerely,

Marc McGill

2011-07-15 Bennion J-MCC.pdf

Jon Bennion
89 Whitetail
Clancy, MT 59634
406-442-2405

July 15, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Montana DEQ and Kootenai National Forest:

Thank you for allowing me to comment on the Troy Mine Draft EIS. The Montana Chamber of Commerce is very committed to promoting natural resource development projects, but only if they will be done in ways that minimize impacts to the environment.

After reviewing the studies, I believe the agency mitigated preferred alternative is the right action moving forward, but I would like to suggest a few modifications to it before the ROD is issued.

E7 First, I would like to applaud the agency for recognizing that the current water treatment at the site for 30 years now has been a complete success, and that no further additional requirements such as a water treatment facility will be necessary. The water being discharged from the Troy mine (even while in operation) meets drinking water standards, and aquatic standards are met within two inches of filtration at the tailings impoundment, as has been illustrated during the thirty years of aggressive monitoring. With the low copper and nitrate levels being attenuated with relative ease during operations, previous monitoring of the water while operations were idle provides clear and defensible scientific data that these low levels of copper and nitrates are significantly reduced even further and will pose no threat to either surface or groundwater upon decommissioning.

H1 K1 H2 After reading through the preferred actions during the final reclamation of the tailings impoundment, I question the use of the topsoil that is being proposed to be used at a cap on the impoundment. This requirement will needlessly disturb the area immediately adjacent to Lake Creek and the great wildlife habitat that has resulted around the toe ponds over the last 30 years. The Western Toad, a sensitive species, has found this area to be great habitat and it makes no sense to adversely impact it when there is other material that could be used that will more than adequately meet reclamation standards. The proposed action by Revett was to use the course borrow that is approximately 3,000 feet away as the cap material. This material has been proven to be more than adequate for reclamation as has been illustrated in the documented test plots over the last several years.

E1
E2
E3

I also question the need to replace the seven miles of pipelines that have several decades of safe use left in them and the requirement to bury replacement lines. If there is a need to replace the pipelines that will essentially be carrying clean water, they should be left above ground next to the access road, where they are currently located. Should there be a leak in a buried line, how long would it be before detected? How much disturbance will be required every time the line is to be inspected? If the mine operates for another 10 years, the logic requiring the lines to be replaced then would require then to be replaced every 40 years. Does it make sense to disturb the entire watershed by digging up seven miles of pipeline every 40 years regardless of the pipeline's condition? Leaving the lines above ground will allow for much easier monitoring and replacement should the lines ever need it. The long term impacts to the watershed with this proposed action should be heavily considered and revisited before a final determination is made.

I1

One last suggestion I would like to make is regarding the access road itself. The proposed alternative would have the company remove the asphalt and return to a gravel surface. Why is this being required? MTâ€™s 62nd legislature just passed a piece of legislation regarding TMDLâ€™s that was aimed at reducing opportunities for sediments to get into waterways. One of the best ways to minimize sediment loads is to put asphalt on roads; this requirement seems to fly in the face of the same mitigation requirements that led to the road being covered with asphalt in the first place.

G3

In closing, I would like to comment on the importance of this applications approval. This operation is very important to the socio-economic wellbeing of Lincoln and Sanders counties. These areas have some of the highest unemployment rates in the state, but have hundreds of folks eager and ready to work. There are over 190 men and women working at this operation and over three million dollars a month of real wealth being distributed into Montana's economy through vendors, payroll, and taxes. Good development projects like the Troy Mine help the overall state economy as well.

Montana has always been the â€œTreasure State,â€• and we must do everything we can to help keep it that way. This project allows us to develop some of those treasures, while also protecting the natural treasures of the land and water for future generations.

Thank you for considering my support for the agency mitigated alternative, and the common sense modifications that should be reconsidered before the ROD is issued.

Sincerely,

Jon Bennion
Government Relations Director
Montana Chamber of Commerce
406-442-2405, ext. 104
jon@montanachamber.com

Sincerely,

Jon Bennion

2011-07-22 McLeodP.pdf

From: Pat McLeod
To: TroyMineReclamation@fs.fed.us; DEQ Troy Mine
Subject: Troy Mine EIS
Date: Friday, July 22, 2011 7:34:21 AM

RE: Environmental Impact Study for the Troy Mine Tailings Impoundment Reclamation Plan

Please consider:

B1 • placing the buildings in the mine.
F1 • leaving the paved road to leading to Spar Lake open to the public.
H3 • using composite to provide the organic material needed for the top soil. Leave the top soil that
H1 was stock piled where it is because it is now supporting new vegetation.
E12 • assuring monitoring and recording for any signs of harmful material.

Thank you
Pat McLeod
904 Winchester Ct
Friendswood, TX 77546

pat_mcleod@yahoo.com

2011-07-24 Lopushok P.pdf

From: peter lopushok
To: Paul Bradford; DEQ Troy Mine
Subject: EIS for troy Mine Taillings
Date: Sunday, July 24, 2011 11:43:32 PM

Gentalman,

H1 The original plan called for reclaiming top soil that was stockpiled below the impoundment, the mine managers are reluctand to do so, I say they should do so.

I1 I2 F2 The present paved mine road should be left intact. The portion leading to the Spar Lake fork should remain open for public use. Beyond the fork, the mine road should be gated. The removal of the paved road and replace it with gravel is an unnecessary, uneconomical and unsound project.

B1 As for the agencies advise, of hauling the concreate block buildings to Colorado for disposal, because of the rebar, they could be placed in the mine. If it's the steel rebar in the buildings that is of agencies concern, then why hasn't the 500 tons of iron released into the tailings impoundment annually through the milling prosses been analyzed.

E12 In accordance with EPA's Emergency Planning and Community Right to Know Act (EPCRA) Section 313 Toxics Release Inventory (TRI) we request a TRI log for as far back as possible. There are a lot of solvents, grease, lube oils and cleaning agents that should be accounted for.

E13 An investigation of the "Midnight Barrel Burials " must be included in the EIS and the barrels contents must be known to create a useful EIS.

Sincerely,

Peter Lopushok
Cabinet Resource Group, board member
221 Mt. Hwy 200
Heron Mt. 59844
pclopushok@wildblue.net
406-847-2330

2011-07-26 GariglietiR.pdf

From: Randy Gariglietti
To: troyminereclamation@fs.fed.us
Subject: Troy Mine
Date: 07/26/2011 03:17 PM

This letter is in regard to the Environmental Impact Study for the Troy Mine Tailings Impoundment Reclamation Plan.

H1 The original [*i.e. proposed]* plan called for reclaiming top soil that was stockpiled below the impoundment. Since then, toe ponds and natural regeneration have made this plan questionable. Revett has expressed concern that disturbance of this already vegetated area would create great potential for siltation into Lake Creek, and we share this concern. Revett suggests borrowing material from the east

H2 side of the tailings impoundment to cover the tailings, pointing out that the soil is already supporting trees on the reclaimed lower slopes of the tailing dike. DEQ is concerned that more organic materials are needed and we agree with this. [redacted]

H3 [redacted]

I1 The [redacted]. The portion leading to the Spar Lake fork should

I2 remain open for public use. Beyond the fork, the road should be gated. Removal of the paved road to replace with gravel is an unnecessary, uneconomical and unsound project.

B1 Rather than--as the agencies advise-- hauling the buildings to another disposal site or --as Revett has suggested -- digging a hole and burying them, [redacted] If it is the steel rebar in the buildings that is of agency concern, then why hasn't the 500 tons of iron released into the tailings impoundment annually through the milling process been analyzed?

E12 [redacted] *[be made available].* There are a lot of solvents, grease, and lube oils that should be accounted for.

E13 [redacted]. Testimony given under oath from a former mine manager and ground penetrating radar surveys prove barrels are buried in the tailings. We hope that no toxic compounds were in these barrels, but the initial denial, the night time disposal, and the admission of alleged "just flocculents" causes great concern. The barrels'contents must be known to create a useful EIS.

Thank you,
Randy Gariglietti
1574 Lake Creek Road
Troy, Mt 59935

2011-07-28 Anderson C. pdf

Cole Anderson
625 Schoolhouse Lk Road
Troy, MT 59935
4062955340

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Montana DEQ:

Please accept my recommendations to the proposed Troy reclamation revisions. I believe that requiring the company to tear down the existing pipeline that is in great shape to replace it with another one immediately upon decommissioning of the mine is not a reasonable requirement. An even more unreasonable request would be to require the company to bury the line.

E1 At a minimum, the document should contain a discussion about the actual condition of the pipeline, how long it is expected to last and a much stronger discussion of why the pipeline should be buried.

After decommissioning, the pipeline will be carrying nothing but clean water and could last another fifty years before it needs replaced. Perhaps you could allow the pipeline to stay above ground and require the Company to repair or replace the line if it becomes necessary or to provide data about the condition of the line periodically to the agencies. I hope that the final reclamation plan allows the existing pipeline to be used until it needs replaced and that it is replaced with another in the same place alongside the road for easy monitoring into the future.

Thank you for considering my common sense recommendations and thank you for approving the Troy mine reclamation plans so they can continue to employ the almost two hundred men and women that depend on it.

Sincerely yours,

Sincerely,

Cole Anderson

2011-07-28 Beard J. pdf

Justin Beard
185 Bighorn Way
Troy, MT 59935
4062959454

July 28, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

I would like to provide some comments regarding the Troy reclamation revision that is open for public comment.

E7 It seems that the agency has done a very thorough examination of all the data that has been collected over the last 30 years and has made an accurate assessment of the water being discharged. From what I have seen, there is simply going to be clean water flowing out of the adit down to the impoundment, and requiring a water treatment facility will not be required.

E1 One thing that really makes me scratch my head though has to do with the pipeline analysis. Is the existing pipeline in a condition that requires replacement immediately upon the mine being decommissioned? I would suggest leaving the existing pipeline infrastructure in place until it needs replacement, and I can't see the logic in burying it when it does get replaced. Wouldn't it be easier to detect leaks and work on it if it was above ground? Aren't we going to be disturbing much more ground by doing it this way? This just doesn't make a whole lot of sense to me.

Thank you for accepting my comments. I eagerly await your response!

Sincerely,

Sincerely,

Justin Beard

2011-07-28 Boswell M.pdf

Mark Boswell
po box 457
Troy, MT 59935
295-9016

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

I would like to provide some comments regarding the Troy reclamation revision that is open for public comment.

E7 It seems that the agency has done a very thorough examination of all the data that has been collected over the last 30 years and has made an accurate assessment of the water being discharged. From what I have seen, there is simply going to be clean water flowing out of the adit down to the impoundment, and requiring a water treatment facility will not be required.

E1 One thing that really makes me scratch my head though has to do with the pipeline analysis. Is the existing pipeline in a condition that requires replacement immediately upon the mine being decommissioned? I would suggest leaving the existing pipeline infrastructure in place until it needs replacement, and I can't see the logic in burying it when it does get replaced. Wouldn't it be easier to detect leaks and work on it if it was above ground? Aren't we going to be disturbing much more ground by doing it this way? This just doesn't make a whole lot of sense to me.

Thank you for accepting my comments. I eagerly await your response!

Sincerely,

Sincerely,

Mark Boswell

2011-07-28 BrickerD.pdf

Derek Bricker
375 Conifer
Libby, MT 59923
4062831204

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Kootenai National Forest and Montana DEQ:

Thank you for accepting the following comments on the revised reclamation plan for the Troy mine. I would like to focus my comments on the DEIS to the pipeline and impoundment mitigation recommendations. In general, I support the reclamation plan but there are areas that don't make a great deal of sense to me and that I fmd contradictory or unnecessary.

E1 Why would you want to dig up and disturb more ground if you were going to decommission the existing water pipeline and replace it with a new one for adit discharges? Aren't we trying to minimize TMDL impacts in the watershed? Why not just make safety precautions or improvements to the existing pipeline that has more than adequate capacity and seems to be working just fine?

If you did require replacement, why would you want it buried when it would be much more difficult to monitor in the future? Why would you want to disturb ground to bury it originally and perhaps again to repair or replace the line when it is completely unnecessary?

K1 H3 Wouldn't using the toe pond stockpiled top soils for reclamation impact the western toad that currently has great habitat there now? Why not just use the coarse borrow material east of the impoundment instead? The DIES indicates that this could be just as successful in achieving reclamation goals and criteria. Are the wood based organic amendments that add 1,100 lbs of nitrogen per acre for the mill and impoundment really necessary? What is mycorrhizal fungi and why is it needed for reclamation at the mill? Why are the agencies requiring organic versus chemical fertilizer for reclamation in general?

Thank you for listening and I look forward to seeing the final reclamation plan include some further modifications to address some of the areas I have outlined above.

Respectfully,

Sincerely,

Derek Bricker

2011-07-28 Carlberg L. pdf

Levi Carlberg
2107 Farm to Market
Libby, MT 59923
4062932318

July 28, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

I would like to comment on the Troy Mine Revised Reclamation Plan Draft EIS.

G3 The Troy Mine has emerged as a shining light in the tough economic picture of northwestern Montana. The mine made it through the dark days of the recession with pay cuts from top to bottom but not one single employee was laid off. The mine, now with ownership that includes the employees themselves through stock options, now underscores the hopeful economic potential of mining for an area that, for a decade, has led the state with catastrophically high unemployment.

Numbers tell the story. Troy Mine now represents over 190 jobs, over $14 million in payroll, over $10 million in goods and services purchased in Montana, over $1.4 million in metal mines taxes for our schools, and over $1.25 in other state and local taxes.

If an incredibly conservative rollover factor of 2 is used to generate an idea of total local impact in this isolated and depressed area, the Troy Mine serves to economically support an additional 380 local jobs in other main street businesses and local government. This is a huge impact on the area.

E7 Thankfully, this economic impact comes with little impact to the environment. In fact, the EIS recognizes this fact when it repeats the conclusions of 30 years of evaluation of water quality that have shown no impacts to the water quality in the mine's area streams. If society wants to have 'green' metals production, Troy Mine is a good source for providing that need.

E1 I generally support the conclusions of the preferred alternative. I have some questions about the reclamation requests in the document â€" specifically as it concerns the water delivery pipeline. It is currently above ground for the vast majority of its route. It has been in use for nearly 30 years and seems to be functioning as needed and desired. Once the mine is no longer operating, this pipe will just carry water. Therefore, I think it is not

E1 in the best interest of the environment to disturb ground for the many miles that would be need to remove the above ground line and install a new line underground the entire way. This just seems to reflect a desire to remove the visual of the pipe â€“ as if it is a negative thing to share with the public of the future.

E2 I, for one, like to see evidence of the ingenuity of man and think that personal opinion about visual qualities should not trump the need to be environmentally sound. Repair and replacement work in the future would be way less disturbing if the pipe was above ground and easy to access. The agency claims that the above ground pipeline would provide a target for vandalism does not square with the local experience of 30 years of that same pipeline's existence without one incident.

Thank you for considering my comment.

Sincerely,

Sincerely,

Levi Carlberg

2011-07-28 CaudillR.pdf

Ron Caudill
80 Wood Street
Libby, MT 59923
293-6909

July 28, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

Please accept my comments for the Troy Mine revised reclamation plans that have been submitted to your agency. After reading most of the DEIS, I wanted to applaud the agency and the diligent work that it has done in coming up with its preferred alternative.

E1 I would like to comment on two things that I believe may need changed before the final decision to move forward with your preferred approach is made. One is the pipeline that you are requiring to be buried. I'm no hydrologist, but it just seems silly to be burying a pipeline that may need dug up and replaced later if in fact you are accurate that the water needs to go through the infiltration process at the impoundment. Why tear up the entire hillside when you could just put it above ground next to the road as it is now for easy access in case there is a problem decades down the road?

H1 K1 Another is with regards to the toe ponds that have all the topsoil that is being recommended to cover the impoundment for reclamation. There has been a lot of praise to the company because of the habitat that has been created for the western toad. It would seem like a no brainer that they use the course borrow to reclaim it even if it takes a bit longer to achieve the standards required. How long will it take to replace the habitat for the western toad?

Thanks for your consideration,

Sincerely,

Ron Caudill

2011-07-28 Chambers R. pdf

Roland Chambers
12 Pillick Ridge Lane
Noxon, MT 59853
529-5294

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Montana DEQ and Kootenai National Forest:

E7 Thank you for allowing me to comment on the Troy Mine Draft EIS. I believe that all of the past and current studies of the impoundment clearly indicate that it will not have a significant impact on ground or surface waters. The attenuation study that was done while the mine was closed and additional studies conducted recently support my conclusion. The rock characterization studies all show little to no potential for ARD or metal releases. These deposits are some of the most environmentally benign metal systems in the world.

After thirty years of this impoundment being in place with no significant impacts to water, it is clear that the decision of the agency will have solid, reliable data documenting the lack of impacts and substantial evidence to support its decision to permit the mine and its proposed reclamation plans.

G3 This operation is very important to the socio-economic wellbeing of Lincoln and Sanders counties. There are over 185 men and women working at this operation and over three million dollars a month of real wealth being distributed into Montana's economy through vendors, payroll, and taxes.

G1 The importance of this operation in two counties that represent the highest unemployment numbers in the state is without question. There will be no significant impacts to the environment by approving this mine's reclamation plans.

Respectfully,

Sincerely,

Roland Chambers

2011-07-28 Colgan B. pdf

Ben Colgan
PO Box 1050
Troy, MT 59935
4062911239

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Kootenai National Forest and Montana DEQ:

Thank you for accepting the following comments on the revised reclamation plan for the Troy mine. I would like to focus my comments on the DEIS to the pipeline and impoundment mitigation recommendations. In general, I support the reclamation plan but there are areas that don't make a great deal of sense to me and that I find contradictory or unnecessary.

E1 Why would you want to dig up and disturb more ground if you were going to decommission the existing water pipeline and replace it with a new one for adit discharges? Aren't we trying to minimize TMDL impacts in the watershed? Why not just make safety precautions or improvements to the existing pipeline that has more than adequate capacity and seems to be working just fine?

If you did require replacement, why would you want it buried when it would be much more difficult to monitor in the future? Why would you want to disturb ground to bury it originally and perhaps again to repair or replace the line when it is completely unnecessary?

K1 H3 Wouldn't using the toe pond stockpiled top soils for reclamation impact the western toad that currently has great habitat there now? Why not just use the coarse borrow material east of the impoundment instead? The DIES indicates that this could be just as successful in achieving reclamation goals and criteria. Are the wood based organic amendments that add 1,100 lbs of nitrogen per acre for the mill and impoundment really necessary? What is mycorrhizal fungi and why is it needed for reclamation at the mill? Why are the agencies requiring organic versus chemical fertilizer for reclamation in general?

Thank you for listening and I look forward to seeing the final reclamation plan include some further modifications to address some of the areas I have outlined above.

Respectfully,

Sincerely,

Ben Colgan

2011-07-28 ConnerD.pdf

Denise Conner
106 Ski Road
Libby, MT 59923
293-7145

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

I would like to comment on the Troy Mine Revised Reclamation Plan Draft EIS.

G3 The Troy Mine has emerged as a shining light in the tough economic picture of northwestern Montana. The mine made it through the dark days of the recession with pay cuts from top to bottom but not one single employee was laid off. The mine, now with ownership that includes the employees themselves through stock options, now underscores the hopeful economic potential of mining for an area that, for a decade, has led the state with catastrophically high unemployment.

Numbers tell the story. Troy Mine now represents over 190 jobs, over $14 million in payroll, over $10 million in goods and services purchased in Montana, over $1.4 million in metal mines taxes for our schools, and over $1.25 in other state and local taxes.

If an incredibly conservative rollover factor of 2 is used to generate an idea of total local impact in this isolated and depressed area, the Troy Mine serves to economically support an additional 380 local jobs in other main street businesses and local government. This is a huge impact on the area.

E7 Thankfully, this economic impact comes with little impact to the environment. In fact, the EIS recognizes this fact when it repeats the conclusions of 30 years of evaluation of water quality that have shown no impacts to the water quality in the mine's area streams. If society wants to have 'green' metals production, Troy Mine is a good source for providing that need.

E1 I generally support the conclusions of the preferred alternative. I have some questions about the reclamation requests in the document â€“ specifically as it concerns the water delivery pipeline. It is currently above ground for the vast majority of its route. It has been in use for nearly 30 years and seems to be functioning as needed and desired. Once the mine is no longer operating, this pipe will just carry water. Therefore, I think it is not

E1 in the best interest of the environment to disturb ground for the many miles that would be need to remove the above ground line and install a new line underground the entire way. This just seems to reflect a desire to remove the visual of the pipe â€“ as if it is a negative thing to share with the public of the future.

E2 I, for one, like to see evidence of the ingenuity of man and think that personal opinion about visual qualities should not trump the need to be environmentally sound. Repair and replacement work in the future would be way less disturbing if the pipe was above ground and easy to access. The agency claims that the above ground pipeline would provide a target for vandalism does not square with the local experience of 30 years of that same pipeline's existence without one incident.

Thank you for considering my comment.

Sincerely,

Sincerely,

Denise Conner

2011-07-28 Coon P. pdf

Paul Coon
83 Swanson Rd
Troy, MT 59935
4062938876

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

I would like to comment on the Troy Mine Revised Reclamation Plan Draft EIS.

G3 The Troy Mine has emerged as a shining light in the tough economic picture of northwestern Montana. The mine made it through the dark days of the recession with pay cuts from top to bottom but not one single employee was laid off. The mine, now with ownership that includes the employees themselves through stock options, now underscores the hopeful economic potential of mining for an area that, for a decade, has led the state with catastrophically high unemployment.

Numbers tell the story. Troy Mine now represents over 190 jobs, over $14 million in payroll, over $10 million in goods and services purchased in Montana, over $1.4 million in metal mines taxes for our schools, and over $1.25 in other state and local taxes.

If an incredibly conservative rollover factor of 2 is used to generate an idea of total local impact in this isolated and depressed area, the Troy Mine serves to economically support an additional 380 local jobs in other main street businesses and local government. This is a huge impact on the area.

E7 Thankfully, this economic impact comes with little impact to the environment. In fact, the EIS recognizes this fact when it repeats the conclusions of 30 years of evaluation of water quality that have shown no impacts to the water quality in the mine's area streams. If society wants to have 'green' metals production, Troy Mine is a good source for providing that need.

E1 I generally support the conclusions of the preferred alternative. I have some questions about the reclamation requests in the document â€“ specifically as it concerns the water delivery pipeline. It is currently above ground for the vast majority of its route. It has been in use for nearly 30 years and seems to be functioning as needed and desired. Once the mine is no longer operating, this pipe will just carry water. Therefore, I think it is not

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E2 I, for one, like to see evidence of the ingenuity of man and think that personal opinion about visual qualities should not trump the need to be environmentally sound. Repair and replacement work in the future would be way less disturbing if the pipe was above ground and easy to access. The agency claims that the above ground pipeline would provide a target for vandalism does not square with the local experience of 30 years of that same pipeline's existence without one incident.

Thank you for considering my comment.

Sincerely,

Sincerely,

Paul Coon

2011-07-28 JaynesK.pdf

Kirk Jaynes
PO Box 624
Libby, MT 59923
291-5328

July 28, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Corsi and Ms. Lacklen:

E7 I would like to provide some comments on the revised reclamation plans for the Troy Mine. For the past three decades the water and rock studies have proven that this is one of the most environmentally benign mining operations in the country. The DEQ and the KNF have recognized this fact throughout the document, and I believe it has firm conclusive data to justify its decision.

B2 One thing that I did question while reading the document was the decommissioning plans for the building foundations. As I understand your preferred alternative, you are going to require the concrete foundations to be dug up, broken up, and deposited elsewhere. The justification was that it may create water quality issues if it was just backfilled on site, which seems the most common sense approach. I am failing to understand how digging it up and hauling it down to private property solves the issue of water quality. It might impact water quality up there, but not elsewhere? The logic doesn't work for me.

E1 One other thing that I read that seems illogical is the requirement for the pipeline to be buried. The existing pipeline is in good shape and runs right next to the road for easy access. Why would we bury it and then have to dig it up again if it ever needs replaced or repaired? This doesn't make much sense to me. It seems as though we are actually going to be requiring unneeded disturbance in the future when the goal is to remove or mitigate what impacts we can.

Thank you for your time.

Very truly yours,

Sincerely,

Kirk Jaynes

2011-07-28 JulsonR.pdf

Ross Julson
930 Quartz Rd
Libby, MT 59923
4062935278

July 28, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Corsi and Ms. Lacklen:

Thank you for the opportunity to comment on the proposed revisions to the Troy reclamation plans. I would like to give my support for the preferred alternative as selected by the agencies, but would like to see some modifications to it.

I1 I don't understand why you would be taking the asphalt off of the road and returning the road surface to dirt. Wouldn't this create more BMP work to ensure that TMDLs are as low as possible? The current road needs some repair, but the costs of those repairs would be virtually insignificant compared to the long term work and maintenance you would be avoiding by doing so. I would imagine as this is a Forest Service road that it will also have I2 a gate on it not far from the tailings impoundment, which would allow the asphalt to have a very good life span for continued access for monitoring of the pipelines carrying water from the adit.

E2 This brings me to my next issue with the preferred alternative. I don't understand why you want to require the Company to bury the pipeline underground when it could be monitored and accessed easily if it was left above ground and next to the road. Putting strict monitoring requirements on the existing line until it truly needs replaced and making them bond to replace it with an above ground line seems like the most common sense approach that will have the least impact to the watershed long term.

Please consider my suggestions before making your final decision.

Sincerely,

Sincerely,

Ross Julson

2011-07-28 KellerK.pdf

Kyle Keller
PO Box 1058
Libby, MT 59923
4062931902

July 28, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

Please accept my comments for the Troy Mine revised reclamation plans that have been submitted to your agency. After reading most of the DEIS, I wanted to applaud the agency and the diligent work that it has done in coming up with its preferred alternative.

E1 I would like to comment on two things that I believe may need changed before the final decision to move forward with your preferred approach is made. One is the pipeline that you are requiring to be buried. I'm no hydrologist, but it just seems silly to be burying a pipeline that may need dug up and replaced later if in fact you are accurate that the water needs to go through the infiltration process at the impoundment. Why tear up the entire hillside when you could just put it above ground next to the road as it is now for easy access in case there is a problem decades down the road?

H1 K1 Another is with regards to the toe ponds that have all the topsoil that is being recommended to cover the impoundment for reclamation. There has been a lot of praise to the company because of the habitat that has been created for the western toad. It would seem like a no brainer that they use the course borrow to reclaim it even if it takes a bit longer to achieve the standards required. How long will it take to replace the habitat for the western toad?

Thanks for your consideration,

Sincerely,

Kyle Keller

2011-07-28 LameyC.pdf

Cody Lamey
225 Redfox
Lolo, MT 59847
283-1101

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

Thank you for accepting my comments on the revised reclamation plans for the Troy mine. In the thirty years this impoundment has been in place, there has been a great amount of solid reliable data to support your preferred alternative, and I would like to say thank you for your acknowledging it.

K1 I would also like to comment on the reclamation using the topsoil that is currently providing habitat for the western toad. Many people have also acknowledged that careful soil management and wildlife can coexist and that this is something that should be applauded, not destroyed.

H1 From what I understand, it isn't going to cost any more to use the borrow or the topsoil that has been set aside, but it may take a bit longer for the borrow to produce the same
H2 reclamation goals if used. I would submit to you that saving habitat that is currently being created and allowing a little longer to create more is a win, win.

I believe that whenever we can showcase an active mining operation creating habitat to any species that is struggling we should. If it isn't going to cost any more either way, and our goal is to reclaim the ground to provide erosion controls and wildlife habitat, we should use the borrow material instead.

Thank you for your consideration of my comments.

Respectfully,

Sincerely,

Cody Lamey

2011-07-28 Lampshire T. pdf

Tom Lampshire
12 Lodgepole Lane
Thompson Falls, MT 59873
546-2853

July 28, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi,

I am writing to support the Troy Mine and provide comment on their Revised Reclamation Plan Draft EIS.

G3 This project is incredibly important to the communities of Lincoln County and our state. The 190 plus jobs are the last industrial, wealth generating jobs in the County. These jobs and the $14,000,000 per year payroll they represent coupled with $20,000,000 per year spent on services â€" one half of which are purchased in Montana â€" are huge factors in the local economy. The $1.4 million paid annually on Montana Metal Mines license taxes and the $250,000 paid in property taxes benefits the local, county and state schools $1million paid annually on gross proceeds taxes benefits the State of Montana's bottom line.

None of this would matter if the mine were not environmentally sound. Thankfully, it is â€" and I applaud the EIS's conclusion, specifically with water impacts, that backs this conclusion.

E1 However, I do have some issues with the EIS and the potential impact on the environmental footprint of the closure requirements. Specifically, I take issues with the need to bond for removal of the pipelines above ground and replace them with lines below ground when the mine is done. The above ground pipelines are not hurting anything. Digging to bury a new line will cause more impacts to the environment than leaving them in place. Further, every time the pipes need work done to them or replaced the impacts will be revisited. When we are doing all we can to disallow the potential of sediment into our streams, it seems inconsistent to require such ground disturbances being repeated in perpetuity.

Thank you for taking my comment.

Sincerely yours,

Sincerely,

Tom Lampshire

2011-07-28 Leir R. pdf

Randy Leir
803 Dakota Av
Libby, MT 59923
4062934624

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Kootenai National Forest and Montana DEQ:

Please accept my comments for the proposed reclamation revision at the Troy mine. I am fully supportive of the Troy mine and the success that it has had with controlling and mitigating environmental impacts while it has been in operation.

With all of the studies that have been done on the rock and all of the monitoring that has proven no impacts should make this an easy decision. Reading through some of the proposed mitigation measures that have been suggested, it obvious that there has been a very in depth analysis of the revision. It also looks like there is a bit of overkill with some of the suggestions.

I1
E1

You want to take the asphalt out and take it down to dirt again? You feel that you need to dig up the entire existing pipeline and replace it with another line that must be buried? The existing pipelines are sufficient to transport the very clean water from the adit down to the impoundment. Why not disturb less ground and ensure further safety precautions on the existing line that has plenty of capacity to get the job done? Isn't our goal to have the least amount of disturbance necessary?

A5

The men and women at the Troy Mine operate a very safe, very productive, environmentally benign operation. We all want proper reclamation plans approved by the regulators and we certainly want proper bond requirements. That said, there are some things that simply aren't necessary, may not benefit the environment and don't make sense. I approve of the preferred alternative as put forth by the agencies but would like to see some modifications made to in the Record of Decision that reflect proper but not excessive reclamation plans.

Please keep these considerations in mind when making your final decisions on the mitigation measures and the final reclamation plan.

Respectfully yours,

Sincerely,

Randy Leir

2011-07-28 LeivestadRO.pdf

July 28, 2011

Paul Bradford, Forest Supervisor
Kootenai National Forest
31374 US 2
Libby, MT 59923-3022

RE: Public Comments re Troy Mine Reclamation Plan

Dear Sir:

E13 It is important that prior to other reclamation work, the buried barrels MUST be dug up to determine what is inside before they corrode and leak their contents. The toxic materials used must be made public. Maybe there is nothing toxic inside but the shroud of secrecy is puzzling.

J3 A5 Finally, there must be 1) enough organic soil to properly revegetate the entire tailings impoundment, and 2) a reclamation and contingency bond large enough to cover the cost of a worst case scenario.

Thank you.

Sincerely,

Ole and Rusti Leivestad
28 Fern Hollow Drive
Trout Creek, MT 59874

AUG 01 2011
RECEIVED

2011-07-28 Leverette K.pdf

Kurt Leverette
PO Box 925
Troy, MT 59935
249-4909

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

G3 The Troy Mine Reclamation plans needs to be approved and permitted for several reasons. The operation is a huge asset to northwest Montana and provides over 190 good paying family wage jobs in an area that has the highest unemployment in the state.

For over thirty years the mine has been depositing its tailings in the impoundment and there has not been any significant impact to the areas streams or wildlife.

E7 K2 Several studies have been done that confirm this and I believe that allowing them to amend their reclamation plan to continue operating is a no brainer. It seems that both the USFS and the DEQ has done a thorough job of analyzing the revised reclamation plans, though there seems to be some recommendations that would actually create more disturbance than should be necessary.

E1 E2 Removing the water pipeline that is buried below the surface (if it is decided that it needs to be replaced) seems impractical as it wouldn't hurt anything to just leave it and remove the pipeline that is above ground. Completely burying a new pipeline (which I'm not convinced is even needed) seems to contradict the desire of all parties to ensure that the lines can be monitored and that there is ability to quickly detect any leakage or break in the line and just as quickly get necessary repairs made while disturbing the least ground or water resources as possible.

That being said, I'm confident the agency will listen to those that have more experience than I in this area and arrive at common sense mitigations while approving this reclamation permit. But I would like to go on record as supporting the preferred alternative with some modifications to the requirements for the pipeline.

Thank you for your time,

Sincerely,

Kurt Leverette

2011-07-28 LymanDa.pdf

From: D Lyman
To: DEQ Troy Mine
Subject: Troy Mine draft EIS - reclamation
Date: Thursday, July 28, 2011 7:28:55 PM

Richard Opper, Director
Montana Department of Environmental Quality

Dear Mr. Opper,
I am writing to submit my comments regarding the Troy Mine Tailings (and other) Reclamation Plan draft EIS. My comments are summarized below.

E11 My primary concerns have always been related to water, its pollution as a result of mine development and operation and its disposal back into the environment. The EIS should identify and specify all water resources that have been or will be impacted by the operation or the closing of the mine. Monitoring, in 'perpetuity', if necessary to assure the best possible treatment or simple discharge should be required. A complete inventory of all chemicals, solvents, fuels and other serious pollutants should be provided by Revett in the form of a Toxic Release Log. Any spill sites identified in the EIS should be evaluated and treated as needed as a part of the Reclamation Plan.

E12

I1 The paved mine road should be left intact to reduce the volume of dust on the road leading to Spar Lake. The road that forks off of the Spar Lake road should be gated. All other parking areas, storage areas, material staging areas should be covered with topsoil and re-vegetated. The buildings should be stripped of all hazardous materials and recyclable materials and then be demolished. The hazardous materials should be removed from the site for proper disposal and the recyclable materials could be sold. The remaining building rubble should be trucked back into the mine for disposal.

I2

B1

E13 Since I have been following the Troy mine since it was built, I would like to request that the EIS call for a complete investigation and resolution of the missing, buried barrels that are in the tailings piles. Since no one has any certain knowledge of the contents but all parties acknowledge their existence, Revett should investigate, identify the contents and then proceed with whatever treatment is required before reclaiming the tailings piles.

H3 The tailings piles should be covered with topsoil to an appropriate depth and if there is not enough topsoil available at the site I would suggest hiring a large slash chipper to process waste wood and other organic material for mixing with the available topsoil so that the job can be done right. The covered piles should be re-vegetated with appropriate plants and trees.

J2

Sincerely,
Dave Lyman
34 Beaver Peak Road
Heron, MT 59844
406-847-2388

2011-07-28 LymanDe.pdf

From: D Lyman
To: DEQ Troy Mine
Subject: Troy Mine draft EIS - reclamation
Date: Thursday, July 28, 2011 7:52:21 PM

Richard Opper, Director
Montana Department of Environmental Quality
Dear Mr. Opper,
I am writing to submit my comments regarding the Troy Mine Tailings (and other) Reclamation Plan draft EIS. My comments are summarized below.

E11 My primary concerns have always been related to water, its pollution as a result of mine development and operation and its disposal back into the environment. The EIS should identify and specify all water resources that have been or will be impacted by the operation or the closing of the mine. Monitoring, in 'perpetuity', if necessary to assure the best possible treatment or simple

E12 discharge should be required. A complete inventory of all chemicals, solvents, fuels and other serious pollutants should be provided by Revett in the form of a Toxic Release Log. Any spill sites identified in the EIS should be evaluated and treated as needed as a part of the Reclamation Plan.

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B1 hazardous materials should be removed from the site for proper disposal and the recyclable materials could be sold. The remaining building rubble should be trucked back into the mine for disposal.

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H3 The tailings piles should be covered with topsoil to an appropriate depth and if there is not enough topsoil available at the site I would suggest hiring a large slash chipper to process waste wood and

J2 other organic material for mixing with the available topsoil so that the job can be done right. The covered piles should be re-vegetated with appropriate plants and trees.

Sincerely,
Debbie S. Lyman
34 Beaver Peak Road
Heron, MT 59844
406-847-2388

2011-07-28 mclindenD.pdf

Daniel Mclinden
PO Box 44
Noxon, MT 59853
4068472693

July 28, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi,

I am writing to support the Troy Mine and provide comment on their Revised Reclamation Plan Draft EIS.

G3 This project is incredibly important to the communities of Lincoln County and our state. The 190 plus jobs are the last industrial, wealth generating jobs in the County. These jobs and the $14,000,000 per year payroll they represent coupled with $20,000,000 per year spent on services â€" one half of which are purchased in Montana â€" are huge factors in the local economy. The $1.4 million paid annually on Montana Metal Mines license taxes and the $250,000 paid in property taxes benefits the local, county and state schools $1million paid annually on gross proceeds taxes benefits the State of Montana's bottom line.

None of this would matter if the mine were not environmentally sound. Thankfully, it is â€" and I applaud the EIS's conclusion, specifically with water impacts, that backs this conclusion.

E1 However, I do have some issues with the EIS and the potential impact on the environmental footprint of the closure requirements. Specifically, I take issues with the need to bond for removal of the pipelines above ground and replace them with lines below ground when the mine is done. The above ground pipelines are not hurting anything. Digging to bury a new line will cause more impacts to the environment than leaving them in place. Further, every time the pipes need work done to them or replaced the impacts will be revisited. When we are doing all we can to disallow the potential of sediment into our streams, it seems inconsistent to require such ground disturbances being repeated in perpetuity.

Thank you for taking my comment.

Sincerely yours,

Sincerely,

Daniel Mclinden

2011-07-28 Moe R. pdf

Ron Moe
311 Parmenter Cr Rd
Libby, MT 59923
4062938358

July 28, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

Please accept my comments for the Troy Mine revised reclamation plans that have been submitted to your agency. After reading most of the DEIS, I wanted to applaud the agency and the diligent work that it has done in coming up with its preferred alternative.

E1 I would like to comment on two things that I believe may need changed before the final decision to move forward with your preferred approach is made. One is the pipeline that you are requiring to be buried. I'm no hydrologist, but it just seems silly to be burying a pipeline that may need dug up and replaced later if in fact you are accurate that the water needs to go through the infiltration process at the impoundment. Why tear up the entire hillside when you could just put it above ground next to the road as it is now for easy access in case there is a problem decades down the road?

H1 K1 Another is with regards to the toe ponds that have all the topsoil that is being recommended to cover the impoundment for reclamation. There has been a lot of praise to the company because of the habitat that has been created for the western toad. It would seem like a no brainer that they use the course borrow to reclaim it even if it takes a bit longer to achieve the standards required. How long will it take to replace the habitat for the western toad?

Thanks for your consideration,

Sincerely,

Ron Moe

2011-07-28 Pattie D. pdf

Donald Pattie
PO Box 901
Troy, MT 59935
4062959489

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

I would like to provide some comments regarding the Troy reclamation revision that is open for public comment.

E7 It seems that the agency has done a very thorough examination of all the data that has been collected over the last 30 years and has made an accurate assessment of the water being discharged. From what I have seen, there is simply going to be clean water flowing out of the adit down to the impoundment, and requiring a water treatment facility will not be required.

E1 One thing that really makes me scratch my head though has to do with the pipeline analysis. Is the existing pipeline in a condition that requires replacement immediately upon the mine being decommissioned? I would suggest leaving the existing pipeline infrastructure in place until it needs replacement, and I can't see the logic in burying it when it does get replaced. Wouldn't it be easier to detect leaks and work on it if it was above ground? Aren't we going to be disturbing much more ground by doing it this way? This just doesn't make a whole lot of sense to me.

Thank you for accepting my comments. I eagerly await your response!

Sincerely,

Sincerely,

Donald Pattie

2011-07-28 PettyD.pdf

Dean Petty
121 Shingle Mill LP
Bonners Ferry, ID 83805
208-946-9744

July 28, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

G3 The Troy Mine Reclamation plans needs to be approved and permitted for several reasons. The operation is a huge asset to northwest Montana and provides over 190 good paying family wage jobs in an area that has the highest unemployment in the state.

For over thirty years the mine has been depositing its tailings in the impoundment and there has not been any significant impact to the areas streams or wildlife.

E7 K2 Several studies have been done that confirm this and I believe that allowing them to amend their reclamation plan to continue operating is a no brainer. It seems that both the USFS and the DEQ has done a thorough job of analyzing the revised reclamation plans, though there seems to be some recommendations that would actually create more disturbance than should be necessary.

E1 E2 Removing the water pipeline that is buried below the surface (if it is decided that it needs to be replaced) seems impractical as it wouldn't hurt anything to just leave it and remove the pipeline that is above ground. Completely burying a new pipeline (which I'm not convinced is even needed) seems to contradict the desire of all parties to ensure that the lines can be monitored and that there is ability to quickly detect any leakage or break in the line and just as quickly get necessary repairs made while disturbing the least ground or water resources as possible.

That being said, I'm confident the agency will listen to those that have more experience than I in this area and arrive at common sense mitigations while approving this reclamation permit. But I would like to go on record as supporting the preferred alternative with some modifications to the requirements for the pipeline.

Thank you for your time,

Sincerely,

Dean Petty

2011-07-28 Ratliff D. pdf

Donald Ratliff
111 Vista Loop
Kalispell, MT 59901
4062147205

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Montana DEQ and Kootenai National Forest:

Thank you for accepting my comments to the proposed revisions to the Troy Revised Reclamation Plan preferred alternative. I have just a couple of suggestions for you before you make your final determination.

I1 I would like to see the asphalt remain on the main road leading to the mine site. Removing it and returning it to dirt will just create more BMP work trying to mitigate for TMDL's in the watershed. You might require the asphalt to be repaired in places that it needs to be, but I believe it would be a short term investment that will pay long term dividends for the watershed.

H1 I also believe that using the readily available materials that is suitable for growth medium located on the mine to reclaim the tailing impoundment would be the better option. The topsoil that has been saved for that purpose has become great habitat for the western toad, and I believe that using the other material instead will grow the trees and shrubs necessary to ensure proper reclamation.

B1 I also think that breaking up the foundations and burying the concrete onsite would be just fine rather than digging them up, breaking them up and burying them somewhere else. It's just concrete and won't impact water quality any more than the rip rap along the Bull Trout stream at the bottom of the mountain.

E1 Requiring the company to bury the pipeline when it could just be replaced with another above ground line doesn't make sense either. It seems that if you are serious about water quality and TMDL impacts, you wouldn't want to be disturbing an entire hillside to bury the line not to mention disturbing the ground and the advanced reclamation down the road if the line were to need replacement or repair. Leaving the pipeline above ground and next to the road with asphalt on it makes the most sense in my opinion.

Thanks for your time and consideration.

Sincerely yours,

Sincerely,

Donald Ratliff

2011-07-28 RoseJ.pdf

Joseph Rose
PO 1094
Troy, MT 59935
4062955538

July 28, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

I would like to provide some comments regarding the Troy reclamation revision that is open for public comment.

E7 It seems that the agency has done a very thorough examination of all the data that has been collected over the last 30 years and has made an accurate assessment of the water being discharged. From what I have seen, there is simply going to be clean water flowing out of the adit down to the impoundment, and requiring a water treatment facility will not be required.

E1 One thing that really makes me scratch my head though has to do with the pipeline analysis. Is the existing pipeline in a condition that requires replacement immediately upon the mine being decommissioned? I would suggest leaving the existing pipeline infrastructure in place until it needs replacement, and I can't see the logic in burying it when it does get replaced. Wouldn't it be easier to detect leaks and work on it if it was above ground? Aren't we going to be disturbing much more ground by doing it this way? This just doesn't make a whole lot of sense to me.

Thank you for accepting my comments. I eagerly await your response!

Sincerely,

Sincerely,

Joseph Rose

2011-07-28 Shaw J.pdf

Jim Shaw
104 Granite St.
Libby, MT 59923
291-6561

July 28, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

I would like to comment on the Troy Mine Revised Reclamation Plan Draft EIS.

G3 The Troy Mine has emerged as a shining light in the tough economic picture of northwestern Montana. The mine made it through the dark days of the recession with pay cuts from top to bottom but not one single employee was laid off. The mine, now with ownership that includes the employees themselves through stock options, now underscores the hopeful economic potential of mining for an area that, for a decade, has led the state with catastrophically high unemployment.

Numbers tell the story. Troy Mine now represents over 190 jobs, over $14 million in payroll, over $10 million in goods and services purchased in Montana, over $1.4 million in metal mines taxes for our schools, and over $1.25 in other state and local taxes.

If an incredibly conservative rollover factor of 2 is used to generate an idea of total local impact in this isolated and depressed area, the Troy Mine serves to economically support an additional 380 local jobs in other main street businesses and local government. This is a huge impact on the area.

E7 Thankfully, this economic impact comes with little impact to the environment. In fact, the EIS recognizes this fact when it repeats the conclusions of 30 years of evaluation of water quality that have shown no impacts to the water quality in the mine's area streams. If society wants to have 'green' metals production, Troy Mine is a good source for providing that need.

E1 I generally support the conclusions of the preferred alternative. I have some questions about the reclamation requests in the document â€" specifically as it concerns the water delivery pipeline. It is currently above ground for the vast majority of its route. It has been in use for nearly 30 years and seems to be functioning as needed and desired. Once the mine is no longer operating, this pipe will just carry water. Therefore, I think it is not

E1 in the best interest of the environment to disturb ground for the many miles that would be need to remove the above ground line and install a new line underground the entire way. This just seems to reflect a desire to remove the visual of the pipe â€“ as if it is a negative thing to share with the public of the future.

E2 I, for one, like to see evidence of the ingenuity of man and think that personal opinion about visual qualities should not trump the need to be environmentally sound. Repair and replacement work in the future would be way less disturbing if the pipe was above ground and easy to access. The agency claims that the above ground pipeline would provide a target for vandalism does not square with the local experience of 30 years of that same pipeline's existence without one incident.

Thank you for considering my comment.

Sincerely,

Sincerely,

Jim Shaw

2011-07-28 Singbeil T.pdf

Tad Singbeil
PO Box 1464
Noxon, MT 59853
498-8623

July 28, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi,

I am writing to support the Troy Mine and provide comment on their Revised Reclamation Plan Draft EIS.

G3 This project is incredibly important to the communities of Lincoln County and our state. The 190 plus jobs are the last industrial, wealth generating jobs in the County. These jobs and the $14,000,000 per year payroll they represent coupled with $20,000,000 per year spent on services â€“ one half of which are purchased in Montana â€“ are huge factors in the local economy. The $1.4 million paid annually on Montana Metal Mines license taxes and the $250,000 paid in property taxes benefits the local, county and state schools $1million paid annually on gross proceeds taxes benefits the State of Montana's bottom line.

None of this would matter if the mine were not environmentally sound. Thankfully, it is â€“ and I applaud the EIS's conclusion, specifically with water impacts, that backs this conclusion.

E1 However, I do have some issues with the EIS and the potential impact on the environmental footprint of the closure requirements. Specifically, I take issues with the need to bond for removal of the pipelines above ground and replace them with lines below ground when the mine is done. The above ground pipelines are not hurting anything. Digging to bury a new line will cause more impacts to the environment than leaving them in place. Further, every time the pipes need work done to them or replaced the impacts will be revisited. When we are doing all we can to disallow the potential of sediment into our streams, it seems inconsistent to require such ground disturbances being repeated in perpetuity.

Thank you for taking my comment.

Sincerely yours,

Sincerely,

Tad Singbeil

2011-07-28 Thorstenson R.pdf

Rod Thorstenson
PO Box 197
Libby, MT 59923
334-1944

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

Please accept my comments for the Troy Mine revised reclamation plans that have been submitted to your agency. After reading most of the DEIS, I wanted to applaud the agency and the diligent work that it has done in coming up with its preferred alternative.

E1 I would like to comment on two things that I believe may need changed before the final decision to move forward with your preferred approach is made. One is the pipeline that you are requiring to be buried. I'm no hydrologist, but it just seems silly to be burying a pipeline that may need dug up and replaced later if in fact you are accurate that the water needs to go through the infiltration process at the impoundment. Why tear up the entire hillside when you could just put it above ground next to the road as it is now for easy access in case there is a problem decades down the road?

H1 K1 Another is with regards to the toe ponds that have all the topsoil that is being recommended to cover the impoundment for reclamation. There has been a lot of praise to the company because of the habitat that has been created for the western toad. It would seem like a no brainer that they use the course borrow to reclaim it even if it takes a bit longer to achieve the standards required. How long will it take to replace the habitat for the western toad?

Thanks for your consideration,

Sincerely,

Rod Thorstenson

2011-07-28 WallaceV.pdf

Vaughn Wallace
106 Ski Road
Libby, MT 59923
293-7145

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Corsi and Ms. Lacklen:

Thank you for the opportunity to comment on the proposed revisions to the Troy reclamation plans. I would like to give my support for the preferred alternative as selected by the agencies, but would like to see some modifications to it.

I1 I don't understand why you would be taking the asphalt off of the road and returning the road surface to dirt. Wouldn't this create more BMP work to ensure that TMDLs are as low as possible? The current road needs some repair, but the costs of those repairs would be virtually insignificant compared to the long term work and maintenance you would be avoiding by doing so. I would imagine as this is a Forest Service road that it will also have a gate on it not far from the tailings impoundment, which would allow the asphalt to have a very good life span for continued access for monitoring of the pipelines carrying water from the adit.

I2

E2 This brings me to my next issue with the preferred alternative. I don't understand why you want to require the Company to bury the pipeline underground when it could be monitored and accessed easily if it was left above ground and next to the road. Putting strict monitoring requirements on the existing line until it truly needs replaced and making them bond to replace it with an above ground line seems like the most common sense approach that will have the least impact to the watershed long term.

Please consider my suggestions before making your final decision.

Sincerely,

Sincerely,

Vaughn Wallace

2011-07-28 Warner J. pdf

Joe Warner
56 W Pipe Cr Rd
Libby, MT 59923
4062932482

July 28, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

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G3 The Troy Mine has emerged as a shining light in the tough economic picture of northwestern Montana. The mine made it through the dark days of the recession with pay cuts from top to bottom but not one single employee was laid off. The mine, now with ownership that includes the employees themselves through stock options, now underscores the hopeful economic potential of mining for an area that, for a decade, has led the state with catastrophically high unemployment.

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E1 in the best interest of the environment to disturb ground for the many miles that would be need to remove the above ground line and install a new line underground the entire way. This just seems to reflect a desire to remove the visual of the pipe â€“ as if it is a negative thing to share with the public of the future.

E2 I, for one, like to see evidence of the ingenuity of man and think that personal opinion about visual qualities should not trump the need to be environmentally sound. Repair and replacement work in the future would be way less disturbing if the pipe was above ground and easy to access. The agency claims that the above ground pipeline would provide a target for vandalism does not square with the local experience of 30 years of that same pipeline's existence without one incident.

Thank you for considering my comment.

Sincerely,

Sincerely,

Joe Warner

2011-07-28 Wilson A.pdf

Austin Wilson
2317 MT Hwy 200
Trout Creek, MT 59874
847-9669

July 28, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

G3 The Troy Mine Reclamation plans needs to be approved and permitted for several reasons. The operation is a huge asset to northwest Montana and provides over 190 good paying family wage jobs in an area that has the highest unemployment in the state.

For over thirty years the mine has been depositing its tailings in the impoundment and there has not been any significant impact to the areas streams or wildlife.

E7 K2 Several studies have been done that confirm this and I believe that allowing them to amend their reclamation plan to continue operating is a no brainer. It seems that both the USFS and the DEQ has done a thorough job of analyzing the revised reclamation plans, though there seems to be some recommendations that would actually create more disturbance than should be necessary.

E1 E2 Removing the water pipeline that is buried below the surface (if it is decided that it needs to be replaced) seems impractical as it wouldn't hurt anything to just leave it and remove the pipeline that is above ground. Completely burying a new pipeline (which I'm not convinced is even needed) seems to contradict the desire of all parties to ensure that the lines can be monitored and that there is ability to quickly detect any leakage or break in the line and just as quickly get necessary repairs made while disturbing the least ground or water resources as possible.

That being said, I'm confident the agency will listen to those that have more experience than I in this area and arrive at common sense mitigations while approving this reclamation permit. But I would like to go on record as supporting the preferred alternative with some modifications to the requirements for the pipeline.

Thank you for your time,

Sincerely,

Austin Wilson

2011-07-28 WurzB.pdf

Ben Wurz
63 timberlane
Libby, MT 59923
4062937485

July 28, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Kootenai National Forest and Montana DEQ:

Thank you for accepting the following comments on the revised reclamation plan for the Troy mine. I would like to focus my comments on the DEIS to the pipeline and impoundment mitigation recommendations. In general, I support the reclamation plan but there are areas that don't make a great deal of sense to me and that I find contradictory or unnecessary.

E1 Why would you want to dig up and disturb more ground if you were going to decommission the existing water pipeline and replace it with a new one for adit discharges? Aren't we trying to minimize TMDL impacts in the watershed? Why not just make safety precautions or improvements to the existing pipeline that has more than adequate capacity and seems to be working just fine?

If you did require replacement, why would you want it buried when it would be much more difficult to monitor in the future? Why would you want to disturb ground to bury it originally and perhaps again to repair or replace the line when it is completely unnecessary?

K1 H3 Wouldn't using the toe pond stockpiled top soils for reclamation impact the western toad that currently has great habitat there now? Why not just use the coarse borrow material east of the impoundment instead? The DIES indicates that this could be just as successful in achieving reclamation goals and criteria. Are the wood based organic amendments that add 1,100 lbs of nitrogen per acre for the mill and impoundment really necessary? What is mycorrhizal fungi and why is it needed for reclamation at the mill? Why are the agencies requiring organic versus chemical fertilizer for reclamation in general?

Thank you for listening and I look forward to seeing the final reclamation plan include some further modifications to address some of the areas I have outlined above.

Respectfully,

Sincerely,

Ben Wurz

2011-07-28 Zajanc G. pdf

Gary Zajanc
318 Wards Rd
Libby, MT 59923
4062931130

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Montana DEQ:

Please accept my recommendations to the proposed Troy reclamation revisions. I believe that requiring the company to tear down the existing pipeline that is in great shape to replace it with another one immediately upon decommissioning of the mine is not a reasonable requirement. An even more unreasonable request would be to require the company to bury the line.

E1 At a minimum, the document should contain a discussion about the actual condition of the pipeline, how long it is expected to last and a much stronger discussion of why the pipeline should be buried.

After decommissioning, the pipeline will be carrying nothing but clean water and could last another fifty years before it needs replaced. Perhaps you could allow the pipeline to stay above ground and require the Company to repair or replace the line if it becomes necessary or to provide data about the condition of the line periodically to the agencies. I hope that the final reclamation plan allows the existing pipeline to be used until it needs replaced and that it is replaced with another in the same place alongside the road for easy monitoring into the future.

Thank you for considering my common sense recommendations and thank you for approving the Troy mine reclamation plans so they can continue to employ the almost two hundred men and women that depend on it.

Sincerely yours,

Sincerely,

Gary Zajanc

2011-07-29 Benson M. pdf

Mitchell Benson
PO Box 654
Troy, MT 59935
295-5014

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi:

Please consider my comment on the Troy Mine Revised Reclamation Plan Draft EIS.

G3

The northwestern area of Montana has been in a deep recession for a decade longer than the rest of our nation. Much of this is because of the systematic dismantling of the forestry management system of the United States Forest Service. The resultant collapse of the local economies of the area has been catastrophic. Over 3500 industrial, family wage jobs have been lost in the logging and milling businesses of Lincoln and Sanders Counties. The social ills such as alcoholism, drug addictions, family destructive behaviors, suicides, domestic abuse that follow these types of economic losses are well documented and were tragically predicted.

For the last several years, there has been a growing hope that mineral activity could replace some of the lost jobs and help to lower the unemployment rates of 20% that is found in these two counties. That hope will not be met with reality unless mines like the Troy Mine can stay in business. The economic benefit of nearly 200 jobs that average over $55,000 per year - not counting the benefits packages that includes health insurance, retirement plans and stock options â€“ cannot be overstated. The impact the Troy Mine has with $14 million in payroll, $10 million in local purchases of goods and services, $250,000 in property taxes, $1 million in gross proceeds taxes, $1.4 million in metal mines taxes cannot be overstated.

With this economic need as a backdrop to the discussion of the future of the mine, I would like to offer my support for the agency's preferred alternative â€“ with some suggestions for necessary changes.

H2

First, I do not think it is in the best interest of the environment to remove the topsoil from the toe of the impoundment area. Although it is true that this soil was once topsoil on the site, it has now been in place of over 30 years and it seems unnecessary and possibly even foolish to disturb the area so close to the water courses that have successfully protected

H2 during mine operation. Surely, in order to grow the trees and other vegetation that is native to the area, the soil from area borrow pits can be utilized with success and without the potential impacts associated with gross disturbance of areas near streams that have already healed up.

Thank you for accepting and considering my comment.

Sincerely,

Sincerely,

Mitchell Benson

2011-07-29 Boespflug D. pdf

Darby Boespflug
1461 Sundowner CT APT A
San Diego, CA 92126

July 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi:

Please accept my following comments for the proposed reclamation plan revisions at the Troy mine. I fully support the mine and their desire to continue operating under the Company Proposed Action. I have many family members working a the mine who may be out of a good job if the mine does not continue operating. It is a good resource for the residents of Troy, as well as Libby.

E7 With thirty years of documented analysis and several studies completed during the impoundments history showing no environmental impacts to water or wildlife this plan should be approved.

K1 D1 We as a society have very few examples where we actually extract mineral resources from deposits such as these that are so benign and have no long lasting negative impacts to the environment. I have seen firsthand the impoundment and the abundance of existing wildlife that cohabitates it. The fisheries have had zero negative impacts from this impoundment and the attenuation study done while the mine was dormant clearly illustrates what to expect when this operation is decommissioned.

G3 Between now and then, allowing this permit to move forward will allow for the mine to continue operating in a responsible manner. The contribution of millions of dollars every month into the local and state economy will continue and the 190 employees and their families will have continued job security.

I urge the agencies to approve this plan as soon as possible and thank you for allowing me to comment.

Sincerely,

Sincerely,

Darby Boespflug

2011-07-29 Boespflug N.pdf

Nate Boespflug
1461 Sundowner CT APT A
San Diego, CA 92126

July 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi:

Please accept my following comments for the proposed reclamation plan revisions at the Troy mine. I fully support the mine and their desire to continue operating under the Company Proposed Action.

E7 K1 D1 With thirty years of documented analysis and several studies completed during the impoundments history showing no environmental impacts to water or wildlife this plan should be approved.

We as a society have very few examples where we actually extract mineral resources from deposits such as these that are so benign and have no long lasting negative impacts to the environment. I have seen firsthand the impoundment and the abundance of existing wildlife that cohabitates it. The fisheries have had zero negative impacts from this impoundment and the attenuation study done while the mine was dormant clearly illustrates what to expect when this operation is decommissioned.

G3 Between now and then, allowing this permit to move forward will allow for the mine to continue operating in a responsible manner. The contribution of millions of dollars every month into the local and state economy will continue and the 190 employees and their families will have continued job security.

I urge the agencies to approve this plan as soon as possible and thank you for allowing me to comment.

Sincerely,

Sincerely,

Nate Boespflug

2011-07-29 BrownJ.pdf

Justin Brown
2462 Montana HWY 200
Trout Creek, MT 59874
827-8181

July 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

I would like to provide some comments regarding the Troy reclamation revision that is open for public comment.

E7 It seems that the agency has done a very thorough examination of all the data that has been collected over the last 30 years and has made an accurate assessment of the water being discharged. From what I have seen, there is simply going to be clean water flowing out of the adit down to the impoundment, and requiring a water treatment facility will not be required.

E1 One thing that really makes me scratch my head though has to do with the pipeline analysis. Is the existing pipeline in a condition that requires replacement immediately upon the mine being decommissioned? I would suggest leaving the existing pipeline infrastructure in place until it needs replacement, and I can't see the logic in burying it when it does get replaced. Wouldn't it be easier to detect leaks and work on it if it was above ground? Aren't we going to be disturbing much more ground by doing it this way? This just doesn't make a whole lot of sense to me.

Thank you for accepting my comments. I eagerly await your response!

Sincerely,

Sincerely,

Justin Brown

2011-07-29 Brown M.pdf

Matt Brown
160 Swamp Creek Loop
Trout Creek, MT 59874
827-0438

July 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Kootenai National Forest and Montana DEQ:

Please accept my comments for the proposed reclamation revision at the Troy mine. I am fully supportive of the Troy mine and the success that it has had with controlling and mitigating environmental impacts while it has been in operation.

With all of the studies that have been done on the rock and all of the monitoring that has proven no impacts should make this an easy decision. Reading through some of the proposed mitigation measures that have been suggested, it obvious that there has been a very in depth analysis of the revision. It also looks like there is a bit of overkill with some of the suggestions.

I1
E1

You want to take the asphalt out and take it down to dirt again? You feel that you need to dig up the entire existing pipeline and replace it with another line that must be buried? The existing pipelines are sufficient to transport the very clean water from the adit down to the impoundment. Why not disturb less ground and ensure further safety precautions on the existing line that has plenty of capacity to get the job done? Isn't our goal to have the least amount of disturbance necessary?

A5

The men and women at the Troy Mine operate a very safe, very productive, environmentally benign operation. We all want proper reclamation plans approved by the regulators and we certainly want proper bond requirements. That said, there are some things that simply aren't necessary, may not benefit the environment and don't make sense. I approve of the preferred alternative as put forth by the agencies but would like to see some modifications made to in the Record of Decision that reflect proper but not excessive reclamation plans.

Please keep these considerations in mind when making your final decisions on the mitigation measures and the final reclamation plan.

Respectfully yours,

Sincerely,

Matt Brown

2011-07-29 Byrd J. pdf

John Byrd
565 Spencer Rd
Libby, MT 59923
4062919571

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

I would like to comment on the Troy Mine Revised Reclamation Plan Draft EIS.

G3 The Troy Mine has emerged as a shining light in the tough economic picture of northwestern Montana. The mine made it through the dark days of the recession with pay cuts from top to bottom but not one single employee was laid off. The mine, now with ownership that includes the employees themselves through stock options, now underscores the hopeful economic potential of mining for an area that, for a decade, has led the state with catastrophically high unemployment.

Numbers tell the story. Troy Mine now represents over 190 jobs, over $14 million in payroll, over $10 million in goods and services purchased in Montana, over $1.4 million in metal mines taxes for our schools, and over $1.25 in other state and local taxes.

If an incredibly conservative rollover factor of 2 is used to generate an idea of total local impact in this isolated and depressed area, the Troy Mine serves to economically support an additional 380 local jobs in other main street businesses and local government. This is a huge impact on the area.

E7 Thankfully, this economic impact comes with little impact to the environment. In fact, the EIS recognizes this fact when it repeats the conclusions of 30 years of evaluation of water quality that have shown no impacts to the water quality in the mine's area streams. If society wants to have 'green' metals production, Troy Mine is a good source for providing that need.

E1 I generally support the conclusions of the preferred alternative. I have some questions about the reclamation requests in the document â€“ specifically as it concerns the water delivery pipeline. It is currently above ground for the vast majority of its route. It has been in use for nearly 30 years and seems to be functioning as needed and desired. Once the mine is no longer operating, this pipe will just carry water. Therefore, I think it is not

E1 in the best interest of the environment to disturb ground for the many miles that would be need to remove the above ground line and install a new line underground the entire way. This just seems to reflect a desire to remove the visual of the pipe â€“ as if it is a negative thing to share with the public of the future.

E2 I, for one, like to see evidence of the ingenuity of man and think that personal opinion about visual qualities should not trump the need to be environmentally sound. Repair and replacement work in the future would be way less disturbing if the pipe was above ground and easy to access. The agency claims that the above ground pipeline would provide a target for vandalism does not square with the local experience of 30 years of that same pipeline's existence without one incident.

Thank you for considering my comment.

Sincerely,

Sincerely,

John Byrd

2011-07-29 DavisW.pdf

Ward Davis
249 Copper Mt Rd
Troy, MT 59935
4062955558

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

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E1

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Please keep these considerations in mind when making your final decisions on the mitigation measures and the final reclamation plan.

Respectfully yours,

Sincerely,

Ward Davis

2011-07-29 Dolan M. pdf

Mark Dolan
PO Box 302
Troy, MT 59935
4062955867

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

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E7
K1
D1

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Between now and then, allowing this permit to move forward will allow for the mine to continue operating in a responsible manner. The contribution of millions of dollars every month into the local and state economy will continue and the 190 employees and their families will have continued job security.

I urge the agencies to approve this plan as soon as possible and thank you for allowing me to comment.

Sincerely,

Sincerely,

Mark Dolan

2011-07-29 Erickson O. pdf

Owen Erickson
61 Halo Drive
Troy, MT 59935
291-7095

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Montana DEQ and Kootenai National Forest:

E7 Thank you for allowing me to comment on the Troy Mine Draft EIS. I believe that all of the past and current studies of the impoundment clearly indicate that it will not have a significant impact on ground or surface waters. The attenuation study that was done while the mine was closed and additional studies conducted recently support my conclusion. The rock characterization studies all show little to no potential for ARD or metal releases. These deposits are some of the most environmentally benign metal systems in the world.

After thirty years of this impoundment being in place with no significant impacts to water, it is clear that the decision of the agency will have solid, reliable data documenting the lack of impacts and substantial evidence to support its decision to permit the mine and its proposed reclamation plans.

G3 This operation is very important to the socio-economic wellbeing of Lincoln and Sanders counties. There are over 185 men and women working at this operation and over three million dollars a month of real wealth being distributed into Montana's economy through vendors, payroll, and taxes.

G1 The importance of this operation in two counties that represent the highest unemployment numbers in the state is without question. There will be no significant impacts to the environment by approving this mine's reclamation plans.

Respectfully,

Sincerely,

Owen Erickson

2011-07-29 Farmer C. pdf

Cory Farmer
1384 Kootenai River Rd
Libby, MT 59923
406.293.1018

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

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Respectfully,

Sincerely,

Cory Farmer

2011-07-29 Foote C. pdf

Chris Foote
PO Box 125
Troy, MT 59935
291-6346

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

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Thank you for considering my comment.

Sincerely,

Sincerely,

Chris Foote

2011-07-29 Fredin 8.pdf

Stephanie Fredin
169 Mt Zion Rd
Libby, MT 59923
406-293-6335

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Corsi and Ms. Lacklen:

E7 I would like to provide some comments on the revised reclamation plans for the Troy Mine. For the past three decades the water and rock studies have proven that this is one of the most environmentally benign mining operations in the country. The DEQ and the KNF have recognized this fact throughout the document, and I believe it has firm conclusive data to justify its decision.

B2 One thing that I did question while reading the document was the decommissioning plans for the building foundations. As I understand your preferred alternative, you are going to require the concrete foundations to be dug up, broken up, and deposited elsewhere. The justification was that it may create water quality issues if it was just backfilled on site, which seems the most common sense approach. I am failing to understand how digging it up and hauling it down to private property solves the issue of water quality. It might impact water quality up there, but not elsewhere? The logic doesn't work for me.

E1 One other thing that I read that seems illogical is the requirement for the pipeline to be buried. The existing pipeline is in good shape and runs right next to the road for easy access. Why would we bury it and then have to dig it up again if it ever needs replaced or repaired? This doesn't make much sense to me. It seems as though we are actually going to be requiring unneeded disturbance in the future when the goal is to remove or mitigate what impacts we can.

G1 The price of silver is high right now, so the mine becomes very profitable for this area. Also, unemployment in Libby/Troy area is at 20%. We need jobs and the mine provides good paying ones.

Thank you for your time.

Very truly yours,

Sincerely,

Stephanie Fredin

2011-07-29 Hawthorne C. pdf

Chris Hawthorne
PO Box 12
Troy, MT 59935
295-7005

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi:

Please consider my comment on the Troy Mine Revised Reclamation Plan Draft EIS.

G3 The northwestern area of Montana has been in a deep recession for a decade longer than the rest of our nation. Much of this is because of the systematic dismantling of the forestry management system of the United States Forest Service. The resultant collapse of the local economies of the area has been catastrophic. Over 3500 industrial, family wage jobs have been lost in the logging and milling businesses of Lincoln and Sanders Counties. The social ills such as alcoholism, drug addictions, family destructive behaviors, suicides, domestic abuse that follow these types of economic losses are well documented and were tragically predicted.

For the last several years, there has been a growing hope that mineral activity could replace some of the lost jobs and help to lower the unemployment rates of 20% that is found in these two counties. That hope will not be met with reality unless mines like the Troy Mine can stay in business. The economic benefit of nearly 200 jobs that average over $55,000 per year - not counting the benefits packages that includes health insurance, retirement plans and stock options â€“ cannot be overstated. The impact the Troy Mine has with $14 million in payroll, $10 million in local purchases of goods and services, $250,000 in property taxes, $1 million in gross proceeds taxes, $1.4 million in metal mines taxes cannot be overstated.

With this economic need as a backdrop to the discussion of the future of the mine, I would like to offer my support for the agency's preferred alternative â€“ with some suggestions for necessary changes.

H2 First, I do not think it is in the best interest of the environment to remove the topsoil from the toe of the impoundment area. Although it is true that this soil was once topsoil on the site, it has now been in place of over 30 years and it seems unnecessary and possibly even foolish to disturb the area so close to the water courses that have successfully protected

H2 during mine operation. Surely, in order to grow the trees and other vegetation that is native to the area, the soil from area borrow pits can be utilized with success and without the potential impacts associated with gross disturbance of areas near streams that have already healed up.

Thank you for accepting and considering my comment.

Sincerely,

Sincerely,

Chris Hawthorne

2011-07-29 Higareda M. pdf

Mike Higareda
1015 Nevada Ave.
Libby, MT 59923
293-3581

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Corsi and Ms. Lacklen:

Thank you for the opportunity to comment on the proposed revisions to the Troy reclamation plans. I would like to give my support for the preferred alternative as selected by the agencies, but would like to see some modifications to it.

I1 I don't understand why you would be taking the asphalt off of the road and returning the road surface to dirt. Wouldn't this create more BMP work to ensure that TMDLs are as low as possible? The current road needs some repair, but the costs of those repairs would be virtually insignificant compared to the long term work and maintenance you would be avoiding by doing so. I would imagine as this is a Forest Service road that it will also have
I2 a gate on it not far from the tailings impoundment, which would allow the asphalt to have a very good life span for continued access for monitoring of the pipelines carrying water from the adit.

E2 This brings me to my next issue with the preferred alternative. I don't understand why you want to require the Company to bury the pipeline underground when it could be monitored and accessed easily if it was left above ground and next to the road. Putting strict monitoring requirements on the existing line until it truly needs replaced and making them bond to replace it with an above ground line seems like the most common sense approach that will have the least impact to the watershed long term.

Please consider my suggestions before making your final decision.

Sincerely,

Sincerely,

Mike Higareda

2011-07-29 HolcombM.pdf

Mike Holcomb
213 W Balsam
Libby, MT 59923
4062933520

July 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

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Thank you for your time.

Very truly yours,

Sincerely,

Mike Holcomb

2011-07-29 Holder J. pdf

Jeff Holder
154 Noerman Av
Libby, MT 59923
4062938220

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi,

I am writing to support the Troy Mine and provide comment on their Revised Reclamation Plan Draft EIS.

G3 This project is incredibly important to the communities of Lincoln County and our state. The 190 plus jobs are the last industrial, wealth generating jobs in the County. These jobs and the $14,000,000 per year payroll they represent coupled with $20,000,000 per year spent on services â€" one half of which are purchased in Montana â€" are huge factors in the local economy. The $1.4 million paid annually on Montana Metal Mines license taxes and the $250,000 paid in property taxes benefits the local, county and state schools $1million paid annually on gross proceeds taxes benefits the State of Montana's bottom line.

None of this would matter if the mine were not environmentally sound. Thankfully, it is â€" and I applaud the EIS's conclusion, specifically with water impacts, that backs this conclusion.

E1 However, I do have some issues with the EIS and the potential impact on the environmental footprint of the closure requirements. Specifically, I take issues with the need to bond for removal of the pipelines above ground and replace them with lines below ground when the mine is done. The above ground pipelines are not hurting anything. Digging to bury a new line will cause more impacts to the environment than leaving them in place. Further, every time the pipes need work done to them or replaced the impacts will be revisited. When we are doing all we can to disallow the potential of sediment into our streams, it seems inconsistent to require such ground disturbances being repeated in perpetuity.

Thank you for taking my comment.

Sincerely yours,

Sincerely,

Jeff Holder

2011-07-29 JensenC.pdf

Clint Jensen
PO Box 71
Heron, MT 59844
4068472127

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

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Dear Kootenai National Forest and Montana DEQ:

Please accept my comments for the proposed reclamation revision at the Troy mine. I am fully supportive of the Troy mine and the success that it has had with controlling and mitigating environmental impacts while it has been in operation.

With all of the studies that have been done on the rock and all of the monitoring that has proven no impacts should make this an easy decision. Reading through some of the proposed mitigation measures that have been suggested, it obvious that there has been a very in depth analysis of the revision. It also looks like there is a bit of overkill with some of the suggestions.

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Please keep these considerations in mind when making your final decisions on the mitigation measures and the final reclamation plan.

Respectfully yours,

Sincerely,

Clint Jensen

2011-07-29 JungstM.pdf

Matt Jungst
37694 Hwy 2
Libby, MT 59923
293-6491

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

G3 The Troy Mine Reclamation plans needs to be approved and permitted for several reasons. The operation is a huge asset to northwest Montana and provides over 190 good paying family wage jobs in an area that has the highest unemployment in the state.

For over thirty years the mine has been depositing its tailings in the impoundment and there has not been any significant impact to the areas streams or wildlife.

E7 K2 Several studies have been done that confirm this and I believe that allowing them to amend their reclamation plan to continue operating is a no brainer. It seems that both the USFS and the DEQ has done a thorough job of analyzing the revised reclamation plans, though there seems to be some recommendations that would actually create more disturbance than should be necessary.

E1 E2 Removing the water pipeline that is buried below the surface (if it is decided that it needs to be replaced) seems impractical as it wouldn't hurt anything to just leave it and remove the pipeline that is above ground. Completely burying a new pipeline (which I'm not convinced is even needed) seems to contradict the desire of all parties to ensure that the lines can be monitored and that there is ability to quickly detect any leakage or break in the line and just as quickly get necessary repairs made while disturbing the least ground or water resources as possible.

That being said, I'm confident the agency will listen to those that have more experience than I in this area and arrive at common sense mitigations while approving this reclamation permit. But I would like to go on record as supporting the preferred alternative with some modifications to the requirements for the pipeline.

Thank you for your time,

Sincerely,

Matt Jungst

2011-07-29 Kanzler K. pdf

Kent Kanzler
PO Box 1041
Troy, MT 59935
291-2638

July 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

Please accept my comments for the Troy Mine revised reclamation plans that have been submitted to your agency. After reading most of the DEIS, I wanted to applaud the agency and the diligent work that it has done in coming up with its preferred alternative.

E1 I would like to comment on two things that I believe may need changed before the final decision to move forward with your preferred approach is made. One is the pipeline that you are requiring to be buried. I'm no hydrologist, but it just seems silly to be burying a pipeline that may need dug up and replaced later if in fact you are accurate that the water needs to go through the infiltration process at the impoundment. Why tear up the entire hillside when you could just put it above ground next to the road as it is now for easy access in case there is a problem decades down the road?

H1 K1 Another is with regards to the toe ponds that have all the topsoil that is being recommended to cover the impoundment for reclamation. There has been a lot of praise to the company because of the habitat that has been created for the western toad. It would seem like a no brainer that they use the course borrow to reclaim it even if it takes a bit longer to achieve the standards required. How long will it take to replace the habitat for the western toad?

Thanks for your consideration,

Sincerely,

Kent Kanzler

2011-07-29 KimK.pdf

Kasie Kim
208 W. Balsam St.
Libby, MT 59923
406-293-5696

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

G3 The Troy Mine Reclamation plans needs to be approved and permitted for several reasons. The operation is a huge asset to northwest Montana and provides over 190 good paying family wage jobs in an area that has the highest unemployment in the state.

E7 For over thirty years the mine has been depositing its tailings in the impoundment and there has not been any significant impact to the areas streams or wildlife.

K2 Several studies have been done that confirm this and I believe that allowing them to amend their reclamation plan to continue operating is a no brainer. It seems that both the USFS and the DEQ has done a thorough job of analyzing the revised reclamation plans, though there seems to be some recommendations that would actually create more disturbance than should be necessary.

E1 E2 Removing the water pipeline that is buried below the surface (if it is decided that it needs to be replaced) seems impractical as it wouldn't hurt anything to just leave it and remove the pipeline that is above ground. Completely burying a new pipeline (which I'm not convinced is even needed) seems to contradict the desire of all parties to ensure that the lines can be monitored and that there is ability to quickly detect any leakage or break in the line and just as quickly get necessary repairs made while disturbing the least ground or water resources as possible.

That being said, I'm confident the agency will listen to those that have more experience than I in this area and arrive at common sense mitigations while approving this reclamation permit. But I would like to go on record as supporting the preferred alternative with some modifications to the requirements for the pipeline.

Thank you for your time,

Sincerely,

Kasie Kim

2011-07-29 KochD.pdf

Dan Koch
PO Box 32
Troy, MT 59935
295-7066

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

Thank you for accepting my comments on the revised reclamation plans for the Troy mine. In the thirty years this impoundment has been in place, there has been a great amount of solid reliable data to support your preferred alternative, and I would like to say thank you for your acknowledging it.

K1 I would also like to comment on the reclamation using the topsoil that is currently providing habitat for the western toad. Many people have also acknowledged that careful soil management and wildlife can coexist and that this is something that should be applauded, not destroyed.

H1 From what I understand, it isn't going to cost any more to use the borrow or the topsoil that has been set aside, but it may take a bit longer for the borrow to produce the same reclamation goals if used. I would submit to you that saving habitat that is currently being created and allowing a little longer to create more is a win, win.

H2 I believe that whenever we can showcase an active mining operation creating habitat to any species that is struggling we should. If it isn't going to cost any more either way, and our goal is to reclaim the ground to provide erosion controls and wildlife habitat, we should use the borrow material instead.

Thank you for your consideration of my comments.

Respectfully,

Sincerely,

Dan Koch

2011-07-29 KyrissJ.pdf

Jon Kyriss
PO Box 772
Libby, MT 59923
4062912798

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Kootenai National Forest and Montana DEQ:

Please accept my comments for the proposed reclamation revision at the Troy mine. I am fully supportive of the Troy mine and the success that it has had with controlling and mitigating environmental impacts while it has been in operation.

With all of the studies that have been done on the rock and all of the monitoring that has proven no impacts should make this an easy decision. Reading through some of the proposed mitigation measures that have been suggested, it obvious that there has been a very in depth analysis of the revision. It also looks like there is a bit of overkill with some of the suggestions.

I1
E1

You want to take the asphalt out and take it down to dirt again? You feel that you need to dig up the entire existing pipeline and replace it with another line that must be buried? The existing pipelines are sufficient to transport the very clean water from the adit down to the impoundment. Why not disturb less ground and ensure further safety precautions on the existing line that has plenty of capacity to get the job done? Isn't our goal to have the least amount of disturbance necessary?

A5

The men and women at the Troy Mine operate a very safe, very productive, environmentally benign operation. We all want proper reclamation plans approved by the regulators and we certainly want proper bond requirements. That said, there are some things that simply aren't necessary, may not benefit the environment and don't make sense. I approve of the preferred alternative as put forth by the agencies but would like to see some modifications made to in the Record of Decision that reflect proper but not excessive reclamation plans.

Please keep these considerations in mind when making your final decisions on the mitigation measures and the final reclamation plan.

Respectfully yours,

Sincerely,

Jon Kyriss

2011-07-29 LauttR.pdf

Rod Lautt
173 Frazey Lp
Libby, MT 59923
4062917437

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

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With all of the studies that have been done on the rock and all of the monitoring that has proven no impacts should make this an easy decision. Reading through some of the proposed mitigation measures that have been suggested, it obvious that there has been a very in depth analysis of the revision. It also looks like there is a bit of overkill with some of the suggestions.

I1
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A5

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Please keep these considerations in mind when making your final decisions on the mitigation measures and the final reclamation plan.

Respectfully yours,

Sincerely,

Rod Lautt

2011-07-29 Lucibello C. pdf

Charla Lucibello
918 Idaho Ave PMB 179
Libby, MT 59923
406-334-0185

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi,

I am writing to support the Troy Mine and provide comment on their Revised Reclamation Plan Draft EIS.

G3 This project is incredibly important to the communities of Lincoln County and our state. The 190 plus jobs are the last industrial, wealth generating jobs in the County. These jobs and the $14,000,000 per year payroll they represent coupled with $20,000,000 per year spent on services â€“ one half of which are purchased in Montana â€“ are huge factors in the local economy. The $1.4 million paid annually on Montana Metal Mines license taxes and the $250,000 paid in property taxes benefits the local, county and state schools $1million paid annually on gross proceeds taxes benefits the State of Montana's bottom line.

None of this would matter if the mine were not environmentally sound. Thankfully, it is â€“ and I applaud the EIS's conclusion, specifically with water impacts, that backs this conclusion.

E1 However, I do have some issues with the EIS and the potential impact on the environmental footprint of the closure requirements. Specifically, I take issues with the need to bond for removal of the pipelines above ground and replace them with lines below ground when the mine is done. The above ground pipelines are not hurting anything. Digging to bury a new line will cause more impacts to the environment than leaving them in place. Further, every time the pipes need work done to them or replaced the impacts will be revisited. When we are doing all we can to disallow the potential of sediment into our streams, it seems inconsistent to require such ground disturbances being repeated in perpetuity.

Thank you for taking my comment.

Sincerely yours,

Charla Lucibello

Sincerely,

Charla Lucibello

2011-07-29 mackM.pdf

Margaret Mack
2044 Rocky draw Road
troy, MT 59935
4062955207

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Corsi and Ms. Lacklen:

E7 I would like to provide some comments on the revised reclamation plans for the Troy Mine. For the past three decades the water and rock studies have proven that this is one of the most environmentally benign mining operations in the country. The DEQ and the KNF have recognized this fact throughout the document, and I believe it has firm conclusive data to justify its decision.

B2 One thing that I did question while reading the document was the decommissioning plans for the building foundations. As I understand your preferred alternative, you are going to require the concrete foundations to be dug up, broken up, and deposited elsewhere. The justification was that it may create water quality issues if it was just backfilled on site, which seems the most common sense approach. I am failing to understand how digging it up and hauling it down to private property solves the issue of water quality. It might impact water quality up there, but not elsewhere? The logic doesn't work for me.

E1 One other thing that I read that seems illogical is the requirement for the pipeline to be buried. The existing pipeline is in good shape and runs right next to the road for easy access. Why would we bury it and then have to dig it up again if it ever needs replaced or repaired? This doesn't make much sense to me. It seems as though we are actually going to be requiring unneeded disturbance in the future when the goal is to remove or mitigate what impacts we can.

Thank you for your time.

Very truly yours,

Sincerely,

Margaret Mack

2011-07-29 Matott J. pdf

Judy Matott
180 Parmenter Ave.
Libby, MT 59923
406-293-3366

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Montana DEQ and Kootenai National Forest:

G1 Both the Troy Mine, and Montanore Mine have met evry demand thus far. STOP DELAYS, STOP MAKING UNNECESSARY, MORE COSTLY, DEMANDS. PUTOUR PEOPLE TO WORK AT THE MONTANORE MINE, AND KEEP THE TROY MINE GOING. DON'T KILL JOBS ... HELP CREATE THEM! BOTH MINES HAVE JUMPED THROUGH ENOUGH HOOPS.

Thank you for accepting my comments to the proposed revisions to the Troy Revised Reclamation Plan preferred alternative. I have just a couple of suggestions for you before you make your final determination.

I1 I would like to see the asphalt remain on the main road leading to the mine site. Removing it and returning it to dirt will just create more BMP work trying to mitigate for TMDL's in the watershed. You might require the asphalt to be repaired in places that it needs to be, but I believe it would be a short term investment that will pay long term dividends for the watershed.

H1 I also believe that using the readily available materials that is suitable for growth medium located on the mine to reclaim the tailing impoundment would be the better option. The topsoil that has been saved for that purpose has become great habitat for the western toad, and I believe that using the other material instead will grow the trees and shrubs necessary to ensure proper reclamation.

B1 I also think that breaking up the foundations and burying the concrete onsite would be just fine rather than digging them up, breaking them up and burying them somewhere else. It's just concrete and won't impact water quality any more than the rip rap along the Bull Trout stream at the bottom of the mountain.

Requiring the company to bury the pipeline when it could just be replaced with another above ground line doesn't make sense either. It seems that if you are serious about water

E1 quality and TMDL impacts, you wouldn't want to be disturbing an entire hillside to bury the line not to mention disturbing the ground and the advanced reclamation down the road if the line were to need replacement or repair. Leaving the pipeline above ground and next to the road with asphalt on it makes the most sense in my opinion.

Thanks for your time and consideration.

Sincerely yours,

Sincerely,

Judy Matott

2011-07-29 Medlinger R. pdf

Ryan Medlinger
1037 Kern
Troy, MT 59935
295-5529

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

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Thank you for taking my comment.

Sincerely yours,

Sincerely,

Ryan Medlinger

2011-07-29 PeekJ.pdf

Johnny Peek
89 Vaughn Ln Space 3
Libby, MT 59923
4062930935

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

Please accept my comments for the Troy Mine revised reclamation plans that have been submitted to your agency. After reading most of the DEIS, I wanted to applaud the agency and the diligent work that it has done in coming up with its preferred alternative.

E1 I would like to comment on two things that I believe may need changed before the final decision to move forward with your preferred approach is made. One is the pipeline that you are requiring to be buried. I'm no hydrologist, but it just seems silly to be burying a pipeline that may need dug up and replaced later if in fact you are accurate that the water needs to go through the infiltration process at the impoundment. Why tear up the entire hillside when you could just put it above ground next to the road as it is now for easy access in case there is a problem decades down the road?

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Thanks for your consideration,

Sincerely,

Johnny Peek

2011-07-29 Pepiot J.pdf

Joe Pepiot
217 Estate Dr
troy, MT 59935
4062959974

July 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Montana DEQ and Kootenai National Forest:

E7 Thank you for allowing me to comment on the Troy Mine Draft EIS. I believe that all of the past and current studies of the impoundment clearly indicate that it will not have a significant impact on ground or surface waters. The attenuation study that was done while the mine was closed and additional studies conducted recently support my conclusion. The rock characterization studies all show little to no potential for ARD or metal releases. These deposits are some of the most environmentally benign metal systems in the world.

After thirty years of this impoundment being in place with no significant impacts to water, it is clear that the decision of the agency will have solid, reliable data documenting the lack of impacts and substantial evidence to support its decision to permit the mine and its proposed reclamation plans.

G3 This operation is very important to the socio-economic wellbeing of Lincoln and Sanders counties. There are over 185 men and women working at this operation and over three million dollars a month of real wealth being distributed into Montana's economy through vendors, payroll, and taxes.

G1 The importance of this operation in two counties that represent the highest unemployment numbers in the state is without question. There will be no significant impacts to the environment by approving this mine's reclamation plans.

Respectfully,

Sincerely,

Joe Pepiot

2011-07-29 Posselt K. pdf

Kim Posselt
15417 Bull Lake Road
Troy, MT 59935
295-9581

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Montana DEQ:

E1

Please accept my recommendations to the proposed Troy reclamation revisions. I believe that requiring the company to tear down the existing pipeline that is in great shape to replace it with another one immediately upon decommissioning of the mine is not a reasonable requirement. An even more unreasonable request would be to require the company to bury the line.

At a minimum, the document should contain a discussion about the actual condition of the pipeline, how long it is expected to last and a much stronger discussion of why the pipeline should be buried.

After decommissioning, the pipeline will be carrying nothing but clean water and could last another fifty years before it needs replaced. Perhaps you could allow the pipeline to stay above ground and require the Company to repair or replace the line if it becomes necessary or to provide data about the condition of the line periodically to the agencies. I hope that the final reclamation plan allows the existing pipeline to be used until it needs replaced and that it is replaced with another in the same place alongside the road for easy monitoring into the future.

Thank you for considering my common sense recommendations and thank you for approving the Troy mine reclamation plans so they can continue to employ the almost two hundred men and women that depend on it.

Sincerely yours,

Sincerely,

Kim Posselt

2011-07-29 Savage S. pdf

Scott Savage
2175 Bull Lk Rd
Troy, MT 59935
4062954039

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

I would like to provide some comments regarding the Troy reclamation revision that is open for public comment.

E7 It seems that the agency has done a very thorough examination of all the data that has been collected over the last 30 years and has made an accurate assessment of the water being discharged. From what I have seen, there is simply going to be clean water flowing out of the adit down to the impoundment, and requiring a water treatment facility will not be required.

E1 One thing that really makes me scratch my head though has to do with the pipeline analysis. Is the existing pipeline in a condition that requires replacement immediately upon the mine being decommissioned? I would suggest leaving the existing pipeline infrastructure in place until it needs replacement, and I can't see the logic in burying it when it does get replaced. Wouldn't it be easier to detect leaks and work on it if it was above ground? Aren't we going to be disturbing much more ground by doing it this way? This just doesn't make a whole lot of sense to me.

Thank you for accepting my comments. I eagerly await your response!

Sincerely,

Sincerely,

Scott Savage

2011-07-29 Scott M. pdf

Michael Scott
PO Box 261
Troy, MT 59935
291-9702

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Kootenai National Forest and Montana DEQ:

Please accept my comments for the proposed reclamation revision at the Troy mine. I am fully supportive of the Troy mine and the success that it has had with controlling and mitigating environmental impacts while it has been in operation.

With all of the studies that have been done on the rock and all of the monitoring that has proven no impacts should make this an easy decision. Reading through some of the proposed mitigation measures that have been suggested, it obvious that there has been a very in depth analysis of the revision. It also looks like there is a bit of overkill with some of the suggestions.

I1
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You want to take the asphalt out and take it down to dirt again? You feel that you need to dig up the entire existing pipeline and replace it with another line that must be buried? The existing pipelines are sufficient to transport the very clean water from the adit down to the impoundment. Why not disturb less ground and ensure further safety precautions on the existing line that has plenty of capacity to get the job done? Isn't our goal to have the least amount of disturbance necessary?

A5

The men and women at the Troy Mine operate a very safe, very productive, environmentally benign operation. We all want proper reclamation plans approved by the regulators and we certainly want proper bond requirements. That said, there are some things that simply aren't necessary, may not benefit the environment and don't make sense. I approve of the preferred alternative as put forth by the agencies but would like to see some modifications made to in the Record of Decision that reflect proper but not excessive reclamation plans.

Please keep these considerations in mind when making your final decisions on the mitigation measures and the final reclamation plan.

Respectfully yours,

Sincerely,

Michael Scott

2011-07-29 Shaw J. pdf

John Shaw
46493 Hwy 2
Libby, MT 59923
4062915662

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

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Please keep these considerations in mind when making your final decisions on the mitigation measures and the final reclamation plan.

Respectfully yours,

Sincerely,

John Shaw

2011-07-29 Shea M. pdf

Michael Shea
691 Northwood
Libby, MT 59923
406-293-7270

July 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

Thank you for extending the comment period. I want to express my support for the Troy mine. Extensive evaluation, responsivness by the mine oprators and strong enviromnetal safeguards make this an extraction operation that can be a job poroducer locally as well as meet the nation consumtion needs for metals.

Thank you, Michael Shea

Sincerely,

Michael Shea

2011-07-29 StindtD.pdf

Danny Stindt
551 Silver Tip Way
Troy, MT 59935
291-1619

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi,

I am writing to support the Troy Mine and provide comment on their Revised Reclamation Plan Draft EIS.

G3 This project is incredibly important to the communities of Lincoln County and our state. The 190 plus jobs are the last industrial, wealth generating jobs in the County. These jobs and the $14,000,000 per year payroll they represent coupled with $20,000,000 per year spent on services â€" one half of which are purchased in Montana â€" are huge factors in the local economy. The $1.4 million paid annually on Montana Metal Mines license taxes and the $250,000 paid in property taxes benefits the local, county and state schools $1million paid annually on gross proceeds taxes benefits the State of Montana's bottom line.

None of this would matter if the mine were not environmentally sound. Thankfully, it is â€" and I applaud the EIS's conclusion, specifically with water impacts, that backs this conclusion.

E1 However, I do have some issues with the EIS and the potential impact on the environmental footprint of the closure requirements. Specifically, I take issues with the need to bond for removal of the pipelines above ground and replace them with lines below ground when the mine is done. The above ground pipelines are not hurting anything. Digging to bury a new line will cause more impacts to the environment than leaving them in place. Further, every time the pipes need work done to them or replaced the impacts will be revisited. When we are doing all we can to disallow the potential of sediment into our streams, it seems inconsistent to require such ground disturbances being repeated in perpetuity.

Thank you for taking my comment.

Sincerely yours,

Sincerely,

Danny Stindt

2011-07-29 ThompsonT.pdf

Timothy Thompson
12652 Bull Lake Rd
Troy, MT 59935
4062959216

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Corsi and Ms. Lacklen:

E7 I would like to provide some comments on the revised reclamation plans for the Troy Mine. For the past three decades the water and rock studies have proven that this is one of the most environmentally benign mining operations in the country. The DEQ and the KNF have recognized this fact throughout the document, and I believe it has firm conclusive data to justify its decision.

B2 One thing that I did question while reading the document was the decommissioning plans for the building foundations. As I understand your preferred alternative, you are going to require the concrete foundations to be dug up, broken up, and deposited elsewhere. The justification was that it may create water quality issues if it was just backfilled on site, which seems the most common sense approach. I am failing to understand how digging it up and hauling it down to private property solves the issue of water quality. It might impact water quality up there, but not elsewhere? The logic doesn't work for me.

E1 One other thing that I read that seems illogical is the requirement for the pipeline to be buried. The existing pipeline is in good shape and runs right next to the road for easy access. Why would we bury it and then have to dig it up again if it ever needs replaced or repaired? This doesn't make much sense to me. It seems as though we are actually going to be requiring unneeded disturbance in the future when the goal is to remove or mitigate what impacts we can.

Thank you for your time.

Very truly yours,

Sincerely,

Timothy Thompson

2011-07-29 VennE.pdf

Echo Jo Venn
51 Hutchison Lane
Miles City, MT 59301
406.531.00207

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

I would like to provide some comments regarding the Troy reclamation revision that is open for public comment.

E7 It seems that the agency has done a very thorough examination of all the data that has been collected over the last 30 years and has made an accurate assessment of the water being discharged. From what I have seen, there is simply going to be clean water flowing out of the adit down to the impoundment, and requiring a water treatment facility will not be required.

E1 One thing that really makes me scratch my head though has to do with the pipeline analysis. Is the existing pipeline in a condition that requires replacement immediately upon the mine being decommissioned? I would suggest leaving the existing pipeline infrastructure in place until it needs replacement, and I can't see the logic in burying it when it does get replaced. Wouldn't it be easier to detect leaks and work on it if it was above ground? Aren't we going to be disturbing much more ground by doing it this way? This just doesn't make a whole lot of sense to me.

Thank you for accepting my comments. I eagerly await your response!

Sincerely,

Sincerely,

Echo Jo Venn

2011-07-29 Venn8.pdf

Justin L. Venn
51 Hutchison Lane
Miles City, MT 59301
406.672.0205

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Corsi and Ms. Lacklen:

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Thank you for your time.

Very truly yours,

Sincerely,

Justin L. Venn

2011-07-29 Vincent B. pdf

Brandon Vincent
1168 Farm To Market RD
Libby, MT 59923
291-4543

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Montana DEQ and Kootenai National Forest:

Thank you for accepting my comments to the proposed revisions to the Troy Revised Reclamation Plan preferred alternative. I have just a couple of suggestions for you before you make your final determination.

I1 I would like to see the asphalt remain on the main road leading to the mine site. Removing it and returning it to dirt will just create more BMP work trying to mitigate for TMDL's in the watershed. You might require the asphalt to be repaired in places that it needs to be, but I believe it would be a short term investment that will pay long term dividends for the watershed.

H1 I also believe that using the readily available materials that is suitable for growth medium located on the mine to reclaim the tailing impoundment would be the better option. The topsoil that has been saved for that purpose has become great habitat for the western toad, and I believe that using the other material instead will grow the trees and shrubs necessary to ensure proper reclamation.

B1 I also think that breaking up the foundations and burying the concrete onsite would be just fine rather than digging them up, breaking them up and burying them somewhere else. It's just concrete and won't impact water quality any more than the rip rap along the Bull Trout stream at the bottom of the mountain.

E1 Requiring the company to bury the pipeline when it could just be replaced with another above ground line doesn't make sense either. It seems that if you are serious about water quality and TMDL impacts, you wouldn't want to be disturbing an entire hillside to bury the line not to mention disturbing the ground and the advanced reclamation down the road if the line were to need replacement or repair. Leaving the pipeline above ground and next to the road with asphalt on it makes the most sense in my opinion.

Thanks for your time and consideration.

Sincerely yours,

Sincerely,

Brandon Vincent

2011-07-29 Vincent8.pdf

Scott Vincent
51243 Hwy 2
Libby, MT 59923
293-7042

July 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi,

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Thank you for taking my comment.

Sincerely yours,

Sincerely,

Scott Vincent

2011-07-29 VincentV.pdf

Vance Vincent
37 Broadwater
Billing, MT 59103
406.293.1935

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

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The owners of the mine and the mine workers have done all they can to ensure the best possible out come from the mine, please support them in keeping them working.

Thank you for your time.

Very truly yours,

Sincerely,

Vance Vincent

2011-07-29 Williams G.pdf

George Williams
269 Farm To Market
Libby, MT 59923
293-1345

July 29, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi:

Please consider my comment on the Troy Mine Revised Reclamation Plan Draft EIS.

G3

The northwestern area of Montana has been in a deep recession for a decade longer than the rest of our nation. Much of this is because of the systematic dismantling of the forestry management system of the United States Forest Service. The resultant collapse of the local economies of the area has been catastrophic. Over 3500 industrial, family wage jobs have been lost in the logging and milling businesses of Lincoln and Sanders Counties. The social ills such as alcoholism, drug addictions, family destructive behaviors, suicides, domestic abuse that follow these types of economic losses are well documented and were tragically predicted.

For the last several years, there has been a growing hope that mineral activity could replace some of the lost jobs and help to lower the unemployment rates of 20% that is found in these two counties. That hope will not be met with reality unless mines like the Troy Mine can stay in business. The economic benefit of nearly 200 jobs that average over $55,000 per year - not counting the benefits packages that includes health insurance, retirement plans and stock options â€" cannot be overstated. The impact the Troy Mine has with $14 million in payroll, $10 million in local purchases of goods and services, $250,000 in property taxes, $1 million in gross proceeds taxes, $1.4 million in metal mines taxes cannot be overstated.

With this economic need as a backdrop to the discussion of the future of the mine, I would like to offer my support for the agency's preferred alternative â€" with some suggestions for necessary changes.

H2

First, I do not think it is in the best interest of the environment to remove the topsoil from the toe of the impoundment area. Although it is true that this soil was once topsoil on the site, it has now been in place of over 30 years and it seems unnecessary and possibly even foolish to disturb the area so close to the water courses that have successfully protected

H2 during mine operation. Surely, in order to grow the trees and other vegetation that is native to the area, the soil from area borrow pits can be utilized with success and without the potential impacts associated with gross disturbance of areas near streams that have already healed up.

Thank you for accepting and considering my comment.

Sincerely,

Sincerely,

George Williams

2011-07-30 Coe P. pdf

patty coe
po564
plains, MT 59859
406-826-3714

July 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

I would like to comment on the Troy Mine Revised Reclamation Plan Draft EIS.

The Troy Mine has emerged as a shining light in the tough economic picture of northwestern Montana. The mine made it through the dark days of the recession with pay cuts from top to bottom but not one single employee was laid off. The mine, now with ownership that includes the employees themselves through stock options, now underscores the hopeful economic potential of mining for an area that, for a decade, has led the state with catastrophically high unemployment.

G3

Numbers tell the story. Troy Mine now represents over 190 jobs, over $14 million in payroll, over $10 million in goods and services purchased in Montana, over $1.4 million in metal mines taxes for our schools, and over $1.25 in other state and local taxes.

If an incredibly conservative rollover factor of 2 is used to generate an idea of total local impact in this isolated and depressed area, the Troy Mine serves to economically support an additional 380 local jobs in other main street businesses and local government. This is a huge impact on the area.

Thankfully, this economic impact comes with little impact to the environment. In fact, the EIS recognizes this fact when it repeats the conclusions of 30 years of evaluation of water quality that have shown no impacts to the water quality in the mine's area streams. If society wants to have 'green' metals production, Troy Mine is a good source for providing that need.

E7

I generally support the conclusions of the preferred alternative. I have some questions about the reclamation requests in the document â€“ specifically as it concerns the water delivery pipeline. It is currently above ground for the vast majority of its route. It has been in use for nearly 30 years and seems to be functioning as needed and desired. Once the mine is no longer operating, this pipe will just carry water. Therefore, I think it is not

E1

E1 in the best interest of the environment to disturb ground for the many miles that would be need to remove the above ground line and install a new line underground the entire way. This just seems to reflect a desire to remove the visual of the pipe â€“ as if it is a negative thing to share with the public of the future.

E2 I, for one, like to see evidence of the ingenuity of man and think that personal opinion about visual qualities should not trump the need to be environmentally sound. Repair and replacement work in the future would be way less disturbing if the pipe was above ground and easy to access. The agency claims that the above ground pipeline would provide a target for vandalism does not square with the local experience of 30 years of that same pipeline's existence without one incident.

Thank you for considering my comment.

Sincerely,
patty coe

Sincerely,

patty coe

2011-07-30 Cuffem.pdf

From: mcuffe@interbel.net
To: DEQ Troy Mine; TroyMineReclamation@fs.fed.us
Subject: Comments on Troy Mine Re-Permitting
Date: Saturday, July 30, 2011 6:52:59 PM

Date: July 30, 2011
From: Rep. Mike Cuffe, Montana House District 2
To: Montana DEQ and Kootenai National Forest:

I attended the re-permitting meeting for the proposed revisions for the Revett Mine near Troy, MT., a few weeks ago. I didn't say anything at the time because I'm certainly not a mining expert. But driving home, I realized I am an expert on people of Lincoln County, on the Revett crew and the Revett operation and management.

I spent 2010 going door to door as I campaigned for the responsibility as representative to the Montana Legislature for House District 2, which includes most of rural Lincoln County, Eureka, and borders on both Libby and Troy populations. I spent January through April in Helena trying to help find jobs like these and operations like this one. I have visited with the director of DEQ and the KNF supervisor, so they know my feelings.

I personally know many of the miners employed at that copper mine. Guys like Paul Coon, Belvin Jellesed, Rod Thorstenson, Kelly Cannon and Robert Gonzales. I know how they think and how they work. They are the cream of the crop. I worked with them in the plywood plant in Libby. They were in my work crews. I have watched them grow and raise families. They care about their communities. They are proud of what they do.

I know how this company operates, and I know what employees think of this management team. I know what the community thinks of this company. This company does things right. When they make a mistake, they fix it quick. Not because some regulation says to but because their corporate culture is to do the right thing and to do things right.

As a decision maker and a policy maker, I know it is smart to consider their input. When you make your decisions on re-permitting, please don't leave the human factor out of the equation. Our families need good jobs. Our state needs taxpayers. Our environment needs operators like Revett. You agency officials need folks like these.

How often do you schedule a two hour meeting that draws a crowd like the one I attended? It was a good natured crowd, proud of this operation. There was no rock throwing, no critics, no disgruntled employees, no complaining environmentalists. It was just a bunch of good communioty people backing up a popular company. It got over quickly because people had no complaints.

Most Montana communities dream of an operation like this coming to their home town.

I remember meetings years ago when this mine was proposed by ASARCO, and I recall all the doomsday stories about boom and bust with an evironmental disaster left behind. Look around us today. This is a great mine operated by a great crew who have great pride in how their company does things.

Thank you for accepting my comments to the proposed revisions to the Troy Revised Reclamation Plan preferred alternative. I have just a couple of suggestions for you before you make your final determination.

I1 --Let asphalt remain on the main road leading to the mine site. Removing it and returning it to dirt will just create more BMP work trying to mitigate for TMDL's in the watershed. Repair it as needed.

H1 H2 --Using the readily available materials that is suitable for growth medium located on the mine to reclaim the tailing impoundment would be the better option. The topsoil that has been saved for that purpose has become great habitat for the western toad. Using the other material instead will grow the trees and shrubs necessary to ensure proper reclamation.

B1 --Breaking up the foundations and burying the concrete onsite makes sense rather than digging them up, breaking them up and burying them somewhere else. It's just concrete and won't impact water quality any more than the rip rap along the Bull Trout stream at the bottom of the mountain.

E1 --Keep the pipeline above ground. Don't disturb an entire hillside to bury the line and create a potential future complication if the line were to need replacement or repair later on.

I realize my comments are lengthy, but they are sincere. They reflect my personal feelings, as well as my official position as state representative for House District 2. I trust they will be read and seriously considered. Issue the new permit without unreasonable demands.

Respectfully yours,
Rep. Mike Cuffe,
Montana House District 2

2011-07-30 MosleyD. pdf

DIANE MOSLEY
109 Cottonwood Rd.
Heron, MT 59844
(406) 847-2024

July 30, 2012

Paul Bradford, Forest Supervisor
Kootenai National Forest
31374 US 2
Libby, MT 59923-3022

Richard Opper, Director
Montana Dept. Environmental Quality
PO Box 200901
Helena, MT 59620-0901

Re: Troy Mine Tailings Impoundment Reclamation EIS

Gentlemen:

My comments:

I1 1. Present paved mine road should be left intact. Removing & replacing the paved road with gravel is not economical or sound.

H3 2. Agree that more organic material is needed for impoundment reclamation - possibly mixing wood chips, rotted hay to some top soil from the east side of the impoundment.

E13 3. Investigation of the admitted barrel burial in the impoundment (also proven by ground-penetrating radar) must be included in the EIS. Contents must be clearly identified for proper EIS.

E12 4. A Toxic Release Inventory Log with full history should be required to account for all solvents, grease & lube oils.

B1 5. Suggest that buildings planned for removal be placed in the mine rather than buried or hauled away.

Thank you for the opportunity to submit comments.

Sincerely,

Diane Mosley

DIANE MOSLEY

AUG 02 2011
RECEIVED

2011-07-30 Mosley M.pdf

MILTON H. MOSLEY
109 Cottonwood Rd.
Heron, MT 59844
(406) 847-2024

July 30, 2012

Paul Bradford, Forest Supervisor
Kootenai National Forest
31374 US 2
Libby, MT 59923-3022

Richard Opper, Director
Montana Dept. Environmental Quality
PO Box 200901
Helena, MT 59620-0901

Re: Troy Mine Tailings Impoundment Reclamation EIS

Gentlemen:

My comments:

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E12 5. A Toxic Release Inventory Log with full history should be required to account for all solvents, grease & lube oils.

Thank you for the opportunity to submit comments.

Sincerely,

MILTON H. MOSLEY

AUG 02 2011
RECEIVED

2011-07-30 SharpB.pdf

Brian Sharp
1317 Montana Ave
Libby, MT 59923
406 2912495

July 30, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

Thank you for accepting my comments on the revised reclamation plans for the Troy mine. In the thirty years this impoundment has been in place, there has been a great amount of solid reliable data to support your preferred alternative, and I would like to say thank you for your acknowledging it.

K1 H1 H2

I would also like to comment on the reclamation using the topsoil that is currently providing habitat for the western toad. Many people have also acknowledged that careful soil management and wildlife can coexist and that this is something that should be applauded, not destroyed.

From what I understand, it isn't going to cost any more to use the borrow or the topsoil that has been set aside, but it may take a bit longer for the borrow to produce the same reclamation goals if used. I would submit to you that saving habitat that is currently being created and allowing a little longer to create more is a win, win.

I believe that whenever we can showcase an active mining operation creating habitat to any species that is struggling we should. If it isn't going to cost any more either way, and our goal is to reclaim the ground to provide erosion controls and wildlife babitat, we should use the borrow material instead.

Thank you for your consideration of my comments.

Respectfully,

SSG Sharp, Brian J
ODA 0313, Alpha Company, 3rd BN, 10th Special Forces Group (Airborne)

Sincerely,

Brian Sharp

2011-07-31 Farmer K. pdf

Ken Farmer
148 Manor Drive
Libby, MT 59923
406-293-8470

August 1, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

G3 The Troy Mine Reclamation plans needs to be approved and permitted for several reasons. The operation is a huge asset to northwest Montana and provides over 190 good paying family wage jobs in an area that has the highest unemployment in the state. WE NEED JOBS!

E7 K2 For over thirty years the mine has been depositing its tailings in the impoundment and there has not been any significant impact to the areas streams or wildlife. This reclation plan will have little and most likely no effect on any wildlife in the area and as studies have shown recently the impact studies to wildlife are largely invalid and are hyped by environmentlists and supported by our liberal judges. For example grizzly bears are not supposed to cross major highways, however a couple yearsa go a large male grizzly was killed by a truck on Highway 200 in Lincoln, Montana.

Several studies have been done that confirm this and I believe that allowing them to amend their reclamation plan to continue operating is a no brainer. It seems that both the USFS and the DEQ has done a thorough job of analyzing the revised reclamation plans, though there seems to be some recommendations that would actually create more disturbance than should be necessary.

E1 E2 Removing the water pipeline that is buried below the surface (if it is decided that it needs to be replaced) seems impractical as it wouldn't hurt anything to just leave it and remove the pipeline that is above ground. Completely burying a new pipeline (which I'm not convinced is even needed) seems to contradict the desire of all parties to ensure that the lines can be monitored and that there is ability to quickly detect any leakage or break in the line and just as quickly get necessary repairs made while disturbing the least ground or water resources as possible.

That being said, I'm confident the agency will listen to those that have more experience than I in this area and arrive at common sense mitigations while approving this reclamation

permit. But I would like to go on record as supporting the preferred alternative with some modifications to the requirements for the pipeline.

Thank you for your time,

Sincerely,

Ken Farmer

2011-07-31 Farmer 8.pdf

Susan Farmer
148 Manor Drive
Libby, MT 59923
406-293-8470

July 31, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

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Thank you for taking my comment.

Sincerely yours,

Sincerely,

Susan Farmer

2011-08-01 AntonioliT.pdf

Ted Antonioli
5907 Longview
Missoula, MT 59803

August 1, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Montana DEQ and KNF:

I am writing in my capacity as President of the Missoula Chapter of the Montana Mining Association to comment on the proposed Troy mine reclamation provisions.

Continued mining of copper and silver in the Libby-Troy area depends on several factors, particularly metal prices, exploration success, and a reasonable regulatory environment. We do not want to see the mining industry suffer the fate of the region's forest products industry, irrationally destroyed in order to \\\"save\\\" the forest for rot, bugs, and fires... all in the name of enhancing the environment while in fact degrading it.

We are concerned that mining in the region is being subjected to burdensome and expensive requirements that achieve very little except to drain out the capital that might instead be used for purposes such as exploration to extend the life of the mines and develop new deposits. Certainly the over 25 year \\\"process\\\" of permitting the Rock Creek deposit is one of our nation's starkest examples of over-regulation and economic paralysis. It appears to us that the permitting process at Montanore has also slowed to a glacial pace, preventing these projects from receiving the benefit of record and near-record metal prices and providing a much-needed economic boost to a deeply depressed area.

E1 One example from the current permitting process for Troy... the information we have seen to date indicates to us that requiring Revett to remove a perfectly sound pipeline and to replace it with another one immediately upon decommissioning of the mine doesn't make sense.

We urge speedy approval of a revised reclamation plan for Troy in line with common sense, and expedited permits for the Rock Creek and Montanore mines as well.

Sincerely yours,
Ted Antonioli

2011-08-01 Hill B. pdf

Betti Hill
PO Box 4717
Helena, MT 59604
406-431-3920

August 1, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

Thank you for accepting my comments on the revised reclamation plans for the Troy mine.

I am a big believer in Montana utilizing our natural resources to benefit our country and our state. Mines such as the Troy Mine which have over 30 years of solid evidence of reliable work are places where we need to enlarge our state employment pool with these good paying jobs.

I love the environment but believe that we can have both a healthy environment while developing our resources. We need these jobs, and I hope you will carefully consider this request.

Thank you for your consideration of my comments.

Respectfully,

Sincerely,

Betti Hill

2011-08-01 KaryD.pdf

Doug Kary
415 W. Wicks Ln
Billings, MT 59105
406-698-1478

August 1, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

After 30 years of examination and collecing data, it appears from what I can tell that discharged water is

E7 It seems that the agency has done a very thorough examination of all the data that has been collected over the last 30 years and has made an accurate assessment of the water being discharged, that it is clean water. A water treatment facility should not be required unless there is documented \\\"need\\\".

One thing that really makes me scratch my head though has to do with the pipeline analysis. Is the existing pipeline in a condition that requires replacement immediately upon

E1 the mine being decommissioned? I would suggest leaving the existing pipeline infrastructure in place until it needs replacement, and I can't see the logic in burying it when it does get replaced. Wouldn't it be easier to detect leaks and work on it if it was above ground? Aren't we going to be disturbing much more ground by doing it this way? This just doesn't make a whole lot of sense to me.

I eagerly await your response!

Sincerely,

Sincerely,

Doug Kary

2011-08-01 Mangold S.pdf

From: Steve Mangold
To: DEQ Troy Mine; TroyMineReclamation@fs.fed.us
Subject: Attn: Troy Mine Revised Reclamation Plan
Date: Monday, August 01, 2011 6:48:27 AM

Concerning the mine in Troy, it is essential for many reasons to allow the mine to progress and succeed. Certain safeguards need to be targeted, but we also need to allow an essential activity that has been going on since the dawn of man- mining of the earth's minerals. The industry takes great efforts to care for the environment and animals, shown by their willingness to make huge investments toward these ends.
The regulators and obstructionist want resources and energy for their everyday lives to be available, but somehow want it produced with zero impact which is impossible- and the impact that the mining and oil recovery do have is exaggerated from all reality. Canada has a booming economy, even with their more socialist/ European mentality. They allow more mining, oil and timber harvesting than we do, so now if we see any prosperity in Lincoln County it is from our visiting friends to the North. It is crazy that our people have to find jobs in the North Dakota oilfields, or have poverty jobs here, while the tax base has been so strangled by well meaning but ill-informed environmentalists.
We can have the improved tax base for roads, services and schools and the jobs for our people to provide for their families, while providing the abundant minerals needed for our lives- or we can continue to strangle ourselves, letting other countries prosper while they provide our minerals, oil and timber.
We either sink or chose to swim- hopefully the majority who wish to swim will prevail in this matter.

Most sincerely,

STEVE MANGOLD
Eureka Consulting and Sales, LLC
Ph/Fax (406)889-5959
Cell (406)261-8700
Box 373, Eureka
Montana 59917
Email smangold@interbel.net

2011-08-02 Coleman J. pdf

Jeff Coleman
pobox25
Whitehall, MT 59759
406-533-9833

August 2, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi:

Please accept my following comments for the proposed reclamation plan revisions at the Troy mine. I fully support the mine and their desire to continue operating under the Company Proposed Action.

E7 K1 D1 With thirty years of documented analysis and several studies completed during the impoundments history showing no environmental impacts to water or wildlife this plan should be approved.

We as a society have very few examples where we actually extract mineral resources from deposits such as these that are so benign and have no long lasting negative impacts to the environment. I have seen firsthand the impoundment and the abundance of existing wildlife that cohabitates it. The fisheries have had zero negative impacts from this impoundment and the attenuation study done while the mine was dormant clearly illustrates what to expect when this operation is decommissioned.

G3 Between now and then, allowing this permit to move forward will allow for the mine to continue operating in a responsible manner. The contribution of millions of dollars every month into the local and state economy will continue and the 190 employees and their families will have continued job security.

I urge the agencies to approve this plan as soon as possible and thank you for allowing me to comment.

Sincerely,

Sincerely,

Jeff Coleman

2011-08-02 Cotten R. and K. pdf

From: Ronald and Kathleen Cotten
To: DEQ Troy Mine; TroyMineReclamation@fs.fed.us
Cc: bnboss@frontiernet.net; rwraab@frontiernet.net; ralusamp@frontiernet.net; "Timory"; kcandln@montanasky.net; Opper, Richard
Subject: Comments on Troy Mine EIS
Date: Tuesday, August 02, 2011 4:47:33 PM

To: Bobby Lacklen
Kootenai National Forest

Emily Corsi
Montana Dept. of Environmental Quality

We and our neighbors live just north of the Troy mine's tailings impoundment. This is immediately downstream of the tailings impoundment on Lake Creek and immediately downwind given the prevailing winds. Our proximity to the tailings impoundment gives us a keen interest in both the operation and reclamation of the Troy mine with respect to water and air quality issues as impacted by the mine. We have reviewed the proposed EIS and offer the following comments:

1. We support the MDEQ and Forest Service decision to require a full EIS process instead of the EA process that had been previously pursued. It has been our opinion all along that the EA process was inadequate to ensure that the eventual reclamation would restore the mine site to a state that would not create essentially permanent environmental problems for us and the members of our community.

C2

2. We believe that the final document should be thorough and capable of ensuring an appropriate state of reclamation even in the face of opposition by the mine's operators at the time of its implementation. This is not intended to disparage the current Troy Mine management. Over the last two years that they have managed the mine, they have resolved the most serious environmental issues that preceded their tenure and have proven themselves to be good neighbors. Rather, it is simply a recognition that management teams change from time to time, either at the behest of an internal board of directors or through merger or acquisition. These changes occur all the time in business and we believe it is prudent to assume that a reclamation that will occur some years from now may very well occur under a different management structure that may have different priorities that may not include environmental protection. The requirements of the EIS should be written with this possibility in mind and should be explicit and binding on whomever owns and operates the mine at the time of its closure.

3. We fully support the Agency-Mitigated Alternative (AMA) as the appropriate guideline for the final EIS. Having suffered chronic air pollution problems for several years under the previous Genesis management regime, we can assure you that the 1978 Reclamation Plan is a non-starter. The Proposed Action (PA) plan is deficient in a number of ways as exposed by the AMA. It is important to remember that once the reclamation is completed, any leverage to fix environmental problems that were ignored or overlooked in the reclamation plan will be lost. Indeed, the current operator may no longer even exist.

B4

4. One element that was not addressed in the AMA is the possibility of the tailings impoundment's storage capacity being exceeded prior to the cessation of the mining operation. We believe this is a real possibility given the new reserves that have been found at the mine and the limited expansion available at the tailings impoundment. We believe that the storage capacity of the impoundment will be fundamentally limited by the eventual degree to which the height of the retaining dikes can be raised, and this in turn will be limited by their structural integrity in the face of severe weather events, earthquakes, etc. In the event such a limitation becomes reality, mining could continue by shifting to a paste-and-backfill method of tailings storage within the existing mine cavity. If this situation does indeed occur, we believe the EIS should require the reclamation of the existing tailings impoundment to begin immediately rather than to wait until the mine eventually closes down. In addition we believe that the reclamation period, once begun, should not exceed 2 years.

C3

5. Air quality monitoring should be maintained throughout the reclamation period and thereafter until it is fully demonstrated that the revegetation effort has successfully resolved all air quality and blowing dust issues.

H1
H2
H3
C5

6. The AMA requires that the original topsoil, now stored on the west side of the tailings impoundment, be used to cover the tailings impoundment surface to a depth of 18" and to cover the disturbed areas at the mine itself to a depth of 12". This would restore a reasonable quality soil to these areas to support revegetation, but would require extensive disturbance to an area that is now fully revegetated and stable. The mine operator has proposed using what is essentially pit-run from an existing disturbed area located on the east side of the tailings impoundment instead of the stored topsoil. This would result in a poorer quality soil being used for the reclamation as compared to the stored topsoil, but would leave the revegetated west side of the impoundment that abuts Lake Creek intact. We believe the latter proposal should be considered in order to protect Lake Creek's water quality, but only if the substituted soil is fully amended with the appropriate organic matter to ensure its ability to support the long term robust revegetation that will be needed to prevent air quality issues with blowing dust. While we do believe that there is a role for chemical fertilizers in the revegetating process, it is not a substitute for sufficient organic material content within the soil.

E1
E2

7. With regard to the AMA proposal for the pipelines, we fully support its recommendations. At the public hearing in Troy there were a couple of comments supporting the continued use of the existing pipelines throughout the reclamation process. I would point out that these pipelines were installed in the 1970's and that it could take many years after reclamation for the mine water to improve enough to directly discharge into Stanley Creek. In 2009 there was a discharge of tailings slurry into the Lake Creek drainage that turned the water of Lake Creek into the consistency and color of skim milk. The cause? A break in the same pipeline that is being proposed for continued use under the PA plan. The reality is that all infrastructures, including pipelines, have a finite useful life. The existing pipelines are today over 30 years old. With the continued discovery of new reserves, the mine's life may be extended by many years. It is not inconceivable that these pipelines could be 40 or even 50 years old by the time reclamation at the mine is undertaken. Also to be considered is that the response time to any post-reclamation event with respect to a pipeline failure will almost certainly be extended because of the difficulties in detection, evaluation, and getting the required restoration assets on site, in what will then be a remote and perhaps unmanned location. Relying on the existing pipelines under these circumstances is simply imprudent. As far as the placement of a new pipeline, we support the AMA requirement for underground placement because it will be protected from the elements and from external damage from most causes. It is not a coincidence that virtually all pipelines of all types are installed underground. We also see leakage monitoring as a necessary tool to ensure early detection of pipeline failures and/or leaks.

E13
E12

8. The one issue of concern to us that was not addressed in any of the alternative approaches was the presence or absence of barrels of potentially toxic materials that were allegedly buried in the tailings impoundment by Asarco. While we became aware of this issue in 2009, others have had concerns dating back some years. Since 2009, the MDEQ has required the installation of additional monitoring wells and the implementation of a more robust water monitoring program on the theory that any potential leakage of toxic materials could be dealt with if and when it occurred. To date, there have been no indications of any contaminates. Our concern is that if Asarco did indeed illegally dispose of toxic materials by burying them in the tailings impoundment as alleged, how will a post-reclamation leak be detected, located and either removed or contained before the groundwater, and our community's wells, are contaminated? As it stands now, there is a mining company on site that can be engaged should the problems arise. However, after the mine is closed and there is no local organization on site, the detection and resolution of water contamination becomes much more problematic. We believe that this issue needs to be considered in the final EIS to ensure the long term integrity of Lake Creek and the quality of our community's well water long after the mine has ceased operations.

2011-08-02 GarwoodG.pdf

Greg Garwood
2040 Garrison
Butte, MT 59701
406 723 8848

August 2, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Corsi and Ms. Lacklen:

E7 I would like to provide some comments on the revised reclamation plans for the Troy Mine. For the past three decades the water and rock studies have proven that this is one of the most environmentally benign mining operations in the country. The DEQ and the KNF have recognized this fact throughout the document, and I believe it has firm conclusive data to justify its decision.

B2 One thing that I did question while reading the document was the decommissioning plans for the building foundations. As I understand your preferred alternative, you are going to require the concrete foundations to be dug up, broken up, and deposited elsewhere. The justification was that it may create water quality issues if it was just backfilled on site, which seems the most common sense approach. I am failing to understand how digging it up and hauling it down to private property solves the issue of water quality. It might impact water quality up there, but not elsewhere? The logic doesn't work for me.

E1 One other thing that I read that seems illogical is the requirement for the pipeline to be buried. The existing pipeline is in good shape and runs right next to the road for easy access. Why would we bury it and then have to dig it up again if it ever needs replaced or repaired? This doesn't make much sense to me. It seems as though we are actually going to be requiring unneeded disturbance in the future when the goal is to remove or mitigate what impacts we can.

Thank you for your time.

Very truly yours,

Sincerely,

Greg Garwood

2011-08-02 HeikkinenD.pdf

Donna Heikkinen
P.O.Box 3293
Butte, MT 59702
406 494-5759

August 2, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Montana DEQ and Kootenai National Forest:

E7 Thank you for allowing me to comment on the Troy Mine Draft EIS. I feel that with proper guidelines and bonding, that mining in Montana is a great avenue. I believe that all of the past and current studies of the impoundment clearly indicate that it will not have a significant impact on ground or surface waters. The attenuation study that was done while the mine was closed and additional studies conducted recently support my conclusion. The rock characterization studies all show little to no potential for ARD or metal releases. These deposits are some of the most environmentally benign metal systems in the world.

After thirty years of this impoundment being in place with no significant impacts to water, it is clear that the decision of the agency will have solid, reliable data documenting the lack of impacts and substantial evidence to support its decision to permit the mine and its proposed reclamation plans.

G3 This operation is very important to the socio-economic wellbeing of Lincoln and Sanders counties. There are over 185 men and women working at this operation and over three million dollars a month of real wealth being distributed into Montana's economy through vendors, payroll, and taxes.

G1 Yes, mining has not always been a \\\"clean\\\" industry, but we must learn from past mistakes. By doing this we can avoid harming the environment, and also allow families to thrive. I strongly feel that our state can safely mine and log and still be environmentally sound. A mine can be reclaimed, and forests are a renewable resource.
Thanks for your time.

Respectfully

Sincerely,

Donna Heikkinen

2011-08-02 Inabnit W.pdf

William Inabnit
P.O. Box 223
Cameron, MT 59720
406-490-2059

August 2, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Montana DEQ and Kootenai National Forest:

E7 Thank you for allowing me to comment on the Troy Mine Draft EIS. I believe that all of the past and current studies of the impoundment clearly indicate that it will not have a significant impact on ground or surface waters. The attenuation study that was done while the mine was closed and additional studies conducted recently support my conclusion. The rock characterization studies all show little to no potential for ARD or metal releases. These deposits are some of the most environmentally benign metal systems in the world.

To whom it may concern, I am a miner who works for Golden Sunlight Mine in Whitehall Montana and have been involved in mining for 14 years. I know first hand that mining in montana is a good thing both for the state and the local community. Good jobs are hard to come by and great jobs like mining offers are even harder to come by. Both are available when mining is allowed to happen. Please take the time to look at the positive impacts that mining can have before making your dedision. After thirty years of this impoundment E7 being in place with no significant impacts to water, it is clear that the decision of the agency will have solid, reliable data documenting the lack of impacts and substantial evidence to support its decision to permit the mine and its proposed reclamation plans.

G3 This operation is very important to the socio-economic wellbeing of Lincoln and Sanders counties. There are over 185 men and women working at this operation and over three million dollars a month of real wealth being distributed into Montana's economy through vendors, payroll, and taxes.

G1 The importance of this operation in two counties that represent the highest unemployment numbers in the state is without question. There will be no significant impacts to the environment by approving this mine's reclamation plans.

Respectfully,
Bill Inabnit
Safety Technician

Golden Sunlight Mine, Barrick
Whitehall, Mt. 59759

Sincerely,

William Inabnit

2011-08-02 mihelichm.pdf

Mark Mihelich
2850 Nettie st.
Butte, MT 59701
4062872049

August 2, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Hello:

Thank you for allowing me to comment on the proposed revisions to the Troy reclamation plans. I believe that the DEQ's proposed alternative is the best action to take, though I think there needs to be some minor tweaks made before the final action is taken.

E7 The Troy Mine has a long record of water monitoring and the agency seems to also recognize this by not requiring post closure mechanical water treatment, which I fully support. I also understand that the agency wants the reclamation plan to mitigate as many impacts as they can upon decommissioning of the mine, but there seems to be some contradictions in the proposed action plan.

K1 H2 If we truly want to create wildlife habitat and soil stability at the same time, why are we removing the topsoil berm that is already providing awesome habitat for the western toad? I understand that your analysis showed that it may take a bit longer to achieve your desired ends, but how much longer? The trees and shrubs that are currently surrounding the site are growing just fine in the same soil that would be used instead of the topsoil. I understand that you would want to use the topsoil under other circumstances, but because the Western toad uses the berm I believe there should be a variance made to allow for the borrow to be used instead of the previously stripped topsoil to protect the toad's habitat.

E1 E2 Another glaring contradiction is with burying the pipeline that will need to be monitored for decades according to the EIS. If the existing pipeline that has been there for thirty years needs to be removed after another ten years of use, then are you anticipating removing the pipeline every 40 years or so by digging it back up and burying it again? It makes much more sense to require the Company to replace the pipeline if and when necessary, but leave it above ground next to the road for ease of monitoring and accessing the line for any necessary repair or replacement.

Thank you for considering my comments.

Respectfully,

Sincerely,

Mark Mihelich

2011-08-02 moodryJ.pdf

joe moodry
1843 Texas Ave.
butte, MT 59701
(406)565-9255

August 2, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Montana DEQ and Kootenai National Forest:

E7 Thank you for allowing me to comment on the Troy Mine Draft EIS. I believe that all of the past and current studies of the impoundment clearly indicate that it will not have a significant impact on ground or surface waters. The attenuation study that was done while the mine was closed and additional studies conducted recently support my conclusion. The rock characterization studies all show little to no potential for ARD or metal releases. These deposits are some of the most environmentally benign metal systems in the world.

After thirty years of this impoundment being in place with no significant impacts to water, it is clear that the decision of the agency will have solid, reliable data documenting the lack of impacts and substantial evidence to support its decision to permit the mine and its proposed reclamation plans.

G3 This operation is very important to the socio-economic wellbeing of Lincoln and Sanders counties. There are over 185 men and women working at this operation and over three million dollars a month of real wealth being distributed into Montana's economy through vendors, payroll, and taxes.

G1 The importance of this operation in two counties that represent the highest unemployment numbers in the state is without question. There will be no significant impacts to the environment by approving this mine's reclamation plans.

Respectfully,
Joe A Moodry

Sincerely,

joe moodry

2011-08-02 SantH.pdf

Harold Sant
765 hwy 359
Cardwell, MT 59721
406-287-2052

August 2, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Corsi and Ms. Lacklen:

E7 I would like to provide some comments on the revised reclamation plans for the Troy Mine. For the past three decades the water and rock studies have proven that this is one of the most environmentally benign mining operations in the country. The DEQ and the KNF have recognized this fact throughout the document, and I believe it has firm conclusive data to justify its decision.

B2 One thing that I did question while reading the document was the decommissioning plans for the building foundations. As I understand your preferred alternative, you are going to require the concrete foundations to be dug up, broken up, and deposited elsewhere. The justification was that it may create water quality issues if it was just backfilled on site, which seems the most common sense approach. I am failing to understand how digging it up and hauling it down to private property solves the issue of water quality. It might impact water quality up there, but not elsewhere? The logic doesn't work for me.

E1 One other thing that I read that seems illogical is the requirement for the pipeline to be buried. The existing pipeline is in good shape and runs right next to the road for easy access. Why would we bury it and then have to dig it up again if it ever needs replaced or repaired? This doesn't make much sense to me. It seems as though we are actually going to be requiring unneeded disturbance in the future when the goal is to remove or mitigate what impacts we can.

Thank you for your time.

Very truly yours,

Sincerely,

Harold Sant

2011-08-02 WindomB-and-R.pdf

Bob and Rita Windom
P O Box 830
Libby, MT 59923
293-6764

August 2, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Corsi and Ms. Lacklen:

We have been associated with the Troy Mine since it opened. Bob was a subcontractor providing snacks and soft drinks for years. He had the opportunity to be in different areas of mine weekly. He is a keen observer. Based on his observations he has championed the mine in any opportunity that arose.

As a county commissioner, I also had some upfront tours and observations. We both agree that the Troy Mine has been operated in a manner friendly to the environment and to its employees and the communities. The mitigation proposd below seems totally unjustified and expensive.

E7 I would like to provide some comments on the revised reclamation plans for the Troy Mine. For the past three decades the water and rock studies have proven that this is one of the most environmentally benign mining operations in the country. The DEQ and the KNF have recognized this fact throughout the document, and I believe it has firm conclusive data to justify its decision. We have discussed the following comments and believe them to be sound.

B2 One thing that I did question while reading the document was the decommissioning plans for the building foundations. As I understand your preferred alternative, you are going to require the concrete foundations to be dug up, broken up, and deposited elsewhere. The justification was that it may create water quality issues if it was just backfilled on site, which seems the most common sense approach. I am failing to understand how digging it up and hauling it down to private property solves the issue of water quality. It might impact water quality up there, but not elsewhere? The logic doesn't work for me.

E1 One other thing that I read that seems illogical is the requirement for the pipeline to be buried. The existing pipeline is in good shape and runs right next to the road for easy access. Why would we bury it and then have to dig it up again if it ever needs replaced or repaired? This doesn't make much sense to me. It seems as though we are actually going

to be requiring unneeded disturbance in the future when the goal is to remove or mitigate what impacts we can.

Thank you for your time.

Very truly yours,

Sincerely,

Bob and Rita Windom

2011-08-03 ClarkB.pdf

Bruce Clark
P.O. Box 479
Troy, MT 59935
406-295-5582 x226

August 3, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi:

My name is Bruce Clark. I have worked at the Troy Mine for over 31 years. I am currently the Mine Manager.

Please accept my following comments for the proposed reclamation plan revisions at the Troy mine. I fully support the mine and their desire to continue operating under the Company Proposed Action.

By virture of having worked at the Troy Mine for over 31 years, I believe Revett Minerals position on the Draft EIS is the correct way to go. I have personnally been involved with Tailings reclamation during the 12 year shutdown period, water transport through tailings / reclaim pipelines, and road maintenance. All of these actions have been very successful in protecting the Troy Mine environment.

Following is text from Revett Mineral's response to the Draft EIS that I fully endorse. Please incorporate it into the records.

Pipeline to Transport Mine Water at Closure

E-TMI 1

The DEIS concludes that the existing dual 8â€• urethane lined steel pipelines that carry tailing slurry during operations need to be replaced with a new buried line at closure. TMI disagrees that the lines need to be replaced and there is little rational in the DEIS to justify this suggested replacement. The main reasons TMI disagrees with the installation of a new buried line are:

1) The existing two surface tailing lines and the existing buried pipeline have more than enough capacity and useful life to transport the mine water to the tailing facility as verified in discussions with the pipeline manufacturer;
2) The installation of a new buried line at closure would create significant new ground disturbance that will require additional reclamation;

3) There are areas in the pipeline and road corridor that are impractical for burial due to proximity of live streams (Stanley Creek and Lake Creek); and
4) TMI is installing additional secondary containment for monitoring and leak detection near stream crossings, on the existing tailing lines, that will allow better monitoring and the surface lines will be easier to repair if necessary.

It is TMIâ€™s opinion, based on actual review and testing by the pipeline manufacturer, that these lines currently have significant safe and useful life and should continue to be used following closure. TMIâ€™s proposed Closure Operations Manual (see Appendix A) summarized in this section provides a reasonable engineering approach to minimizing risk of a mine water spill during post closure.

The DEIS does not document any particular flaw or problem with the two existing 8â€• lines, but indicates that they are â€œoldâ€• and that above ground pipelines would be â€œmore susceptible to vandalismâ€•. It is further indicated (with no documentation or explanation) that a leak from a buried pipeline would be less likely to cause sediment to reach surface water. The DEIS incorrectly implies that the current operations does not include secondary containment of the tailing pipelines and that there is no monitoring of possible pipeline leaks. The Closure Operations Manual addresses secondary containment and leak detection monitoring. TMI would like to note that the installation of a new buried line will include a number of stream crossings where the line will either have to be buried under the stream or attached to bridge structures creating new areas of both engineering and installation challenge.

E-TMI 1

TMI has substantiated that the existing above ground tailing lines will have many years of service left at closure. Based on actual testing conducted in 2004 with the pipeline manufacturer (Irathane), the urethane lining in the existing pipelines is in excellent shape. At the time of the testing each of the slurry lines had a total of sixteen million tons of slurry flow through them, yet the lining was like new. In discussions with the manufacturer, they believe that the lining would last indefinitely with the continuous flow of mine water.

Therefore, TMI considers the addition of a 10 to 18 inch diameter buried pipeline for transporting mine water to the tailing storage facility unnecessary. The life and capacity of the two existing two surface 8 inch pipelines and the existing 10 inch buried pipeline will be every bit as effective as the proposed HDPE pipe and there is no new disturbance required.

TMI believes excavation for burial of the proposed pipeline will cause undue environmental disturbance; increase risk of sedimentation to nearby streams; and not provide any more assurance against discharge to nearby streams nor protect against vandalism. Assuming that the pipe must be buried below the frost line, the 6.1 miles of pipeline will require disturbing a 25 ft width or a minimum additional disturbance of 18.5 acres.

The DEIS documents concern with the tailings lines plugging and an over pressure event occurring which may break the lines. This will not happen for the following reasons:
1)The tailing line design includes a rupture disk installed in each tailings line that will open at 586 psi in the event of a pressure surge with the discharge directed to a containment pond. These rupture disks will prevent a tailing line breakage from an over

E-TMI 1

pressure event from occurring; and
2)The tailings lines have been pressure tested at 1,110 psi. At closure, when running water in the line, the potential maximum pressure will be only 475 psi.

Soil Replacement and Amendment

TMI disagrees with the agencies recommended use of the topsoil located below the toe ponds because:

1. An adequate and proven source of topsoil / growth medium exists on the east side of the tailing facility;
2. The topsoil area below the toe ponds has been successfully reclaimed with over 30 years of re-vegetation that would be re-disturbed;
3.The control of sedimentation to Lake Creek during reclamation activities and topsoil excavation will be a challenge; and
4.The area around the toe ponds is providing breeding habitat for the western toad which has been listed as a species of a concern.

The agency alternative in the DEIS indicates that that soil salvaged in the tailing pond area be used for reclamation rather than borrow soil. TMI is concerned that use of the toe pond salvaged soil will increase long term risk of sediment impacts to Lake Creek, will impact documented western toad habitat and will result in the same reclamation success outcome as using the borrow soil (return of similar forest vegetation to that before the mine). The existing topsoil piles are fully re-vegetated with a thick growth of grass, alders, brush and coniferous trees. The potential impacts to neighbors from dust during soil replacement is higher with the fine grained soils than with the borrow soil. TMI requests the agencies to reconsider their decision to require use of the salvaged soil.

H-TMI 1

TMI provides Appendix B (Westech, 2011), a report on borrow soil availability and suitability that supports the use of borrow soil for reclamation at the TMI. The following are some of the specific areas in the DEIS that address soil use and amendment issues that should be revisited in preparation of the FEIS. According to the Westech Report (Appendix B), the tailings embankment face supports a young forest of planted, healthy ponderosa pine, white pine and lodge pole pine at a stocking rate suitable for proposed post-mining land uses. Natural reinvasion of trees is occurring. The understory is primarily herbaceous, dominated by hard fescue. Cover of trees, herbaceous species, litter, lichens, moss and rock is adequate to provide a stable surface. The presence of existing forest on soils with high coarse fragments and the analysis in the DEIS â€“ [(Section 3.16.2.9, Resource Impact Summary (page 3-149)] demonstrate that borrow area material will support the proposed post-mining land uses of forest and wildlife habitat consistent with the MMRA.

The requirements for use of organic fertilizer, organic matter addition to soil, mulch and placement of coarse woody debris on reclaimed sites is by the DEISâ€™s own admission not necessary to achieve reclamation goals. TMI recognizes its responsibility to successfully reclaim the land disturbed by the mine, but doesnâ€™t agree that use of unnecessary amendments are required; if it takes a few years longer to achieve the vegetation density to meet bond release criteria that is TMIâ€™s option. At the 19th Annual Mine Design, Operation and Closure Conference, May 2011, Mr. Rich Prodgers, Bighorn Environmental, provided a presentation; â€œEffectiveness of Two Compost Products and One Mycorrhizal Inoculum in

Promoting Nutrient Cycling in Cover Soils Originating as Deep Borrowâ€• (see Appendix C). According to Mr. Prodgersâ€™ field work, analyses and presentation, he was not able to conclude from vascular plant performance or microbiological analysis that compost confers a benefit. Further he presented information that composts role in establishing nutrient cycling was far less than expected.

TMI understands that the constructed toe ponds provide breeding habitat for the western toad that would not be available without the toe ponds. The toe ponds and toad habitat at the tailing impoundment are on private land and will remain in place at closure. Evidence provided in an attached report on western toad occurrence provided with this letter from Patrick Farmer, 2011 (Appendix D) indicates that the salvage soil stockpile is used by toads during the breeding season and may be important toad habitat during other seasons. This is another reason to reevaluate the removal of the soil stockpiles when a reasonable alternative exists.

ES14 â€“ summarizes agency alternative for use of salvage soil and organic addition; no justification provided.

ES17 â€“ The DEIS states: â€œUnder the Agency-Mitigated Alternative,
No additional measures would be required to mitigate geochemical impacts to reclamation success. The use of the rocky glacial and the lacustrine and volcanic ash-derived soils as growth media would minimize root contact with mined materials. This would effectively minimize the potential effects of plant uptake of metals from the development rock and tailings.â€•

H-TMI 1 This implies that the tailing has a deleterious or toxic effect on plant growth; there is no evidence known to TMI or provided in the DEIS that toxicity exists and this must be corrected in the FEIS.

ES18 â€“ The DEIS indicates that under the agency alternative chemical fertilizer would not be used in reclamation. No justification, reason or authority for this decision is provided here or elsewhere in the document.

ES19 â€“ The summary statement that the TMI proposed action would not achieve comparable utility in not supported here or elsewhere in the document and in fact is contradicted elsewhere in the document. TMI strongly disagrees that this standard cannot be met with borrow soil and further that the agencies have presented any substantive analysis documenting this conclusion. According to the Westech Report, 2011, the tailings embankment face supports a young forest of planted, healthy ponderosa pine, white bark pine and lodge pole pine at a stocking rate suitable for proposed post-mining land uses. Natural reinvasion of trees is occurring. The understory is primarily herbaceous dominated by hard fescue. Diversity is low with few species present. Cover of trees, herbaceous species, litter, lichens, moss and rock is adequate to provide a stable surface. Previous re-vegetation trials on Cell 2; the presence of existing forest on soils with high coarse fragments; and, the analysis of the DEIS demonstrate that borrow area material will support the proposed post-mining land uses of forest and wildlife habitat consistent with the MMRA.

2-54: Soil amendments listed for the agency alternative include that all disturbed ground at mill site will be covered with mulch and 25 tons/acre wood debris. Nowhere in the document provides the justification, authority or even describes the potential benefits of this treatment.

3-42: TMI is not aware of any documentation indicating â€œplant uptake of metalsâ€• has caused any problem at the tailing impoundment. The use of the borrow soils as compared to stockpiled topsoil will accomplish the same objective; therefore, this argument needs to be revised in the FEIS.

3-115: TMI is not aware of any data or evidence indicating metals phytotoxicity from the tailing exists nor was any data or evidence referenced in the DEIS. If such documentation exists TMI would like to have a chance to discuss this issue with the agencies prior to completion of the FEIS.

3-119, 2nd paragraph: â€œHowever, using a glacial outwash material instead would result in gradual, but slower vegetative recovery.â€•

The DEIS states that borrow soils would result in successful but slower vegetative recovery and thus meet the â€œcomparable utilityâ€• requirement. TMI agrees with this statement and argues that the long history of reclamation pilot tests supports it. The speed of re-vegetation is not a requirement of the Metal Mine Reclamation Act.
3-119, 5th paragraph: â€œThe organic matter would increase infiltration, fertility, and the water-holding capacity of the rocky glacial materials, all of which would speed up soil development on the reclaimed areas.â€•

H-TMI 1

This only establishes that the organic matter addition would speed up re-vegetation, not that it is necessary to meet the reclamation requirements.

3-119, 6th paragraph: â€œTwenty-five tons/acre of coarse woody debris (larger than three inches in diameter) would be scattered across the reclaimed areas at the mine portals and mill. All disturbed ground would be covered with an agency-approved mulch.â€•

There is no discussion of the justification, benefits, rational or authority for requiring the addition of wood debris or mulch. More importantly, there is no discussion why this requirement in the Agency-Mitigated Alternative is more effective than the Proposed Action for achieving reclamation requirements.

3-120, 3rd paragraph: â€œThese materials would be used because they would produce better soil quality and a more productive plant growth medium due to their larger water-holding capacity. The material proposed under this alternative would eventually produce a quality soil with a more productive forested plant community, even with the presence of noxious weeds.â€•

This documents that the main benefit of using the stockpiled soils is increased forest productivity. Since the uses of the alternative borrow soils can achieve the DEQâ€™s requirements for stability and utility on these private lands, the requirement to use the stockpiled soil is not warranted.

3-121: â€œAll three alternatives would meet these guidelines on NFSL. However, the Agency-Mitigated Alternative would restore soil function in a shorter period of time.â€•

The DEIS documents the agencies are in agreement with TMIâ€™s Proposed Action which achieves Forest Service requirements. Therefore, there is no need for unnecessary activities just to shorten the time period.

3-121, last paragraph: â€œThe Proposed Action would not produce comparable utility on the reclaimed tailings impoundment.â€•

H-TMI1 The statement is not justified and apparently relies on an interpretation of the MMRA â€œcomparable utilityâ€• requirement that is not documented in any agency guidance but seems to be the â€œmore is betterâ€• philosophy. The â€œcomparable utilityâ€• wording is clearly meant to indicate a level of sustainable re-vegetation that achieves an acceptable level of cover and species diversity. There is no standard to support a minimum level of productivity. On page 3-146 (3rd paragraph) the DEIS indicates the Proposed Action achieves the â€œcomparable utility standardâ€•. This statement must be corrected in the FEIS.

Road Reclamation

I-TMI1 The Agency-Mitigated Alternative road reclamation plan includes removal of several spur roads that have been passively decommissioned. TMI views reverting road 4626 to a gravel surface will cause undue environmental disturbance and increase risk of sedimentation to nearby streams. TMI performs annual maintenance on road 4626 and believes the surface will perform for decades after closure with minimal maintenance and cause no sedimentation risk to nearby streams. TMI believes roads 4626G, 4624B and most of 4624 to be passively decommissioned as of this date, and by closure of the Troy Mine, road 4624 will be passively reclaimed. TMI agrees that the portion of road 4551 on private land should be decommissioned â€“ converted to a trail; however, the portion of the road on national forest is already passively decommissioned and is little more than a trail. TMI believes that disturbing this road prism will cause undue environmental disturbance and increase risk of sedimentation to nearby streams. Additionally, TMI believes road 4628A will be passively decommissioned at mine closure and disturbing the steep, narrow, stable road prism in this area will cause undue environmental disturbance; increase risk of sedimentation to nearby streams; and, ultimately the trail will become unstable and unusable.

ES18 â€“ â€œAny additional sediment from untreated roads and stream erosion across the mill site would add to the already elevated sediment load that currently exists in Stanley Creek and would adversely impact beneficial uses for an extended period of time.â€•

This statement implies that Stanley Creek is impaired for sediment, which is not the case, and the claim that beneficial uses would be impacted is not substantiated. In early June 2011 Stanley Creek has been observed flowing at high flows while showing no visible sign of turbidity. Each year TMI sends the final report for the Comprehensive Water Quality Monitoring Program for streams adjacent to the TMI. To date, we have submitted reports for 25 years. According to Mr. Joe Volosin â€“ Parametrix Inc., for 24 years, the benthic macroinvertebrate populations and water quality of the stream systems near the Troy Mine have been monitored. Samples have been collected at locations above and below mining operations in Fairway-Stanley Creek Systems and in the Lake Creek System. The benthic macroinvertebrate and water quality monitoring over the past 24 years have not identified any pollution impacts or degradation of Fairway-Stanley Creek and Lake Creeks due to TMI Facilities.

Over all the years of monitoring, the numbers of clinger taxa in Stanley Creek have been similar to Fairway Creek and similar between Lake Creek Sites. This metric suggests that for both Fairway-Stanley and Lake Creek systems, little sedimentation effects have been

noted in any of the streams evaluated. TMI has included the Comprehensive Water Quality Monitoring Programs for Streams adjacent to Troy Mine: Spring 1986 through Fall 2009, Year 25 in Appendix E to this letter.

3-22; 2nd paragraph: â€œUnder the Proposed Action, unneeded roads that pose a resource risk would not be treated, and restoration work on needed roads would not be implemented.â€•

The definition is not clear as to â€œunneededâ€• and â€œneededâ€• roads.

I-TMI 1 3-23: â€œThe Agency-Mitigated Alternative would reduce sediment loading both by implementing reclamation actions and by treating mining road-related sediment sources.â€•

The statement implies that the Agency-Mitigated Alternative reduces road related sediment more than the companyâ€™s proposal. There is no analysis or discussion of how removing the asphalt surface from the road would reduce sediment more than the Proposed Action. Troy Mine was originally required to install asphalt to mitigate for sediment and it is used elsewhere in the KNF which indicates asphalt road cover is effective for sediment reduction.

3-120: â€œMany roads used for drilling decades ago have revegetated and pose a low erosion risk to the watershed.â€•

The DEIS supports TMIâ€™s argument that natural re-vegetation is an appropriate solution for some of the older roads.

General Comments

A-TMI 1 ES3 â€“ Discussion of â€œpatentedâ€• land may be confusing, may be better to just use private land and NFSL.

B-TMI 2 ES6/ES7 â€“ The No Action description of ground water monitoring is inaccurate and misleading by implying there are only two ground water monitor wells. Currently TMI samples 15 monitoring wells, two of which are at the Libby Load-out Facility. TMI also samples the Service Adit ditch, Service Adit pipe and the EP-1 pump-back station.

The surface water program includes 16 surface water locations for a total of 34 sample locations. Lake Creek 1, 2 and 4; Stanley Creek - 2 and Fairway Creek â€“ 1 are the bio-monitoring (macroinvertebrate) sampling locations. As a point of clarification Lake Creek 1 and 2, date back to 1979.

E-TMI 2 ES10 â€“ â€œThe surface water quality monitoring sites that would be sampled are the same sites as those identified under the No Action Alternative.â€•

TMI adds the following points for clarification: As of 2005/2006, the TMI surface water quality monitoring includes 16 locations as follows:
LC-1, LC-2, LC-4
SC-2, SC-15, SC-17A
FC-1
Emma Gulch,
Weasel Lake, Weasel Gulch
Ross Creek 1 and 2

E-TMI2 Toe Ponds: 4, 3, 2
Decant Pond

A-TMI2 1-11: â€œBased on the analyses in this EIS, the Deciding Officers only determine whether the Proposed Action is in compliance with respective state and federal laws.â€•

The statement does not seem to be correct. The Deciding Officers prepare a Record of Decision (Rod) that determines what if any stipulations may be required to mitigate any impacts. The further discussion that indicates the Rod can only select from one of the alternatives is also incorrect. The Rod may select or modify any alternative including the preferred alternative to address a variety of issues.

B-TMI3 2-25: â€œAnnual aerial inspections of the mine shadow area would be conducted by Troy Mine, Inc. with agency participation. Surveys would be conducted until bond release, and the subsidence portion of the reclamation bond would be held for a minimum of twenty years after the mine has been decommissioned and the adits have been plugged.â€•

The requirement for annual aerial inspections for subsidence is not necessarily an accurate method for determining subsidence based on actual site experience. Surface road erosion could appear to be a subsidence event when viewed from the air. Other methods of field inspection should be considered. Twenty years of subsidence inspection before bond release is excessive.

B-TMI4 2-36: This is the No Action and Proposed Action water monitoring plan, which is the one proposed in the Appendix F of the Revised Reclamation Plan with some additions. TMI adds the following Point of clarification: Table 2-2 is the one we proposed in the Revised Reclamation Plan during March 2006. As of 2005, TMI takes samples at 13 monitoring well sites â€“ (two of which are at the Libby Loadout Facility). We also sample the mineâ€™s service adit ditch, service adit pipe and the Enviro-pump station and these sites are in the monitoring program. During the summer of 2010, two additional monitoring wells were drilled on the north end of the tailing facility, bringing the total to 15 monitoring wells.

The surface water program includes 16 surface water locations. In all we sample 34 locations including the monitoring wells, surface locations, plus the adit ditch, adit pipe and the spring at the Enviro-pump station.

Lake Creek 1, 2 and 4; Stanley Creek - 2 and Fairway Creek â€“ 1 are the bio-monitoring (macroinvertebrate) sampling locations. As a point of clarification Lake Creek 1 and 2, date back to 1979.

B-TMI5 2-57: â€œIf needed, the domestic water well located southeast of the tailings impoundment would be used for irrigation during the first three growing seasons; after which time, the well would be plugged and abandoned as required by ARM 36.21.810.â€•

The company objects to abandoning the well at the industrial site and abandoning the irrigation well at the decant pond area, because these private wells will have future uses.

B-TMI6 2- 59: 6th bullet; â€œThe East Impoundment, North East Impoundment, and Cell 3 borrow areas would be planted with lower elevation forest type vegetation.â€•

The references to an East impoundment and NE impoundment should be East Borrow and

North East Borrow.

3-7: â€œThe Libby loadout facility is not addressed in the No Action Alternative.â€•

C-TMI1 This is not correct. The Libby Load-out is currently permitted, bonded and has a reclamation plan. TMI submitted a â€œMinor Revisionâ€• to our Operating Permit for the New Libby Load-out facility on February 7, 2011. We received Approval for the Minor Revision from the MT DEQ on February 16, 2011. TMI started using the new load-out during March 2011.

3-26: â€œrequiring lands disturbed by miningâ€¦be reclaimed to comparable stability and utility.â€•

A-TMI3 30CFR 228.8(g) is not the USFSâ€™s responsibility in this case to interpret DEQâ€™s regulations. In fact 228.8(h) indicates that â€œcertification or approvalâ€• by state agencies can be taken as acceptance of compliance with parallel regulations. The State and Federal responsibilities and authorities should be accurately described and kept separate from each other.

E-TMI3 3-47 1st paragraph: â€œalong an approximately 200 foot length of a tributary of Ross Creek.â€•

The FEIS should note the tributary is ephemeral.

3-86 1st paragraph: â€œIn Lake Creek, non-mine sediment sources are somewhat more substantial, but would still be substantially less than the sediment generated by the reclamation.â€•

E-TMI4 The statement is not reasonable. The Proposed Action will not produce sediment to Lake Creek or Stanley-Fairway Creek because the topsoil stockpiles would be left in the current reclaimed condition and FR4628 paved surface would not be removed and replaced with a gravel surface.

Over all the years of monitoring, the numbers of clinger taxa in Stanley Creek have been similar to Fairway Creek and similar between Lake Creek Sites. This metric demonstrates that for both Fairway-Stanley and Lake Creek systems, little sedimentation effects have been noted in any of the streams evaluated. TMI has included the Comprehensive Water Quality Monitoring Programs for Streams adjacent to TMI: Spring 1986 through fall 2009, Year 25 in the Appendix E to this letter.

E-TMI5 3-86, last paragraph: TMI believes the Proposed Action concrete closure/water capture structures in the service and conveyor adits would not have any more potential to â€œseepâ€• resulting â€œin water quality impactsâ€• than the agencies concrete water capture and diversion structure. No design was included in the DEIS.

3-90, 1st paragraph: â€œBecause nitrate concentrations would decrease after blasting ceases, closure and reclamation of the mine would reduce nutrient loading to surface water under all alternatives.â€•

E-TMI6 The analysis and conclusions provided elsewhere in the DEIS indicate there has been no nutrient impact to Stanley or Lake Creeks from the mine. The implication that the mine has caused impairment to Stanley of Lake Creeks or that mine closure will somehow â€œreduce nutrient loadingâ€• to these creeks is not accurate.

3-114: â€œMoreover, the water-holding capacity of the borrow materials is low and varies with the rock content.â€•

H-TMI 2

The DEIS is correct that water holding capacity varies with rock content; however, the borrow materials proposed for growth media is composed of organics, clay, silt, sand and gravel. Test plots on Cell 2, embankment slopes and Cell 4 demonstrate the mixed borrow material has adequate water retention for growing grasses, shrubs and trees.

Finally in Appendix F., TMI has included photographs of the tailings facility, that shows the excellent growth on borrow material, photographs of the secondary containment warning system installation, photographs of the topsoil stock pile area and the grass growth on cell #4 â€“ borrow material growth media.

I urge the agencies to approve this plan as soon as possible and thank you for allowing me to comment.

Sincerely,

Bruce Clark
Mine Manager

Sincerely,

Bruce Clark

2011-08-03 Coldwell D. pdf

Darren Coldwell
P.O. Box 336
Troy, MT 59935
406-295-4599

August 3, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear MDEQ and KNF:

I would like to provide some comments regarding the Troy reclamation revision that is open for public comment.

E7 It seems that the agency has done a very thorough examination of all the data that has been collected over the last 30 years and has made an accurate assessment of the water being discharged. From what I have seen, there is simply going to be clean water flowing out of the adit down to the impoundment, and requiring a water treatment facility will not be required.

E1 One thing that really makes me scratch my head though has to do with the pipeline analysis. Is the existing pipeline in a condition that requires replacement immediately upon the mine being decommissioned? I would suggest leaving the existing pipeline infrastructure in place until it needs replacement, and I can't see the logic in burying it when it does get replaced. Wouldn't it be easier to detect leaks and work on it if it was above ground? Aren't we going to be disturbing much more ground by doing it this way? This just doesn't make a whole lot of sense to me.

Thank you for accepting my comments. I eagerly await your response!

Sincerely,

Sincerely,

Darren Coldwell

2011-08-03 Erickson L. pdf

From: Larry Erickson
To: TroyMineReclamation@fs.fed.us
Cc: DEQ Troy Mine
Date: Wednesday, August 03, 2011 5:36:26 PM

I am submitting the following comments on the Draft EIS released by the Forest Service and Montana DEQ and noticed in the Federal Register on May 20, 2011 regarding the TMI revised reclamation plan. There are four primary issues of concern and these are as follows:

1.The DEIS concludes that the existing dual 8" urethane lined steel pipelines that carry tailing slurry during operations need to be replaced with a new buried line at closure. I disagree that the lines need to be replaced and there is little rational in the DEIS to justify this suggested replacement. The main reasons I disagree with the installation of a new buried line are:

a) The existing two surface tailing lines and the existing buried pipeline have more than enough capacity and useful life to transport the mine water to the tailing facility as verified in discussions with the pipeline manufacturer;

E1

b) The installation of a new buried line at closure would create significant new ground disturbance that will require additional reclamation;

c) There are areas in the pipeline and road corridor that are impractical for burial due to proximity of live streams (Stanley Creek and Lake Creek); and

d) TMI is installing additional secondary containment for monitoring and leak detection near stream crossings, on the existing tailing lines, that will allow better monitoring and the surface lines will be easier to repair if necessary.

2. I disagree with the agencies recommended use of the topsoil located below the toe ponds because:

H2

a) An adequate and proven source of topsoil / growth medium exists on the east side of the tailing facility;

H1

b) The topsoil area below the toe ponds has been successfully reclaimed with over 30 years of re-vegetation that would be re-disturbed;

c) The control of sedimentation to Lake Creek during reclamation activities and topsoil excavation will be a challenge; and

K1

d) The area around the toe ponds is providing breeding habitat for the western toad which has been listed as a species of a concern.

3. I disagree that burial of concrete foundations and steel at the mill site pose any risk to water quality. On-site burial of demolition waste is an accepted practice during mill site reclamation. The unnecessary handling and haulage of inert materials to an offsite disposal area would increase risk to air and water quality. TMI's Proposed Action is as follows:

B1

a) Equipment from the mill, shops, office and associated facilities will be salvaged or disposed of offsite. Buildings will be removed and salvaged or demolished. The mill site materials which will be buried on site are primarily concrete, but also may include some metal, glass, plastic and wood. All of these materials will be buried on site with a minimum of three feet of cover material.

4.The Agency-Mitigated Alternative road reclamation plan includes removal of several spur roads that have been passively decommissioned. TMI views reverting road 4626 to a gravel surface will cause undue environmental disturbance and increase risk of

I1

sedimentation to nearby streams. TMI performs annual maintenance on road 4626 and believes the surface will perform for decades after closure with minimal maintenance and cause no sedimentation risk to nearby streams. TMI believes roads 4626G, 4624B and most of 4624 to be passively decommissioned as of this date, and by closure of the Troy Mine, road 4624 will be passively reclaimed. TMI agrees that
I4 the portion of road 4551 on private land should be decommissioned – converted to a trail; however, the portion of the road on national forest is already passively decommissioned and is little more than a trail. TMI believes that disturbing this road prism will cause undue environmental disturbance and increase risk of sedimentation to nearby streams. Additionally, TMI believes road 4628A will be passively decommissioned at mine closure and disturbing the steep, narrow, stable road prism in this area will cause undue environmental disturbance; increase risk of sedimentation to nearby streams; and, ultimately the trail will become unstable and unusable.

Thank you for your consideration.

Regards,

L.A. Erickson, PE/PG
ericksonatwork@yahoo.com
(406)827-3391

2011-08-03 FeebackD.pdf

July 29, 2011

Comments on the Troy Mine Revised Reclamation Plan DEIS

FROM: Derek L. Feeback
P.O. Box 1282
Libby MT 59923

TO: Emily Corsi
Project Coordinator
MT DEQ
P.O. Box 200901
Helena, MT 59620-0901
(406) 444 - 2813

Bobbie Lacklen
Project Coordinator
Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
(406) 283 - 7681

Dear Ms. Corsi and Ms. Lacklen,

E7 After viewing the Draft Environmental Impact Statement for the Troy Mine Revised Reclamation Plan I commend the agencies recognition of over 30 years of water monitoring at the Troy Mine by not pursuing treatment of the verified clean water associated with Revett hosted copper and silver deposits. However, I am concerned in particular with three of the Agency-Mitigated Alternatives for decommissioning the mine: (1) removing and replacing existing tailings pipelines, (2) disturbing the timberland and wildlife habitat on the soil stockpile west of the tailings impoundment and (3) ripping up the asphalt access road to replace it with a gravel road.

E1 First, the two existing tailings pipelines are more than sufficient for transporting the mine water to the tailings impoundment after closure. The existing lines are designed to transport silica-rich slurries which are much more abrasive than the mine water. In addition, the ongoing installation of protective secondary containment structures with leak detection systems on the existing tailings pipelines near the intersections with Stanley Creek and Camp Creek will further insure the tailings slurry/mine water will not enter the creeks in the event of a pipeline leak. The existing pipeline routes are in timberland, grassland and wildlife habitat. Removal of these lines to replace with the agencies proposed buried pipeline would unnecessarily disturb this land with little or no benefit to the local ecosystems.

E4

H1 Second, after 30 years the topsoil stockpile is also now timberland and wildlife habitat at or near the Lake Creek riparian zone. I do not believe that disturbing this ground near Lake Creek for a topsoil layer on the tailings impoundment would benefit the local ecosystems or the water quality of Lake Creek. Asarco reclaimed Cell 2 with material from the borrow pit, ground that is already disturbed, in the 1990's. When the mine restarted in 2005 that ground hosted grasses, shrubs and conifers; elk, deer, moose and birds frequented the area. With this proven reclamation practice there is no clear reason to disturb more ground, especially at or near the Lake Creek drainage.

I1 And third, an asphalt road reduces airborne particulate and reduces erosion of the sediments which could potentially enter the watersheds. The Ross Creek Road is paved for that very reason. It really makes no sense to remove the existing asphalt Access Road to the Troy Mine and replace it with gravel.

These agency mitigated alternatives not only unnecessarily disturb timberland and wildlife habitat and potentially increase the sediments in the watersheds, these alternatives are expensive. I ask you seriously reconsider these recommendations.

Sincerely,

Derek L. Feeback

2011-08-03 KnodleG.pdf

Glenn Knodle
184 Elk Meadow Lane
Heron, MT 59844
406 847 0827

August 3, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

A Joyful day to you Ms. Lacklen and Ms. Corsi:

E7 After viewing the Draft Environmental Impact Statement for the Troy Mine Revised Reclamation Plan I commend the agencies recognition of over 30 years of water monitoring at the Troy Mine by not pursuing treatment of the verified clean water associated with Revett hosted copper and silver deposits. However, I am concerned in particular with three of the Agency-Mitigated Alternatives for decommissioning the mine: (1) removing and replacing existing tailings pipelines, (2) disturbing the timberland and wildlife habitat on the soil stockpile west of the tailings impoundment and (3) ripping up the asphalt access road to replace it with a gravel road.

E1 E4 First, the two existing tailings pipelines are more than sufficient for transporting the mine water to the tailings impoundment after closure. The existing lines are designed to transport silica-rich slurries which are much more abrasive than the mine water. In addition, the ongoing installation of protective secondary containment structures with leak detection systems on the existing tailings pipelines near the intersections with Stanley Creek and Camp Creek will further insure the tailings slurry/mine water will not enter the creeks in the event of a pipeline leak. The existing pipeline routes are in timberland, grassland and wildlife habitat. Removal of these lines to replace with the agencies proposed buried pipeline would unnecessarily disturb this land with little or no benefit to the local ecosystems.

H1 Second, after 30 years the topsoil stockpile is also now timberland and wildlife habitat at or near the Lake Creek riparian zone. I do not believe that disturbing this ground near Lake Creek for a topsoil layer on the tailings impoundment would benefit the local ecosystems or the water quality of Lake Creek. Asarco reclaimed Cell 2 with material from the borrow pit, ground that is already disturbed, in the 1990's. When the mine restarted in 2005 that ground hosted grasses, shrubs and conifers; elk, deer, moose and birds frequented the area. With this proven reclamation practice there is no clear reason to disturb more ground, especially at or near the Lake Creek drainage.

I1 And third, an asphalt road reduces airborne particulate and reduces erosion of the sediments which could potentially enter the watersheds. The Ross Creek Road is paved for that very reason. It really makes no sense to remove the existing asphalt Access Road to the Troy Mine and replace it with gravel.

These agency mitigated alternatives not only unnecessarily disturb timberland and wildlife habitat and potentially increase the sediments in the watersheds, these alternatives are expensive. I ask you seriously reconsider these recommendations

Sincerely,

Sincerely,

Glenn Knodle

2011-08-03 OyerN.pdf

Nancy Oyer
527 Edison Street
Butte, MT 59701
4064908989

August 3, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Corsi and Ms. Lacklen:

Thank you for the opportunity to comment on the proposed revisions to the Troy reclamation plans. I would like to give my support for the preferred alternative as selected by the agencies, but would like to see some modifications to it.

I1 I don't understand why you would be taking the asphalt off of the road and returning the road surface to dirt. Wouldn't this create more BMP work to ensure that TMDLs are as low as possible? The current road needs some repair, but the costs of those repairs would be virtually insignificant compared to the long term work and maintenance you would be avoiding hy doing so. I would imagine as this is a Forest Service road that it will also have
I2 a gate on it not far from the tailings impoundment, which would allow the asphalt to have a very good life span for continued access for monitoring of the pipelines carrying water from the adit.

E2 This brings me to my next issue with the preferred alternative. I don't understand why you want to require the Company to bury the pipeline underground when it could be monitored and accessed easily if it was left above ground and next to the road. Putting strict monitoring requirements on the existing line until it truly needs replaced and making them bond to replace it with an above ground line seems like the most common sense approach that will have the least impact to the watershed long term.

Please consider my suggestions before making your final decision.

Sincerely,

Sincerely,

Nancy Oyer

2011-08-03 Rantala G. pdf

Grace Rantala
98 Ave. A
Libby, MT 59923
406 291 4211

August 3, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Dear Ms. Lacklen and Ms. Corsi:

Please consider my comment on the Troy Mine Revised Reclamation Plan Draft EIS.

G3

The northwestern area of Montana has been in a deep recession for a decade longer than the rest of our nation. Much of this is because of the systematic dismantling of the forestry management system of the United States Forest Service. The resultant collapse of the local economies of the area has been catastrophic. Over 3500 industrial, family wage jobs have been lost in the logging and milling businesses of Lincoln and Sanders Counties. The social ills such as alcoholism, drug addictions, family destructive behaviors, suicides, domestic abuse that follow these types of economic losses are well documented and were tragically predicted.

For the last several years, there has been a growing hope that mineral activity could replace some of the lost jobs and help to lower the unemployment rates of 20% that is found in these two counties. That hope will not be met with reality unless mines like the Troy Mine can stay in business. The economic benefit of nearly 200 jobs that average over $55,000 per year - not counting the benefits packages that includes health insurance, retirement plans and stock options â€“ cannot be overstated. The impact the Troy Mine has with $14 million in payroll, $10 million in local purchases of goods and services, $250,000 in property taxes, $1 million in gross proceeds taxes, $1.4 million in metal mines taxes cannot be overstated.

With this economic need as a backdrop to the discussion of the future of the mine, I would like to offer my support for the agency's preferred alternative â€“ with some suggestions for necessary changes.

H2

First, I do not think it is in the best interest of the environment to remove the topsoil from the toe of the impoundment area. Although it is true that this soil was once topsoil on the site, it has now been in place of over 30 years and it seems unnecessary and possibly even foolish to disturb the area so close to the water courses that have successfully protected

H2 during mine operation. Surely, in order to grow the trees and other vegetation that is native to the area, the soil from area borrow pits can be utilized with success and without the potential impacts associated with gross disturbance of areas near streams that have already healed up.

Thank you for accepting and considering my comment.

Sincerely,

Sincerely,

Grace Rantala

2011-08-03 Shearer J.pdf

Jennifer Shearer
21200 E. Country Vista Dr.
Liberty Lake, WA 99019
509 921 2294

August 3, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

To Whom It May Concern:

Thank you for accepting my comments on the revised reclamation plans for the Troy mine. In the thirty years this impoundment has been in place, there has been a great amount of solid reliable data to support your preferred alternative, and I would like to say thank you for your acknowledging it.

I would also like to comment on the reclamation using the topsoil that is currently providing habitat for the western toad. Many people have also acknowledged that careful soil management and wildlife can coexist and that this is something that should be applauded, not destroyed.

K1

From what I understand, it isn't going to cost any more to use the borrow or the topsoil that has been set aside, but it may take a bit longer for the borrow to produce the same reclamation goals if used. I would submit to you that saving habitat that is currently being created and allowing a little longer to create more is a win, win.

H1

H2

I believe that whenever we can showcase an active mining operation creating habitat to any species that is struggling we should. If it isn't going to cost any more either way, and our goal is to reclaim the ground to provide erosion controls and wildlife habitat, we should use the borrow material instead.

Thank you for your consideration of my comments.

Respectfully,

Sincerely,

Jennifer Shearer

2011-08-03 Zwang m.pdf

Margeaux Zwang
254 Manor Dr.
Libby, MT 59923
406 334 0003

August 3, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

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H2 reclamation goals if used. I would submit to you that saving habitat that is currently being created and allowing a little longer to create more is a win, win.

I believe that whenever we can showcase an active mining operation creating habitat to any species that is struggling we should. If it isn't going to cost any more either way, and our goal is to reclaim the ground to provide erosion controls and wildlife habitat, we should use the borrow material instead.

Thank you for your consideration of my comments.

Respectfully,

Sincerely,

Margeaux Zwang

2011-08-04 Allen D_WETA.pdf

WETA

Western Environmental Trade Association
2301 Colonial Drive, Suite 2A, Helena, MT 59601
406-443-5541

August 4, 2011

Emily Corsi
Project Coordinator
Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Submitted via Email: DEQTroyMine@mt.gov; copy@miningmontana.com

RE: Troy Mine Revised Reclamation Plan DEIS

Dear Ms. Corsi:

The Western Environmental Trade Association would like to go on record in support of the Troy Mine Revised Reclamation Plan.

WETA, organized in 1976, is a coalition of representatives of agriculture, labor, business, commercial industry, the scientific community, recreation, transportation and twenty-one other trade associations, with an interest in promoting the economic well being of the people of Montana while protecting the state's environment. These member associations, companies and other organizations collectively employ or represent thousands of Montanans.

The Troy Mine has put forth its proposed action to reclaim lands disturbed by mining activities and has established reclamation goals and actions that are in full compliance with Montana's Metal Mine Reclamation Act and all federal requirements.

In reviewing the DEIS for the Troy Mine Revised Reclamation Plan, it is apparent that there are some very positive things about the Troy Mine and its operation, not the least of which is the conclusion of the extensive environmental studies that demonstrate there will not be significant impacts to surface or ground water. Water quality is always of primary concern and clearly, as demonstrated by the agencies' various studies, there is no concern about ARD issues or the water quality of the impoundment. The Troy Mine has operated, with some down periods, for over 30 years with no significant impacts to water. We applaud the Troy Mine and its operators and employees, as well as the agencies involved, for the extensive look at the water quality issue and its positive results.

E7

The USFS and the MDEQ have expanded upon the proposed reclamation actions and have included additional mitigation measures in its preferred alternative. We question some of the

proposed mitigation measures preferred by the agencies because in our read of the document and its many components, it appears as though the proposed actions by the Company are indeed adequate. If the proposed actions by the Company for final reclamation meet all the requirements of the law and will result in desired and required reclamation goals, then the agencies should be accepting of those plans and actions.

G2

Many of those who have proposed natural resource projects in Montana have become increasingly frustrated in past years with additional requirements beyond what is required by law that increase costs, produce delays in permitting, and do not result in better operations or reclamation.

Please understand that WETA and its membership have always stood for responsible development, full compliance with Montana and federal laws, and proper financial assurance to protect Montana taxpayers. We do however, respectfully request that the agencies revisit the mitigation measures chosen by the agencies in its preferred alternative, and make certain that the mitigation measures really are necessary to comply with the law and produce proper reclamation.

I appreciate your good work and the time and attention to revisit some of the areas of concern to WETA. As always, I will be happy to answer any questions you may have. I look forward to reviewing the agencies' final EIS and Record of Decision and urge you to move forward in determining a final reclamation plan that meets all requirements while not going beyond the requirements when it is not necessary to produce proper reclamation and environmental stewardship.

Sincerely yours,

Don Allen, Executive Director
Western Environmental Trade Association
2301 Colonial Drive, Suite 2A
Helena, MT 59601
Phone: 406-443-5541
Email: allen@allen-associatesmt.com

2011-08-04 FerrellD.pdf

From: Doug Ferrell
To: DEQ Troy Mine
Subject: Comment On Troy Reclamation EIS
Date: Thursday, August 04, 2011 10:01:32 AM

Bobbie Lacklen, USFS
Emily Corsi, MDEQ

I would like to submit a personal comment on the EIS for the Troy Mine Reclamation.

I have reviewed the EIS, attended a pubic meeting on this issue, and I am familiar with the operation of the mine as well as the surrounding area. I have personally been actively involved for many years working to protect and promote conservation values in the area of the Kootenai National Forest. I have been associated with a number of conservation groups over the years. I currently serve as a board member and officer of both the Montana Wilderness Association and the Friends of Scotchman Peaks for Wilderness. The following comment represents my own personal opinions and does not necessarily represent the position of these groups.

I would first like to acknowledge the good work and good stewardship practiced by the present operators of the Troy Mine. They have earned the respect of our community.

I find both reclamation plans in the EIS to be well thought out, and to be a great improvement over the status quo.

I would like to specifically comment on a few points where decisions are needed to balance conservation values with practical considerations. As a life long conservationist, I hope we will not be afraid to apply common sense to these kinds of questions.

E1 I recommend the tailings pipeline be left above ground. The pipeline is not an eyesore, nor is it a significant barrier to wildlife movements. Leaving the pipeline above ground will minimize disturbance and provide access for monitoring and repair as needed.

B1 I do not see a need to remove non-hazardous construction materials away from the site. This seems to be a waste of energy and more disruptive than the option of burying these materials in the mine or elsewhere on the site.

I1 I also do not favor disturbing existing road surfaces. I favor leaving existing asphalt surfaces in place. Again this approach will minimize disturbance, erosion, cost, and energy expenditure during the reclamation process.

Thank you for the opportunity to comment.

Doug Ferrell

21 Riverfront Drive
Trout Creek, MT 59874
406-827-4341

2011-08-04 Scherzer E. pdf
(page 1)

From:	Ernest
To:	TroyMineReclamation@fs.fed.us; DEQ Troy Mine
Subject:	TROY EIS
Date:	Thursday, August 04, 2011 9:08:43 PM
Attachments:	TROY EIS.doc

Attached is my input into the Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

Ernest Scherzer
33 Lone Wolf Ln.
Trout Creek MT 59874

2011-08-04 ScherzerE.pdf
(page 2)

Bobbie Lacklen
Kootenai National Forest
31374 U.S. 2
Libby, MT 59923-3022

Emily Corsi
Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

It is my opinion that the proposed EIS has five areas which need to be addressed and revised.

I1 1. The present paved mine road should be left intact. Removal of it and burying it or hauling it away would only make a marked increase in siltation. Removal of a perfectly good road and replacing it with a gravel road would be a waste of taxpayers' money.

H1 H2 H3 2. Re-vegetation of the tailings pond and its surrounding areas should follow a simple rule of "do no harm". The removal of soil at the bottom and in the area of the toe ponds is silly. That area is reclaimed and doing well. Leave it. Additional soil for covering the rest can be obtained from the area slightly above and behind the backside of the tailings site. That soil would need to have a significant amount of organic matter added to it. BUT there are years to do that. Revett should begin a large composting site whereby they could create most of the organ matter they would need to add to the soil found in the back.

E13 3. The unresolved of the buried barrels and their contents needs to be solved and should have been done long ago by DEQ. There is no doubt that barrels are buried. In sworn testimony that fact was even admitted by the previous owners. The barrels [or, at least one] need to be removed or tapped with a drill to determine the contents. The circumstances surrounding the barrels are highly suspect - buried in the dead of the night; no record kept of them; denied several times and finally admitted under oath.

E12 4. The issue of buried barrels also reinforces the need for an additional requirement in the EIS. A Toxic Inventory Log - going back as far as possible - should be made available to the public and presented to DEQ. If I am right, federal law requires such a law and allows no exceptions for burial of materials in barrels in a tailings pond with a

record of what is in the barrels, how many, when, etc. I bet the law would even mean that the mine owners could bury lemonade in barrels, but would need to document it. How can DEQ have overlooked this federal mandate for so many years regarding the admitted buried barrels?

B1 5. Hauling the buildings to another site after they are removed or digging a pit on site and burying them should not be done. The materials from their destruction should be placed in the mine; in the safest location possible. It would save time and cost.

E1 E2 6. Lastly, it should not be required that the two above ground pipelines be removed and a new pipeline placed underground. That would mean additional digging and siltation. The lines should be left and fitted with special sensors to warn of any leak and also a system of alerting proper authorities [without delay] of any leak or other danger.

Thank you,
Ernest Scherzer
33 Lone Wolf Ln.
Trout Creek MT 59874

2011-08-04 Skinner D. pdf

From: Dave Skinner
To: DEQ Troy Mine; TroyMineReclamation@fs.fed.us
Subject: Attn: Troy Mine Revised Reclamation Plan
Date: Thursday, August 04, 2011 2:01:26 PM

Dear Kootenai National Forest and Montana DEQ:

Regarding the revised reclamation plan for the Troy mine, in general it is all right, however, I have issues with the agency recommendations on the water pipelines and impoundment.

E1 With the entire point being to minimize disturbance et cetera, I find the recommendation for a new, underground water line rather illogical. In-place infrastructure that is sound should be left in place. Sometimes, obsolete infrastructure should also be left to, um, die quietly.

E2 Access for purposes of vandalism is a spurious concern. For one thing, eco-whack-jobs are not usually very tech-savvy, and they are also lefties which means they hate guns -- so shooting the pipe is out of the question from that quarter. Access for maintenance and monitoring is the flip side...repair and detection should be made easy, not difficult.

If at some point in the distant future the existing lines can no longer work, THEN a new replacement line, not necessarily buried, should be planned for. But for now, make use of what is there and obviously still works-- that's conservation.

H1 Given that the stockpiled dirt is toad habitat these days, perhaps it should be left in place. Amended borrow materials with organic supplementation (which isn't that much in this environment anyway) along with chemical agents should work fine.

H3 As for the call for mycorrhizal fungi, that's pushing it. Although the fungus has a role in forest generation over time, this is not a sterile planet. The fungus will get there and take over soon enough. Why are the agencies requiring organic versus chemical fertilizer for reclamation in general?

B1 Finally, the requirement to render pristine the footings and other concrete whatnot sounds like overkill. There is a mine here and you'll never be able to fool future archaeologists. And the animals won't care even if they were smart enough to understand, which they ain't. In fact, maybe the cement should be retained in broken fashion for a Forest Service road-repair stockpile -- USFS is not going to be a do-nothing agency forever, ya know. At least we HOPE not.

I look forward to seeing the final reclamation plan include some further modifications to address some of the areas I have outlined above.

Respectfully,
Dave Skinner
Hydra Project
Box 1486
Whitefish, MT 59937
406 756 0047 vm no fax

2011-08-05 BanksM.pdf

From: Mike Banks
To: TroyMineReclamation@fs.fed.us
Subject: DEIS - Troy Mine Revised Reclamation Plan
Date: 08/05/2011 04:20 PM

Comments from Mike Banks

888 Big Timberlane
Troy, MT 59935
Cell 678-617-3958

E1

The managing of residual outflows from the mine site, whether they travel via the Stanley Creek watershed down to Lake Creek or by the rather outdated, decaying roadside pipeline will become a future environmental issue, if one practices any reasonable theory of probability. Past problems, leaks, spillage and cave-ins support that present infrastructure does not prevent a failure, and certainly no one would expect the situation to be "better" after the operation is discontinued. As closing of the mine is imminent, we need to step-up protection and preservation of the forgotten natural resources, the riparian element including the fishery and the wildlife and their habitat.

Just as important as it is to finally decide on this new reclamation plan, after a dozen-plus years, should be the diligence and forethought to get it correct or as right as it can be. Many people around the world are already paying dearly for the availability of clean water, perhaps we could consider this into the resolve of this matter.

The very best thing is to do whatever provides the most benefit for the longest period of time, which would mean that as far as this person is concerned or considered, the very best alternative is the Agency-Mitigated Alternative.

2011-08-05 Glader P_Hecla.pdf

Hecla

Transmittal Via Electronic Mail and Facsimile

August 5, 2011

Bobbie Lacklen, Project Coordinator
Kootenai National Forest
31374 US 2
Libby, MT 59923-3022

Emily Corsi, Project Coordinator
Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620—0901

RE: Comments on Troy Mine Reclamation Plan DEIS

Dear Ms. Lacklen and Ms. Corsi:

Hecla appreciates the opportunity to comment on the subject DEIS for the Troy Mine as follows:

B1
B2

1. Support for Troy Mine's reclamation plan regarding the handling of demolition debris. There appears to be no condition in the Montana Solid Waste Management Act ("Act") that would prohibit the on-site disposal of inert demolition materials. In fact, the Act appears to defer such aspects of mining operations to both statutory and regulatory mechanisms specific to the permitting and approval procedures applicable to the mining industry. Further, it appears to be contrary to the concept of net environmental benefit to expend the energy necessary to break up, excavate, load, haul, dump, and cover such inert materials in a landfill many miles away. Costly off-site landfill capacity should not be consumed by such inert materials. Burial of such materials on-site could not impact state water resources any more than natural and man-made wood materials, concrete abutments for both bridges and culverts, and metal culverts. All such materials/structures are located in virtually countless locations statewide, and are continually exposed to both water flows and direct meteoric contact, whereas burial on-site of these same types of materials would eliminate surface water exposure. The totality of environmental considerations clearly leads to the conclusion that on-site burial of inert materials is the

6500 N. Mineral Drive, Suite 200 • Coeur d'Alene, Idaho 83815-9408
(208) 769-4100 • FAX (208) 769-7612 • www.hecla-mining.com

prudent approach.

H1
H2
J2
H3

2. Support for Troy Mine's reclamation plan provisions for soil replacement and amendment. Destruction of the functional habitat that has established in the topsoil stockpile areas, which must be re-reclaimed if these areas are destroyed, makes no sense when the Proposed Action will establish appropriate vegetation with the use of borrow materials. It appears the overriding consideration of the Agency Mitigated Alternative is primarily the rate of growth, which is not dictated by applicable law or regulation. The bond must be maintained until appropriate vegetation is established, thus a moot point from an overall timing standpoint. The presence of certain weeds in the borrow source areas could be mitigated in advance with appropriate week control. Further, the aggressive use of organic materials as proposed in the Agency Mitigated Alternative could result in the generation of organic acids not representative of the surrounding undisturbed areas. Test plots utilizing the borrow area source materials have already demonstrated that the Proposed Action will meet reclamation expectations regarding the establishment of native species on the disturbed areas.

E1

3. Support for the Troy Mine's reclamation plan provisions concerning pipelines. There appears to be no engineering support for the Agency Mitigated Alternative, which indicates the existing pipelines would not support the use timelines considered for the completion of reclamation activities. An engineering report, to establish the integrity of the existing pipelines relative to the applicable reclamation timelines, could be easily secured to determine whether or not the existing pipelines are "too old" for the intended period of use. If shown that the pipelines are structurally sound, the Proposed Action would certainly be preferable to the Agency Mitigated Alternative actions of both new disturbances associated with construction and burial of a new pipeline, with resultant decommissioning of functional in-place pipelines that are appropriate for the Proposed Action use.

We appreciate the agencies' consideration of these comments.

Best Regards,

Dave Halland
for

Paul L. Glader
Manager – Environmental Services

2011-08-05 Hernandez C. pdf

Paul Bradford / Forest Supervisor
Kootenai National Forest
1101 Hwy 2 West
Libby, MT 59923

August 5, 2011

Dear Paul,

Greetings! Please consider this as my official comment on the Troy Mine Reclamation Plan DEIS. First of all it has been the regulatory delinquency of both the Kootenai National Forest and the MT Dept. of Environmental Quality that the Troy Mine has operated without an adequate Reclamation Plan for over the last decade. The only reason this mine is undergoing a Reclamation Plan EIS is because the public through the Cabinet Resource Group (CRG) has held the agencies feet to the legal fire. That said, the document that has been produced is too long, redundant and intentionally ignores issues of such importance that it will probably the courts that have the final say as to it's adequacy. That is not to say that all of the issues and ideas addressed are without merit or some vision.

E13 The primary issue that both regulatory agencies fail to address and actually dismiss regards the buried barrels. Asarco admits that it buried barrels within the tailings impoundment after having denied such a contention for over a year. CRG has provided the regulatory agencies with sufficient data and documentation that demonstrates Asarco used voluminous amounts of hazardous wastes at the mine and failed to produce any documentation of its appropriate disposal. CRG funded the use of advanced technology to locate areas where such barrels of waste may have been disposed of within the tailings impoundment. But the regulatory agencies are afraid to initiate the required due diligence to determine the quantity and content of buried barrels. Shame on the regulatory agencies and the people that direct them.

Without direct knowledge of the contents of the buried barrels it is impossible for the regulatory agencies to determine much less design an adequate reclamation plan that protects the public health or the physical environment. But what the heck, this won't be the first time such issues have been swept under the rug or fallen through the cracks. We only have to look at Libby and the W.R Grace example. Or perhaps the Zortman-Landusky and Beal Mines might be a wake up call? Either way, unless and until the regulatory agencies get off their collective duffs and do what is best for the public interest and not the private interest, the tragedies and costs that have engulfed society from the previous examples is only waiting to be repeated again at

Troy. Do your job people or move aside for folks that will do it for you. Thank you and good luck with the next write of this Reclamation Plan.

Sincerely,

Cesar Hernandez, 36704 Fulkerson Lane, Polson, MT 59860

2011-08-05 HoughP_FSPW.pdf
(page 1)

From:	Philip Hough
To:	troyminereclamation@fs.fed.us; DEQ Troy Mine
Subject:	Friends of Scotchman Peaks Wilderness Comments on Troy Mine Revised Reclamation Plan, Draft EIS
Date:	Friday, August 05, 2011 3:46:58 PM
Attachments:	FSPWCommentsReTroyMineReclamationPlanAug5-2011.docx

Dear Ms. Corsi and Ms. Lacklen,

Please see the Friends of Scotchman Peaks Wilderness comments on Troy Mine Revised Reclamation Plan, Draft EIS (embedded below, as well as attached.)

Phil

Phil Hough
Executive Director
Friends of Scotchman Peaks Wilderness
Home (208) 255-2780
Cell (208) 946-9127

Check out our Website: http://www.ScotchmanPeaks.org
Follow us on Facebook: http://www.Facebook.com/ScotchmanPeaks

COMMENTS:

August 5th, 2011

Emily Corsi
Montana Department of Environmental Quality
PO Box 200901
Helena, MT 59620-0901

Bobbie Lacklen
Kootenai National Forest
31374 U.S. Highway 2
Libby, MT 59923-3022

Via email: DEQTroyMine@mt.gov
TroyMineReclamation@fs.fed.us

Re: Troy Mine Revised Reclamation Plan, Draft EIS

Dear Ms. Corsi and Ms. Lacklen,

The Scotchman Peaks Roadless area, a part of the West Cabinet Mountains, spans the Idaho/Montana border, adjacent to the Troy Mine. We are, literally, very close neighbors. Yet, the Scotchmans remain one of the last, and largest, wild areas in our region.

The **Friends of Scotchman Peaks Wilderness** conducts education, outreach and stewardship activities to preserve the rugged, scenic and biologically diverse 88,000 acre Scotchman Peaks Roadless Area. We believe the Scotchman Peaks deserve congressional designation as Wilderness for the benefit and enjoyment of current and future generations. As we work towards the designation of the Scotchman Peaks as Wilderness we also strive to assure that this special place continues to retain its Wilderness quality and characteristics. The present operation of the Troy mine has been conducted in such a way that the Wilderness quality of the Scotchmans has been preserved. A strong reclamation plan will help assure that these Wilderness qualities will be retained after the mining operations have ended.

We appreciate the time and effort that the Kootenai National Forest, Montana Department of

Environmental Quality and the Troy Mine Company have put into preparing the alternatives explored by the draft EIS for the Troy Mine Revised Reclamation Plan. Both of the alternatives explored are very good improvements over the existing reclamation plan. We appreciate the thoroughness of the mine company's proposal and their willingness to tackle important issues; and we appreciate many of the improvements which DEQ has incorporated into the preferred alternative.

In general, we like many aspects of the "preferred alternative" and believe that it addresses some of the critical issues. We believe that the proposal of the mine operators as well as the additional mitigation measures suggested by the US Forest Service, when combined in some meaningful measure, and when improved upon further, should be able to produce a strong reclamation plan.

J2
J4

Because wildlife roams and does not recognize land ownership boundaries, we are very interested in seeing the strongest possible protections for the quality and security of wildlife habitat. We would encourage the use of native plants in re-vegetation projects and encourage every effort at the control of weeds and other invasive species. Steps to assure that the threats to surface habitat from of subsidence is reduced or eliminated, is also important.

I1

We agree with the decommissioning those mine related roads which would no longer be needed. However for those roads that are necessary for the long-term monitoring and maintenance, the environmental impact from an asphalt road may be less than ripping up the asphalt and maintaining the road to a different standard. Some common sense should prevail in determining what is reasonable to achieve the balance between returning the mine site to a "natural state" and maintaining the structures need for long term monitoring and hydrological management of the site.

E1
E2

The merits of burying pipeline for aesthetics or to keep it from being vandalized may be outweighed by the merit of having access to the pipeline for maintenance and repairs.

A3
B1

Overall, the current mine operation has been conducted with a minimal "footprint" which has not disrupted the Wilderness Character of the nearby Scotchman Peaks proposed wilderness. While the further reduction of that footprint, once the mining operation has ceased, is a desirable goal, we would expect that the long-term monitoring and maintenance needed to assure water quality would have some "minimal footprint" and that reason, prudence and common sense would help guide the decisions on just how much reduction in that footprint is feasible. Filling in the mine with non-hazardous on-site materials, rather than hauling them away may be one such example.

Please keep us updated on the projects status and include us on the distribution for the Final DEIS.

Sincerely,

Phil Hough

Philip Hough
Executive Director
Friends of Scotchman Peaks Wilderness

2011-08-05 Hough P - FSPW.pdf
(page 3)

Friends of Scotchman Peaks Wilderness

www.ScotchmanPeaks.org

FSPW
PO Box 2061
Sandpoint, ID 83864

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Lincoln County Coordinator
(406) 293-2934

August 5th, 2011

Emily Corsi
Montana Department of Environmental Quality
PO Box 200901
Helena, MT 59620-0901

Bobbie Lacklen
Kootenai National Forest
31374 U.S. Highway 2
Libby, MT 59923-3022

Via email: DEQTroyMine@mt.gov
TroyMineReclamation@fs.fed.us

Re: Troy Mine Revised Reclamation Plan, Draft EIS

Dear Ms. Corsi and Ms. Lacklen,

The Scotchman Peaks Roadless area, a part of the West Cabinet Mountains, spans the Idaho/Montana border, adjacent to the Troy Mine. We are, literally, very close neighbors. Yet, the Scotchmans remain one of the last, and largest, wild areas in our region.

The **Friends of Scotchman Peaks Wilderness** conducts education, outreach and stewardship activities to preserve the rugged, scenic and biologically diverse 88,000 acre Scotchman Peaks Roadless Area. We believe the Scotchman Peaks deserve congressional designation as Wilderness for the benefit and enjoyment of current and future generations. As we work towards the designation of the Scotchman Peaks as Wilderness we also strive to assure that this special place continues to retain its Wilderness quality and characteristics. The present operation of the Troy mine has been conducted in such a way that the Wilderness quality of the Scotchmans has been preserved. A strong reclamation plan will help assure that these Wilderness qualities will be retained after the mining operations have ended.

We appreciate the time and effort that the Kootenai National Forest, Montana Department of Environmental Quality and the Troy Mine Company have put into preparing the alternatives explored by the draft EIS for the Troy Mine Revised Reclamation Plan. Both of the alternatives explored are very good improvements over the existing reclamation plan. We appreciate the thoroughness of the mine company's proposal and their willingness to tackle important issues; and we appreciate many of the improvements which DEQ has incorporated into the preferred alternative.

2011-08-05 Hough P- FSPW.pdf
(page 4)

In general, we like many aspects of the "preferred alternative" and believe that it addresses some of the critical issues. We believe that the proposal of the mine operators as well as the additional mitigation measures suggested by the US Forest Service, when combined in some meaningful measure, and when improved upon further, should be able to produce a strong reclamation plan.

J2 J4 Because wildlife roams and does not recognize land ownership boundaries, we are very interested in seeing the strongest possible protections for the quality and security of wildlife habitat. We would encourage the use of native plants in re-vegetation projects and encourage every effort at the control of weeds and other invasive species. Steps to assure that the threats to surface habitat from of subsidence is reduced or eliminated, is also important.

I1 We agree with the decommissioning those mine related roads which would no longer be needed. However for those roads that are necessary for the long-term monitoring and maintenance, the environmental impact from an asphalt road may be less than ripping up the asphalt and maintaining the road to a different standard. Some common sense should prevail in determining what is reasonable to achieve the balance between returning the mine site to a "natural state" and maintaining the structures need for long term monitoring and hydrological management of the site.

E1 E2 The merits of burying pipeline for aesthetics or to keep it from being vandalized may be outweighed by the merit of having access to the pipeline for maintenance and repairs.

A3 B1 Overall, the current mine operation has been conducted with a minimal "footprint" which has not disrupted the Wilderness Character of the nearby Scotchman Peaks proposed wilderness. While the further reduction of that footprint, once the mining operation has ceased, is a desirable goal, we would expect that the long-term monitoring and maintenance needed to assure water quality would have some "minimal footprint" and that reason, prudence and common sense would help guide the decisions on just how much reduction in that footprint is feasible. Filling in the mine with non-hazardous on-site materials, rather than hauling them away may be one such example.

Please keep us updated on the projects status and include us on the distribution for the Final DEIS.

Sincerely,

Phil Hough

Philip Hough
Executive Director
Friends of Scotchman Peaks Wilderness

2011-08-05 Springer Rand Sh. pdf

Robert & Sara Lou Springer
440 Elk Creek Road
Heron, M 59844
August 3, 2011

Paul Bradford, Forest Supervisor
Kootenai National Forest
31374 US
Libby, MT 59923-

RE: Troy Mine Tailings Impoundment EIS

Over the years of the Troy Mine operation, we have noticed that unexpected events have occurred; creation of toe ponds, roof collapses to name a few. So we realize that it is difficult to plan for the unknown hazards of the tailings impoundment, however ISN'T THAT YOUR JOB?

E13 Your agency must demand that the buried barrels be dug up and tested. If toxic material are present —and we believe most likely there is—mitigation must begin.

45 We must have a big enough bond to protect Montana Taxpayers from the Zortman/Landusky screw-up.

Please do your job of protecting National Forest Resources.

Thank you,
Sincerely,

Robert Springer
Sara Lou Springer

AUG 05 2011
KH
RECEIVED

2011-08-18 .Nhpkki.pdf
(page 1)

From:	nhpkki@zwlokk.com
To:	troymine@miningmontana.com
Subject:	Troy Mine Revised Reclamation Plan
Date:	08/18/2011 06:00 AM
Attachments:	jlqnvfvgbc http://bxvfajlbyolt.com/ comments.pdf

Hello,
Attached is a letter stating my views on the Troy Mine Revised Reclamation Plan . Thank you for allowing me to submit my comments.

Sincerely,
jlqnvfvgbc http://bxvfajlbyolt.com/

2011-08-18 NhpKKi.pdf
(page 2)

jlqnvfvgbc http://bxvfajlbyolt.com/
jlqnvfvgbc
New York, NY 99822
45544416286

August 18, 2011

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901
Attention: Emily Corsi - Project Coordinator

Kootenai National Forest
31374 US 2
Libby, MT 59923-3022
Attention: Bobbie Lacklen - Project Coordinator

RE: Troy Mine Revised Reclamation Plan Draft Environmental Impact Statement

QPCeG5 wjvhykrlsnfm, [url=http://uaguyilnsaav.com/]uaguyilnsaav[/url], [link=http://diyetapkrpru.com/]diyetapkrpru[/link], http://mtcxeqbbgavp.com/

Sincerely,

jlqnvfvgbc http://bxvfajlbyolt.com/

2011-08-25 HindsC pdf

From: colleen hinds
To: deqtroymine@mt.gov; troyminereclamation@fs.fed.us
Subject: Comment on the Environmental Impact Study for the Troy Mine Tailings Impoundment Reclamation Plan
Date: 08/25/2011 10:54 AM

August 24, 2011
Pual Bradford, Forest Supervisor /Richard Opper, Director,DEQ

Dear Sirs:

My comments are late, but then the Plan is a bit off target also. My comments run along the smae line as CRG suggestions: 1) on the top soil reclamation create a large scale composting site with organic material and move small amounts at a time. 2) leave the present paved road to the mine intactas removing the paving would be costly and the public enjoys the less dust on atrip to the Spar Lake areas. heavily gate off the fork to the mine. 3) Does the idea of filling the old mine adit with Revett's old buildings sound like a fitting end??4) Make available a Toxic Release Inventory Log for as far back as possible to know how much and what kinds of pollutants were left behind. 5) An investigation into the buried barrels in the tailings pond ,also to know what pollutantsthe public is left to deal with.

H3
I1
I2
B1
E12
E13

Thank-you sirs for your attention and co-operation in this Reclamation Plan. (Family health issues hindered me from earlier discourse.)

Colleen Hinds
10 Picadilly Lane
Heron, Montana 59844

Transcript of Verbal Comments

UNITED STATES DEPARTMENT OF AGRICULTURE

KOOTENAI NATIONAL FOREST

MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY

PUBLIC HEARING RE DRAFT EIS NO. 20110149

TROY MINE REVISED RECLAMATION PLAN

Troy High School Auditorium

116 East Missoula Avenue, Troy, Montana

Wednesday, June 8, 2011 - 7:00 P.M.

Reported By: Bambi A. Goodman, CSR, RPR, CRR

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P R O C E E D I N G S

MS. CORSI: Thank you for coming tonight. My name's Emily Corsi. I'm with the Montana Department of Environmental Quality. I'm the project coordinator for this Environmental Impact Statement.

I'd like to introduce a few people before we get started tonight. Warren McCullough, also with DEQ. He's the head of our Environmental Management Bureau. Herb Rolfes is standing in the back corner. He's also with DEQ, and he's the head of the Hard Rock Mining Program. And he has various members of his staff here today. Hopefully you got a chance to meet all of them.

From the Forest Service, Bobbie Lacklen is my counterpart. She's the project coordinator. And then Linda Ellett-Fee is the district ranger from the Three Rivers Ranger District. And she's standing in the back corner. And then there are various members from the US Forest Service who are here tonight as well. And hopefully you got a chance to meet them.

And also, I'd like to introduce our contractors that helped put this together and put our displays together tonight. We have Kate Stenberg and Darrel Stordahl. There he is in the back. So hopefully you had a chance to meet everyone.

And now, Bobbie wants to give you a brief

overview of the EIS, and then we'll get started.

MS. LACKLEN: Well, I'm not going to give an overview of the EIS, but I do have a couple of things to say. I just want to thank you all for coming to the open house and public hearing tonight.

The purpose of tonight's meeting is to provide a forum for the public to review key aspects of the revised reclamation plan for the Troy Mine; ask questions during the open house portion of the meeting and provide an opportunity to give oral comments on the document.

The formal hearing portion of tonight's meeting is a requirement of the DEQ. It's not a forestry requirement. Hopefully everybody had a chance to meet with the agency personnel and ask questions about the project or components of the draft EIS. Specialists will be available for a short time after the hearing, if you guys have any more questions.

You can also find out project information on the DEQ and the KNF websites. DEQ is the Department of Environmental Quality, and KNF is Kootenai National Forest. The websites are listed on handouts and also on the exhibit board back there.

If you still have questions after tonight's meeting, you can also contact Emily or myself. Our business cards are on the table for contact information.

1 The Kootenai National Forest and the DEQ are
2 both joint lead agencies for this environmental review
3 process. Both agencies are responding to the Troy Mine's
4 request to approve the revised reclamation plan. The
5 Forest Service is evaluating all the reclamation plan
6 components, although the Forest Service's jurisdiction
7 applies only to the National Forest Service lands. The
8 Draft EIS analyzes three alternatives. I think most of
9 you guys understand the alternatives by now. We have the
10 no action alternative, which was the previously approved
11 1978 reclamation plan for the Troy Mine; and then the
12 proposed action, which is the revised reclamation plan
13 that was submitted to the agency by the mine in 2006.
14 And then the third alternative that we're evaluating is
15 the agency-mitigated alternative, which is the agency's
16 preferred alternative. So we welcome your comments on
17 the Draft EIS. Your comments will be invaluable to the
18 agencies as they prepare the final EIS and a record of
19 decision.
20 Now, Emily will discuss the specifics of the
21 public hearing.
22 MS. CORSI: All right. So both agencies
23 began accepting public comments on the Draft EIS on
24 May 20th. And you have until July 5th to send us your
25 comments. Tonight you have the opportunity to submit

1 oral comments by coming here to the microphone, or you
2 can also submit written comments. There are sheets here
3 on the table. And you can either put it in the box or
4 mail it to us later.
5 If you give oral testimony tonight, it will be
6 recorded verbatim. And we have our court reporter here.
7 She's catching everything we say. It will become the
8 basis of an official transcript and record of this
9 hearing. Just so you know, anything that you say or
10 submit will become part of the administrative record for
11 this project and will be available for public review.
12 And ultimately, your comments will be used in the
13 preparation of the final EIS.
14 All parties have the opportunity to express
15 their views on the proposed actions freely, fully and
16 publicly. In order to conduct a fair hearing tonight,
17 it's essential that you complete a card, and Kate has
18 them there for you. We need to make sure we get your
19 name spelled correctly for the record. So if you do plan
20 to comment tonight, please make sure you do fill one of
21 these out.
22 So the way this is going to work is, if you
23 signed up to provide comment, I'll call your name and you
24 can come up to the podium. Each speaker will have five
25 minutes to give testimony. When you come up, please

1 state your name. Please spell it for the court reporter.
2 If you're affiliated with a group or organization, please
3 state that as well. Also, if any of you have a prepared
4 written statement, like I do, please give it to the court
5 reporter. It will help with the transcript.
6 So just quick kind of rules of the hearing.
7 Please don't engage in a debate with other audience
8 members. Remember that the tape recorder is running and
9 there are small children in the room, so try to keep your
10 comments PG. As you come up to speak, Bobbie's going to
11 be our timekeeper. She'll provide a sign that tells you
12 when you can start. She'll give you a one-minute
13 warning, and she'll give you your five-minute stop. No
14 portion of your unused time can be allocated to other
15 presenters. Everyone gets five minutes; no exceptions.
16 And if there's extra time at the end of the hearing,
17 please feel free to ask additional questions with our
18 specialists.
19 With that, we're going to open it up for public
20 testimony. And someone has my list of speakers. No one
21 else has signed up? If you change your mind throughout
22 the hearing, you can always get a card from Kate and she
23 can get it to me.
24 And our first speaker tonight is Max Schrader.
25 MR. MAX SCHRADER: Max Schrader, M-a-x

S-c-h-r-a-d-e-r.

One thing I'd like to tell the people about here is, on the reclamation, I was part of some of the recovering of the tailing ponds back in 1999. We tried to use a test block with the topsoils that was stacked at the toe pond, plus we used the pit run. And nowhere did we see any sign of better growth with the soils -- the record topsoil. So I think in the EIS, it should be pointed out that the pit run material at the Troy tailings pond area could be used to cover that when the mine is done; thank you.

H2

MS. CORSI: Thank you for your comment, Mr. Schrader.

The next speaker is Senator Chas Vincent.

MR. CHAS VINCENT: You said PG. Is that PG-13 or is it just PG?

For the record, Chas Vincent. Tonight I'm just going to be speaking as a resident of Lincoln County. I will be submitting my formal comments as an elected representative for Lincoln County at a later date.

I wanted to start by saying -- giving some thanks to the agencies that have conducted the EIS. I think, after thirty years of monitoring the waters and the waterways around the Troy Mine and the project when it was operating and when it wasn't operating, I believe

E7

E7

1 that your decision to not require further water treatment
2 is a very good one. It is based in very sound science.
3 And I wanted to give you guys some applause in
4 recognizing those factors.
5 I do have a couple of questions, though, after
6 reading through the EIS. And I guess I'm hoping that
7 maybe later on we could get some answers to it, if we
8 have time. But certainly as you guys move forward, I
9 want to give my support for the agency's mitigated
10 alternative, with some consideration of some of the
11 company's proposed actions that I think, integrated or
12 rolled into that preferred alternative, would have the
13 best outcome and the least environmental impact.
14 I'd start with the pipeline. I don't
15 understand how leaving the current existing pipeline in
16 place, until it needs to be replaced, is a wise decision,
17 nor is burying the entire pipeline a wise decision.
18 There is a lot of information. There was a study done in
19 2004 that was after carrying twelve years of slurry
20 through the pipe, eighteen years of pretty much just
21 water, the liner inside the pipes were hardly showing any
22 sort of wear. And I believe, you know, of course the
23 mine's been operating for a couple of years, and you may
24 need to look at it again. But the existing
25 infrastructure is in very good shape. And I think that

E1

1 it should be used as long as is practically possible.
2 But if it is going to be replaced, it ought to
3 be replaced above ground. In the EIS it states that the
4 reasons for burying the entire pipeline had to do with
5 vandalism and perhaps maybe someone might suggest that it
6 would be -- the aesthetic values that would be associated
7 with leaving it above ground. And I would submit to you
8 that there has been no vandalism, for one. And two, if
9 you're going to be digging up or burying this pipeline,
10 and if it is, in fact, going to be need to be replaced
11 after forty-five years of use, then it is going to be
12 requiring quite a bit of disturbance over the next
13 hundred years or however long that additive is going to
14 be discharging water. So my recommendation would be use
15 the existing pipelines as long as possible. If it needs
16 to be replaced, to replace it and leave it above ground.
17 You know, you get a slough on the hillside, and how much
18 of that pipeline you're going to be digging up. And as
19 far as the aesthetics, I would argue that digging up that
20 entire pipeline every forty-five years would provide more
21 harm to somebody's experience, though I would not be one
22 of those people that would be sharing that experience. I
23 think the pipeline next to the road is a good idea and a
24 good place for it.
25 On the to road itself, one of the

E1
E2

I1

recommendations is to completely remove the entire cover, the asphalt, and return it back to dirt. And I'm just not quite understanding that desire. The State has spent a great deal of time, a great deal of time just in the last several months, talking about total daily maximum loads and impacts to watersheds in our current waterway. An effective way to deal with those BMP issues is to cap it with something like asphalt. And I'm not sure exactly what the driving factor is for that, but I would suggest that at the end of the mine's life, which hopefully will be another fifteen years from now, that fixing that asphalt and leaving it for BMP issues, moving forward, would be a wise decision and will have a better net impact.

One comment was made before I got up here alluded to the topsoil, and I would -- one other thing I would add to that is just that the -- I understand that you guys are in position on the topsoil; you're statutorily required if you can save it, you shall use it. And I understand that -- that situation. But I also understand the purpose of a reclamation plan is to mitigate impacts. And you're trying to create habitat in places that maybe there wasn't, upon decommissioning.

H1

These toe ponds, this topsoil that -- is providing a great deal of good habitat for -- I have one

H1
K1
H2

minute left -- for quite a few species of terrestrial and aquatic life. But the sensitive species of the western toad, which I understand has ten different breeding places in Lincoln County, three of them are at that impoundment. I think leaving that topsoil alone and using some of that borrowed soil that we just heard about, we can have the same desired future outcome, is a wise decision and would be leaving that habitat alone and still having our desired outcome in the end. It would be a win-win.

C4

You know, also, I would mention the company, from what I understand, has done a great deal of work on dust abatement. And I think messing with the pit run would be a lot better dealing with that dust abatement issue, moving forward.

B2

The last thing, really quick, that I would mention would be on the removal of the concrete and cement foundations in the buildings up there, an argument being made that it would be best to bust it up and take it away because it could pose a threat to the groundwater quality. But it's going to be busted up and it's going to be buried somewhere else. So I guess I would like to know where exactly it should be buried where it wouldn't be impacting water. And I would suggest that the mine's application to just strip what's necessary out, bury it,

1 would be the proposed action.
2 My time is up. I had one other thing to say,
3 but maybe I'll catch up with you in my formal comments;
4 thank you.
5 MS. CORSI: Thank you.
6 Our next commenter is Steve Lloyd.
7 MR. STEVE LLOYD: My name is Steve Lloyd,
8 L-l-o-y-d. I'm the mill manager at the Troy Mine.
9 I just wanted to talk a little bit about
10 the -- kind of what the EIS was predicated on. And that
11 was the scoping was done back in 2007. And there's three
12 issues that came out of that scoping. And they were all
13 really concerning the mechanical stability of the
14 tailings pipe itself, the threat of tailings water or
15 water from the adit getting into the environment because
16 of a break, the pipeline actually breaking. And my
E1 17 experience, and Chas mentioned it also, is that the
18 mechanical condition of the tailings line is very
19 excellent. The pipe is still three-eights of an inch
20 thick. The lining was designed from the factory between
21 one-quarter and three-eighths of an inch thick. And it
22 is still that thick. So Chas had mentioned that lines
23 had run about thirteen years. They actually had -- each
24 line had over 16 million tons of slurry run through them
25 during that period of time. But yet the liner was

E1

intact. We also have eleven years of down time in between when ASARCO ran this mine and when Genesis started the mine. And during those eleven years, water ran through those tailings lines. And of course, with water, there is no appreciable wear. So we have a really good dynamic test that's already been done at this place that indicates that the tailings lines should take that water for a long period of time. I personally feel like the mechanical condition of the tailings line is very, very good. And so breakage, to me, is the least of our troubles. So that's my perspective on the tailings lines for what it's worth; thank you.

MS. CORSI: Is there anyone else who would like to talk tonight? Oh, come on; there's a lot of people here. Nothing? All right. Well, I hope that you'll take the opportunity while you're here tonight to ask some of those questions. Because I think, Chas, you had a few. I think there's probably some specialists that could address a lot of those. So please stay and --

MR. MCCULLOUGH: He's a senator. Why don't you give him another minute.

MS. CORSI: Well, he speaks.

MS. STENBERG: We will be here until nine o'clock. This was advertised to last until nine o'clock,

so we will be here till 9:00, and we'll be happy to take additional testimony at any time.

MS. CORSI: So I think we'll give Chas another opportunity to come back up, since the Bureau chief says so. But you only have five minutes.

MR. CHAS VINCENT: That's what happens when you go from the House. Then you do get extra time; right?

MR. MCCULLOUGH: I'm just looking forward to the next legislative session.

MR. CHAS VINCENT: They had a hard time shutting me up there, too.

The other thing that I -- and I guess it -- I was going to give some statistics on how much slurry went through those pipes, and it was just covered by the next gentleman.

But I wanted to say one other thing related to the topsoil and what it was going to be, as far as I believe there was one -- there was some discussion about maybe taking half of it or taking a part of it and not -- but I would highly recommend that -- there was quite a few studies that were done on this western toad, the sensitive species. And it has, from what I understand, I have not seen it yet, there is a great body of work relative to that. And I would just encourage the

H1

K1

H2

E1

agencies to take a look at that and see what -- if there was a way -- if there really is a way to mitigate the impact for that habitat. And if there isn't, I think that it's a pretty common sense solution to just use the other borrowed soil. And I don't think that you're going to have anybody -- I've heard from a lot of folks. We do a lot of things around here in a collaborative way. There are a lot of folks from the soil side that would be supportive of that that maybe the agencies may be worried about objecting to doing something like that. But I do believe that you would find some consensus in the State board, if you should choose to have that approach in discussing in that matter. Is that a minute?

MS. CORSI: Bruce, we'll get you to sign a card afterwards.

MR. BRUCE VINCENT: Bruce Vincent, V-i-n-c-e-n-t.

I'd like to concur with the point that Chas brought up, as far as the pipeline. I think we should seriously take a look at the environmental consequences of intermittently having to do repair work and that repair work involve disturbing the ground.

I'd like to also concur that there are some people that don't like to look at that hand of man out in nature. But there are some places where I think it can

E2

be appropriate and aesthetically pleasing for some of us that are watching families getting raised in the mine. So I don't have a problem with the pipeline running next to the road.

K1

I'd like to concur about this discussion of the toad, of the fill and -- and environmentally look at what the consequences are of following that regulation to the letter. Or should this be a case where the environmental impact overrules the letter and we use some common sense? If the fill will work instead of the top -- it's called topsoil, but we've also learned that it's six or ten inches on top is still topsoil and the rest of it is dirt, because the organics have died inside those piles. We need to take a good, hard look at what's really going on there and what the real impact and the real environment is before we decide that we need to follow the exact letter as we currently interpret it.

H3

There are a couple of other things that I'd like to raise real quickly, just personal questions about things like: during the reclamation, there was an instruction in there to provide woody debris on top of the reclaimed area. And I understand why. It used to be we cleaned logging areas completely up. We learned that was wrong. So then we go back and we put our tops and crap out there. But five to eight or maybe sometimes ten

H5

1 tons to the acre is what we used. Twenty-five tons of
2 three-inches and larger is asked for in this EIS. And
3 does that pass Montana Department of State Lands fire
4 requirements? I mean, how much fuel are we putting out
5 there? Twenty-five tons is a lot. I'd like to talk to
6 somebody about that number; how that was arrived at and
7 why that same number isn't used out in logging jobs.
8 The other thing I'd like to raise real quickly
9 is the question of organics. I'm a big believer in
10 environmental sensitivity and not crossing the line into
11 insanity. And there's a discussion about organic
12 fertilizer. And I'd like to see the backup for that.
13 The chemicals that are needed, the minerals and metals
14 and the other things that we add back into the ground to
15 replace what was taken out by the plants and to put it
16 back into the topsoil to make things grow, is there a
17 chemical difference between organic and the kind that
18 comes in a pellet? I know when I think of organic it's
19 not accurate -- you can get organic pellets now -- but I
20 think of manure. And we apply four-and-a-half to five
21 inches, 1100 pounds to the acre, of organics? Can
22 that -- is it true that that is greener than the chemical
23 kind? I know it may be more expensive, and that's not
24 the issue. Is there really an environmental reason for
25 that name on the fertilizer? Are they the same

H3

1 chemicals? I'd like to know.
2 And I'd like to conclude by thanking the DEQ
3 and the National Forest Service for all the work they put
4 into these things. There are many families that are
5 dedicated to making sure that while they're feeding and
6 clothing their families and sending them to college up on
7 that mountain, that the area that they live in, love and
8 play in, is taken care of. That's what this reclamation
9 plan should be; making sure that the next generation is
10 not going to have to pay for what this generation is
11 doing.
12 I'd like to thank you for taking a good, hard
13 look at the water and understanding that we can -- we
14 have a benign -- nearly benign geology up there where we
15 can mine. And one question that's never asked in the
16 EISes that should be asked is If not here, then where?
17 We have a society that consumes like none other in the
18 history of human kind. And we provide strategically
19 appropriate metals and minerals for that society. And
20 never in any EIS do we ask If we don't do it here, where
21 are we going to do it, and what are the environmental
22 consequences of doing that?
23 When they closed Noranda, after they didn't
24 meet their Montana water quality requirements, they moved
25 75 families to Venezuela. And I wonder what the

environmental consequences of providing copper from there instead of here was.

Thank you for taking a good, hard look. Thank you for trying to find common sense in all of this. I look forward to offering my substantive comments in writing; thank you.

(Applause.)

MS. CORSI: Thank you, Mr. Vincent.

Anyone else want to get up and talk? I know that we do have specialists that can address a lot of the questions that were raised in the comments tonight, so I really encourage you to take the opportunity to talk to them. And if you can think of other questions in the meantime, please feel free to give Bobbie and I a call, and we can direct you to the right specialist.

Thank you.

(Hearing concluded at 7:26 p.m.)

1 REPORTER'S CERTIFICATE

2 STATE OF MONTANA)
: ss.
3 County of Flathead)

4

5 I, BAMBI A. GOODMAN, Registered Professional
6 Reporter, Certified Realtime Reporter and Notary Public
7 duly qualified in and for the State of Montana, residing
8 in Whitefish, Montana do hereby certify:
9 That I was duly authorized to and did report
10 the public comments in the above-entitled matter.
11 I further certify that the foregoing pages of
12 this transcript represent a true and accurate
13 transcription of my original stenographic notes.
14 IN WITNESS WHEREOF, I have hereunto set my hand
15 this 17th day of June, 2011.

16

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18 BAMBI A. GOODMAN, RPR, CRR and
19 Official Freelance Court Reporter
Residing in Whitefish, Montana

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