# DRAFT FINAL EXPANDED ENGINEERING EVALUATION/ COST ANALYSIS (EEE/CA) FOR THE GREAT DIVIDE SAND TAILINGS SITE

**Engineering Services Contract Number: W9128F-04-D-0013**
**Delivery Order Number: 005**

Prepared for:

***Department of the Army***
***Corps of Engineers, Omaha District***
106 South 15th Street
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***U.S. Department of the Interior***
***Bureau of Land Management, Butte Field Office***
106 North Parkmont
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Prepared by:

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**November 2007**

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# FOR THE
# GREAT DIVIDE SAND TAILINGS SITE

**Prepared for:**

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# COMMENT RESPONSES TO THE DRAFT EXPANDED ENGINEERING EVALUATION/COST ANALYSIS FOR THE GREAT DIVIDE SAND TAILINGS SITE

Prepared by:
**Pioneer Technical Services, Inc.**
November 2007

Comments by:
**U.S. Department of Interior/Bureau of Land Management (BLM)**
Butte Field Office
March 2007

## General Comments:

### Comment #1

*Kevin reportedly uses an abandoned mine shaft (or adit?) for water to make snow. Has this been sampled, how does the metal level compare to the surface water samples listed below (they are runoff and likely represent in some part mine waters)?*

### Response to Comment #1

The use of mine shaft and/or adit water for snow making purposes has not been confirmed by Pioneer, and therefore was not sampled as part of this investigation. As stated in Section 2.1.5.4, a well located near Jennie's Fork is currently used for snowmaking.

### Comment #2

*Are there any surface water samples taken outside of a runoff period?*

### Response to Comment #2

Only 1 sampling event was completed on May 2, 2006 for this site investigation.

### Comment #3– Section 1.1, Page 1-1, Paragraph 4

*Discuss previous reclamation work – generally here and expand on in subsequent sections. What was done, when, what worked, what did not, and why more reclamation needs to be conducted at the point?*

### Response to Comment #3

Comment incorporated.

**Comment #4 – Section 1.1, Page 1-1, Paragraph 4**
*Who removed the buildings and equipment from site and when?*

**Response to Comment #4**

The buildings and other mine features were presumably removed during the development of the Belmont Ski Area during the 1940s. Comment incorporated in Section 2.1.

**Comment #5 – Section 1.1, Page 1-1, Paragraph 4**
*State specifically now the sediments are impacting water and sediment quality.*

**Response to Comment #5**

Text has been revised to reflect this comment.

**Comment #6 – Section 2.1, Page 2-1, Paragraph 2**
*Reference year of MDEQ/MWBC work.*

**Response to Comment #6**

Text has been revised to reflect this comment.

**Comment #7 – Section 2.1, Page 2-1, Paragraph 2**
*"No active claims" and "all claims have been abandoned" is redundant – just use one reference.*

**Response to Comment #7**

Text has been revised to reflect this comment.

**Comment #8 – Section 2.1, Page 2-1, Paragraph 2**
*Are the "claim lines" referred to here and in Figure 2-1 and 2-2 old claim lines (unpatented) or patented claim lines in which case they really delineate private/public boundary? They are labeled "Property lines" in Figure 2-1 – which I think is correct. Unless old claim lines relate to any PRP searches I don't see their usefulness on the map or in the report. Please check and make document consistent.*

**Response to Comment #8**

Comment incorporated.

**Comment #9 – Section 2.1, Page 2-1, Paragraph 4**
*BLM includes adits and shafts in the term mine features, please include the adits (last paragraph in section) in the section or reword "mine features". Please clarify that the adits are closed and do not pose a threat to public safety.*

**Response to Comment #9**

The adits do not pose a threat. The buildings and other mine features were presumably removed during the development of the Belmont Ski Area during the 1940s. Text has been revised.

**Comment #10 – Section 2.1, Page 2-1, Paragraph 5**
*Reference year of Pioneer/Chem Northern work.*

**Response to Comment #10**

Comment incorporated.

**Comment #11 – Section 2.0, Page 2-1**
*Please add a discussion of the previous EEE/CA and reclamation done on this site. Including what went wrong and why it has to be readdressed. How much background information is used in this report from the last?*

**Response to Comment #11**

No previous EEE/CA was performed for this site. The Removal Site Evaluation (RSE) published by Chem-Northern in 1994 is referenced within this EEE/CA; however, no information from the RSE is used for the EEE/CA risk analysis. More detailed discussion has been incorporated.

**Comment #12 – Figure 2-1**
*Reference source of property line.*

**Response to Comment #12**

A reference to the Montana Cadastral Mapping Program has been added to the figure.

**Comment #13 – Figure 2-1**
*What is the dashed line in the upper middle of the tailings?*

**Response to Comment #13**

The dashed line is the division between upper consolidated and lower surficial tailings.

**Comment #14 – Figure 2-1**
*What is the line with boxes on it across the southern part of the drawing (just above the road)? If it is a chair lift, it is not the same symbol as that in the northeast of the drawing.*

**Response to Comment #14**

It is a chair lift and is now labeled on the figure. The towers for the Northeast lift have not been surveyed.

**Comment #15 – Figure 2-1**
*Can the French drain be included on the map and in the text?*

**Response to Comment #15**

The French drain is now identified on the map and discussion added to the text.

**Comment #16 – Figure 2-1**
*Label the road or include a legend on the map.*

**Response to Comment #16**

The road is now labeled on the map.

**Comment # 17 – Figure 2-1**
*The MS number indicate these are patented claims. Please clarify on all maps and in the text that the **PATENTED** claims indicate **private land** and not active claimants on BLM lands. Please make sure the volume (or proportion) of tails on private land is included in the report.*

**Response to Comment #17**

The surficial tailings on the surface of the parking area are located on private land owned by the Great Divide Skiing Company. The text has been revised.

**Comment #18 – Section 2.1.5.2, Page 2-3, Paragraph 1**
*Reference Walker's map – include as appendix.*

**Response to Comment #18**

Comment incorporated. Geology maps have been included as Figures 2-3 and 2-4 within this report.

**Comment #19 – Section 2.1.5.3, Page 2-4, Paragraph 1 & 2**
*Reference the source for groundwater flow information. Because the adits discussed adjacent to the tails are small, therefore the statement that underground works control groundwater is confusing. Pioneer may want to include a discussion on the larger underground mines in the area, which is what I think this paragraph is referring to.*

**Response to Comment #19**

The text has been revised to reflect this comment.

**Comment #20 – Section 2.1.5.3, Page 2-4, Paragraph 4**
*If possible include the well locations on the maps.*

**Response to Comment #20**

Well locations are now identified on Figure 3-1

**Comment #21 – Section 2.1.5.3**
*Include a discussion of surface water as related to the tailings – there is no stream across them, but surface flow must have an impact and what about the French drain?*

**Response to Comment #21**

Surface water comment has been incorporated. Note that this is background hydrogeology; therefore the drainage ditches are discussed in previous sections.

**Comment #22 – Figure 3-1**
*The text refers to background, tailings, sediment, surface water, and groundwater samples. The legend only indicates bore holes and composites samples. Please make sure each referenced sample type is included in the legend and on the map.*

**Response to Comment #22**

Comment incorporated.

**Comment #23 – Section 3.0, Page 3-1, Paragraph 1**
*Should groundwater be included in the first parentheses - - was it sampled by Pioneer?*

**Response to Comment #23**

Yes – comment incorporated.

**Comment #24 – Table B-2**
*This table is useless if there are no units of measurement and should not be used in the report or applied to any evaluations in the report.*

**Response to Comment #24**

Table B-2 was only included in the appendix to document the previous investigations and was not used for any evaluation purposes in the Draft EEE/CA. This table has been removed from Appendix B in the Draft Final EEE/CA.

**Comment #25 – Section 3.1, Page 3-1, Paragraph 1**
*Suggest removing reference to data because there are no units of measurements available for the data or find out what units are.*

**Response to Comment #25**

Text references to Table B-2 have been removed in the Draft Final EEE/CA.

**Comment # 26 – Section 3.1, Page 3-2, Paragraph 2**
*Reference location of data (Appendix?) and indicate which samples on the map are part of the data set.*

**Response to Comment #26**

The data is correctly referenced. None of the previous samples are shown on the map, and was not used in the analysis. These are used solely for documentation of the previous soils investigations.

**Comment #27 – Section 3.2.1.1, Page 3-2, Paragraph 2**
*I feel it is only fair to compare metal exceedences and the risk analysis to a weighted average of the background. Please include this analysis, it can either be included as an addendum to the report or compared alongside of the original analysis.*

*Also discuss the difference between the 2 background samples, explain that the background samples are soil and the tailings are from mineralized rock.*

**Response to Comment #27**

The comparison within the text has been revised to compare the sample results to an average of the two background samples.

**Comment #28 – Section 3.2.1.2, Page 3-3, Paragraph 2**
*See above.*

**Response to Comment #28**

The comparison within the text has been revised to compare the sample results to an average of the two background samples.

**Comment #29 – Section 3.2.1.3, Page 3-4, Paragraph 2**
*I feel it is misleading to discus sample variation as "significantly" greater than background – Only silver exceeds the higher background sample (N. of tailings) greater than 3X background. As, Cu, Ag, and Zn only exceed the lower background sample. Be precise in descriptions instead of making abstract statements.*

**Response to Comment #29**

The comparison within the text was revised to compare the sample results to an average of the two background samples.

**Comment #30 – Section 3.2.3, Page 3-4**
*This background sample discussion belongs before comparison of samples to background.*

**Response to Comment #30**

The text in Section 3.2.3 has been revised.

**Comment #31 – Section 3.2.4**
*General Comment – I am confused about the groundwater and surface water sample locations, please add to map (or clarify if I am just not finding them?)*

**Response to Comment #31**

All sample locations are shown on Figure 3-1, except GW-1 which was collected from the kitchen faucet in the chalet. A note will be inserted on Figure 3-1 stating where GW-1 was collected.

**Comment #32 – Section 3.2.6, Page 3-5, Paragraph 1**
*Please summarize how the previous geotechnical foundation investigation affects conclusions in this EEE/CA.*

**Response to Comment #32**

The text in Section 3.2.6 has been revised.

**Comment #33 – Section 5.1.1, Page 5-1, Paragraph 1**
*In criteria 2 – please describe how the EPA defines "significantly" and "background".*

**Response to Comment #33**

The EPA has specific statistical criteria for these terms (upper 95th percentile). However, at the Great Divide site, there are not enough sample results to apply meaningful statistics, either for background samples (2) or waste/source samples (5). In this application, the selection of Contaminants of Concern (COCs), background is merely the average of the two sample results. Note that the two sample results represent 12-point and 15-point composite samples.

"Significantly above" is defined as three times the average background, which is specified in Section 3.2.1.1.

**Comment #34 – Section 5.1.1, Page 5-1, Paragraph 2**
*Please include a discussion of how the TCLP and ABA results.*

*This identification of the hazard should be specific – exactly what elements exceed what (high/low/weighted average 3X background) by how much (maybe by % is a better way to compare differences).*

**Response to Comment #34**

The Toxicity Characteristic Leaching Procedure (TCLP) and Acid Base Accounting (ABA) results are not used in the risk assessment.

The Hazard Index (HI) is the ratio of the waste concentration to the benchmark or acceptable risk concentration, not background or 3 times background. Using percent does not convey the same information (i.e., 100% of the benchmark – HI=1.0; 327% - HI= 3.27) and the standard risk assessment methodology for HI is ratios. Also, background has nothing to do with the HI calculation, only the benchmark concentrations.

**Comment #35 – Table 5-1 & Table 5-2**
*Where are these numbers from? I don't find them in the data? Were they calculated? Define RBC table?*

**Response to Comment #35**

The numbers in these tables are from the literature sources cited on the tables and in the text, EPA Region 3 (Risk Based Concentrations [RBC] Table) and the DEQ report. They are used to calculate the HIs in Tables 5-3 and 5-4.

**Comment # 36 – Section 5.1.2, Page 5-2**
*This report states the "water ingestion route was evaluated using the maximum downstream water concentration measured at the site." Please define specifically what this is – the maximum concentration? The maximum distance? Shouldn't the risk be evaluated to the sample closest to the problem being evaluated (e.g. the tails)? If this was not done please include the evaluation as an addendum to the report.*

**Response to Comment #36**

The sample location immediately downstream (SW-2) is closest to the wastes and is the sample used for all surface water evaluation. A sentence was added to clarify that the maximum downstream concentration occurred at the sample taken closest to the site.

**Comment #37 – Section 5.1.4.1, Page 5-4, Paragraph 2**
*Ok – I am Confused – You state that "only HQ values greater than 1.0 indicate the potential for harmful effects by a COC"; then you include As in potential risk elements even though its HQ is <1.0. If so As is not a COC.*

**Response to Comment #37**

The COCs in the tables (5-3 and 5-4) are included because they were present in wastes at more than 3 times background, not because they exceed any risk or hazard value. The COC means that the contaminant is evaluated via the risk assessment to see if there is any risk or hazard to be concerned about, not that it has an HI > 1 or a risk above 1.0E-06. As mentioned earlier, a contaminant is a COC merely if it is present at greater than three times background concentrations – not necessarily that there is any risk.

Note that arsenic has since been dropped as a COC due to the revised evaluation based on the average of the two background sample results.

**Comment #38 – Section 5.1.5**
*The comparison of both residential and recreational risk is nicely done and provides perspective.*

**Response to Comment #38**

Comment noted.

**Comment #39 – Section 5.2.1, Page 5-7, Paragraph 1**
*What would the COC be if weighted average was used for the background? Can include this in the addendum.*

**Response to Comment #39**

The COC evaluation was redone using the average of the two backgrounds. The net result is the elimination of arsenic as a COC. However, the risks for the remaining COCs do not change as risk is evaluated relative to benchmark concentrations, not background.

**Comment #40 – Section 5.2.2, Page 5-8, Paragraph 1**
*This section needs a discussion of why you are using the Deer Ingestion Scenario for capped tailings – It was only clear to me after seeing the photos.*
*Include erosion problems with the old reclamation and the gopher problem.*

**Response to Comment #40**

The problems with the existing conditions at the site have been clarified in Sections 1.1 and 2.1. This discussion, if any, is not appropriate in the risk assessment section. Deer are exposed to waste materials via erosion, and inadequate capping of contaminated materials (tailings). They are evaluated here as potential ecologic receptors of COCs.

**Comment #41 – Section 5.2.3, Page 5-9, Paragraph 1**
*As **no** site specific tests were performed – then explain what is the existing data used and how can the results by applied to the evaluation? Please carry the explanation throughout all of section 5.2 and 5.4.*

**Response to Comment #41**

The caveat in the text refers to the fact that no fish, deer, aquatic insects, etc., were tested with exposure to on-site wastes in order to see how many suffered adverse effects. It is standard risk assessment procedure to explain that on site waste concentrations were compared to benchmark concentrations instead of performing live testing on-site flora and fauna.

**Comment #42 – Section 5.2.3.2, Page 5-10, Paragraph 1**
*See above.*

**Response to Comment #42**

See Response to Comment #41.

**Comment #43 – Section 5.2.4**

See Response to Comment #41.

**Response to Comment #43**

See Response to Comment #41.

**Comment #44 – Section 6.6, Page 6-2 to 6-3**
*How could these values (Tables 6-3 and 6-4) change if a weighed average background was used in the model? If real data was used instead of data from the literature – Include in addendum or here in report.*

**Response to Comment #44**

See Response to Comment #39. The values would not be a meaningful measure of risk because risk is not evaluated relative to background (based on risk assessment protocols developed by EPA).

**Comment #45 – General**
*The No Action Alternative is confusing me, as there is a cap in place. Please give this alternative more background discussion and clarify exactly what "No Action" is – to us it would be to leave the cap as it is and not conduct additional reclamation/removal. Photos comparing spring to summer would help a lot. The existing cap, problems with maintenance and gophers need to be brought into each alternative where appropriate.*

**Response to Comment #45**

As outlined in Section 7.1, the No Action Alternative is a stand-alone general response that is considered baseline to which the remaining alternatives are compared to as required by Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Under the No Action Alternative, a site would remain "as is." See Response to Comment #3 (Section 1.1 of the EEE/CA), and the individual responses to the following comments for site-specific background and evaluation information.

**Comment #46 – Section 7.1.1 and Section 7.3.1**
*The No Action is confusing – see above.*

**Response to Comment #46**

See Response to comment #45. Section 7.3.1 has been revised to clarify the No Action Alternative as it specifically applies to the Great Divide site.

**Comment #47 – Table 7-3 and General Comment**
*Alt 1 – See No Action alt comment above.*

**Response to Comment #47**

See responses to Comments #45 and #46.

**Comment # 48 – Section 7.1.3**
*Engineering controls here may be to improve the cap and storm water controls.*

**Response to Comment #48**

As outlined in Section 7.1, Engineered Controls such as containment/capping and run-on/runoff controls are general response actions that can be evaluated for a site. Alternatives 3b through 4b all include some sort of engineering controls, and are described within Section 7.3 as specifically applied to the Great Divide site.

**Comment #49 – Section 7.3.1, Effectiveness**
*This is where there could be a discussion about the effectiveness of the cap in place.*

**Response to Comment #49**

The text in Section 7.3.1 has been revised to reflect this comment.

**Comment #50 – Section 7.3.1, Implementability**
*This section needs to include a discussion of how the cap is working on a ski resort, the ski resort owner, gophers, and cattle.*

**Response to Comment #50**

See the Effectiveness discussion in Section 7.3.1. There is no Implementability discussion for a No Action alternative, as there is nothing to implement.

**Comment #51 – Section 7.3.3, Alt 3a General**
*Good discussion of existing situation could this be part of the No Action alt?*

**Response to Comment #51**

Section 7.3.1 has been revised.

**Comment #52 – Section 7.3.5, Alt 4a General**
*Isn't Alt 4a what is presently on site? If not describe the difference in the two. Explain why you expect this alt to work then the last cap has not?*

**Response to Comment #52**

Alternative 4b is similar to what is presently on site; however, a thicker cap with more dense vegetation would be utilized to inhibit erosion. Improved run-on and runoff control ditches would also be utilized to prevent excessive surface water flow across the cap. The effectiveness would be further enhanced by the use of institutional controls (fencing, land use restrictions) in conjunction with this alternative.

**Comment #53 – Section 7.3.6, Alt 4b General**
*Same comment as above*

**Response to Comment #53**

See Response to Comment #52.

**Comment #54 – Section 7.3.7, Alt 5a**
*We should work on seeing if a repository sites is in the vicinity, which would work for the alternative.*

**Response to Comment #54**

For the purposes of evaluation within the EEE/CA, it is assumed a suitable repository would be located within approximately six miles of the site.

**Comment #55 – General**
*New alternative – Consolidate waste with those from the Bald Butte project (DEQ in progress). This will entail trying to work out a repository with the state. We should probably see which cap type the state is recommending for Bald Butte and use that style in this alternative, or the type required may be dictated by elevation/location of the potential site.*

**Response to Comment #55**

Alternative 6 has been revised to reflect the use of the Bald Butte Repository in lieu of the Silver Creek Repository originally anticipated for use in the Draft EEE/CA.

**Comment #56 – Section 8.2, General**
*This section needs a discussion of why the old cap is not working.*

**Response to Comment #56**

Section 8.2 has been revised to re-iterate the problems associated with continued erosion of the old cap.

**Comment #57 – Section 8.3, General**
*Same as above.*

**Response to Comment #57**

Under Alternative 4a, a thicker cover soil cap with improved vegetation and drainage ditches would be installed. The old cap and plugged ditches would no longer exist, and are therefore are irrelevant to the evaluation of threshold criteria for Alternative 4a.

**Comment #58 – Section 8.5, General**
*Finding a workable site would allow more specific analysis in the section.*

**Response to Comment #58**

For the purposes of evaluation within the EEE/CA, it is assumed a suitable repository would be located within approximately 6 miles of the site.

**Comment #59 – Section 8.7 and Section 10.0, General**
*Discuss a joint repository with the state.*

**Response to Comment #59**

Alternative 6 has been revised to reflect the use of the Bald Butte repository in lieu of the Silver Creek repository originally anticipated for use in the Draft EEE/CA.

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# 1.0 INTRODUCTION

## 1.1 PURPOSE AND OBJECTIVES

This Draft Final Expanded Engineering Evaluation/Cost Analysis (EEE/CA) for the Great Divide Sand Tailings Site has been prepared for the U.S. Army Corps of Engineers (USACE)-Omaha District and the U.S. Department of Interior/Bureau of Land Management (BLM) by Pioneer Technical Services, Inc. (Pioneer), under Engineering Services Contract Number W9128F-04-D-0013, Delivery Order Number 005.

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) requires the BLM, as the lead agency, to complete removal site evaluations for releases or threatened releases identified for possible Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) responses on Public Lands (40 Code of Federal Regulations [CFR], §300.410 b). The BLM is also responsible, under the guidance of the National Environmental Policy Act (NEPA), for making decisions that are based on the understanding of environmental consequences, and taking actions that protect, restore, and enhance the environment (40 CFR, §1500).

The primary purpose of this report is to present the detailed analysis of reclamation alternatives for the Great Divide Sand Tailings Site in accordance with the NCP. Additionally, the site background, waste characteristics, applicable or relevant and appropriate requirements (ARARs), risk assessment, and preliminary development and screening of reclamation alternatives are presented herein. The purpose of providing this supplemental information with the detailed analysis of alternatives is to give the reviewers and risk managers a comprehensive "stand-alone" decision-making tool.

The Great Divide Sand Tailings Site is located in the Marysville Mining District in Lewis and Clark County, Montana, in Township 12 North, Range 6 West, Section 35 of the Montana Principal Meridian (Figure 1-1). The Great Divide Sand Tailings Site is located on the eastern slopes of Mount Belmont, upgradient of the Great Divide Ski Area and the town of Marysville, Montana. The site encompasses approximately six acres, primarily on BLM-administered land and land owned by the Great Divide Skiing Company.

The tailings impoundment was previously reclaimed by the BLM during the early 1990s with installation of a vegetative cap and drainage ditches to control surface water run-on and runoff. The drainage ditches are inadequately sized to properly convey surface water flow, and are plugged with sediment. The tailings impoundment is moderately vegetated but has developed a headcut through the vegetative cap directly upgradient of Ski Tower #6 from excessive surface water run-on. Numerous rills and gullies have been formed on the surface of the lower end of the impoundment from surface water runoff. The uncontained waste materials carried by the surface water runoff are causing elevated contaminant concentrations within surface water and sediment in Jennie's Fork of Silver Creek. Sediment materials are also being carried off-site and deposited near the ski lodge and parking lot areas during high flow events. Additional reclamation may be warranted to prevent continued erosion of the tailings impoundment surface and thereby reduce the adverse impacts to surface water and sediment in Jennie's Fork.

## 1.2 REPORT ORGANIZATION

This EEE/CA is organized into 11 sections. The contents of Sections 2.0 through 11.0 are briefly described in the following paragraphs:

**SECTION 2.0 BACKGROUND**—presents a background description of the Great Divide Sand Tailings Site. Significant site features; a detailed history of past mining and milling activities, geologic, hydrologic, and climatic characteristics of the site; the biological setting, such as the wildlife and fisheries resources and the vegetation indigenous to the area; and threatened and endangered species concerns, as well as the cultural setting issues, such as present and future land uses, are described in this section.

**SECTION 3.0 GREAT DIVIDE SAND TAILINGS SITE DATA COLLECTION**—describes the characteristics of the sand tailings, including volume estimates, and contaminant concentrations, as well as an evaluation of existing data derived from previous response actions or investigations.

**SECTION 4.0 SUMMARY OF THE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS**—presents the Montana State and Federal government requirements which are considered ARARs for the reclamation effort. Requirements discussed in this section are chemical-, location-, and action-specific in nature.

**SECTION 5.0 BASELINE HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENTS**—presents a summary of the human health and ecological risk assessments performed for the site. Contaminant sources, routes of exposure, and receptors are evaluated to determine the relative threats posed by each source within the project boundary and each exposure pathway.

**SECTION 6.0 RECLAMATION OBJECTIVES AND GOALS**—presents the reclamation objectives and applicable cleanup standards.

**SECTION 7.0 DEVELOPMENT AND SCREENING OF RECLAMATION ALTERNATIVES**—identifies and screens potentially applicable reclamation alternatives. Reclamation alternatives are evaluated based on effectiveness, implementability, and cost.

**SECTION 8.0 DETAILED ANALYSIS OF RECLAMATION ALTERNATIVES**—presents the detailed analysis of reclamation alternatives pertaining to seven of the nine NCP evaluation criteria.

**SECTION 9.0 COMPARATIVE ANALYSIS OF RECLAMATION ALTERNATIVES**—presents a comparative analysis of the reclamation alternatives consistent with the NCP.

**SECTION 10.0 PREFERRED ALTERNATIVE**—presents the preferred alternative and summarizes the reasoning behind selecting this alternative.

**SECTION 11.0 REFERENCES**—lists the references cited in this text.

## 2.0 BACKGROUND

### 2.1 CURRENT SITE SETTING

The Great Divide Sand Tailings Site is located in Lewis and Clark County approximately 21 miles west/northwest of Helena, Montana, and approximately 0.75 mile west of Marysville, Montana. The site is accessed west from the Lincoln Highway and traveling approximately five miles along the Silver Creek road to the Great Divide Ski Area. The legal description of the site is Northeast ¼ of the Southeast ¼ of Section 35, Township 12 North, Range 6 West (see Figure 2-1). The Great Divide Sand Tailings are located on the eastern slopes of Mount Belmont, upgradient of the Great Divide Ski Area chalet at approximately 6,100 feet above mean sea level (amsl). The tailings impoundment is located entirely on land administered by the BLM. Tailings that eroded from the impoundment have been deposited on the parking lot area owned by the Great Divide Skiing Company.

The Great Divide Sand Tailings Site is listed on the Montana Department of Environmental Quality/Mine Waste Cleanup Bureau (DEQ/MWCB) Abandoned Hardrock Mines Priority Sites List (DEQ/MWCB-Pioneer, 1993). The site (Bald Mountain) (#25-061) was ranked using the Abandoned and Inactive Mines Scoring System (AIMSS); the rank is 50 of approximately 284 sites that were inventoried. Using the Abandoned Hardrock Mine Priority Sites Safety Ranking, the site rank is 10 of approximately 276 sites. Current BLM records show the site has no active claimant(s). Figure 2-2 shows the approximate section and patented claim boundaries.

Mining-related features associated with the Great Divide Sand Tailings Site include one collapsed adit located directly north of the tailings impoundment, and one second collapsed adit located directly southeast of the impoundment. The adits do not pose a threat to public safety. The milling equipment and buildings have been removed, presumably when the Belmont Ski Area was originally developed during the 1940s.

Based on the site inventory conducted by Pioneer (DEQ/MWCB-Pioneer, 1993) and Removal Site Evaluation (RSE) by Chen-Northern Inc. (USACE/Chen Northern, 1994), approximately 65,000 cubic yards (cy) of tailings were estimated to be present. On May 25 1994, the BLM Butte Field Office completed a RSE and estimated the volume of tailings at approximately 13,000 cy. A Finding of No Significant Impact (FONSI) was also completed by the BLM in 1994. The site was reclaimed by the BLM by installing a vegetative cap over the tailings impoundment and constructing a series of drainage ditches to control surface water. The soil placed for the cap appears to be approximately six inches thick. The drainage ditches appear to be constructed of 4-inch Polyvinyl Chloride (PVC) drain pipe surrounded by fabric and ¾-inch gravel.

The existing tailings impoundment cap is moderately vegetated but has sustained considerable damage primarily from excessive surface water run-on and runoff during high-flow events. The gravel within the upper run-on control ditch has trapped sediment carried by upgradient surface water flow, and has allowed the surface drainage to flow directly across the ditch onto the upper impoundment area. The cap has been breached by the excessive flow and the tailings material has eroded from the area directly above Ski Tower #6 and carried downgradient onto the lower slope area. The lower drainage ditch has also been plugged with sediment, forcing runoff to flow over the surface of the impoundment resulting in further cap erosion and tailings deposition near the lodge and parking lot areas. Sediment-laden water eventually drains into the Jennie's Fork of Silver Creek near the south end of the upper parking area, resulting in contaminated sediment accumulation in the stream bed and surface water degradation.

The existing impoundment cap has also been compromised by burrowing animals and trenching operations during the installation and repair of utility lines serving the ski area facilities. These disturbances have further degraded the impoundment cap by bringing tailings material to the surface and providing additional areas prone to erosion.

### 2.1.1 Vegetation/Wildlife

The Great Divide Sand Tailings Site is located on a moderately timbered easterly-facing slope. The surrounding topography is generally steep mountainous terrain consisting of moderately forested lands and open meadows that are important habitat for a variety of big game animals, furbearers, and birds. The Great Divide Sand Tailings Site is sparsely to moderately vegetated with native and non-native grass and forb species.

There are no wetlands or riparian areas located within the Great Divide Sand Tailings project area. The Jennie's Fork drainage located directly south of the project area is a riparian zone with small wetland areas scattered along the drainage.

A survey of the Montana Heritage Program (MHP) web site has recorded two species of concern within the general area of the Great Divide Sand Tailings project area (the Olive-sided Flycatcher [*Contopus cooperi*] and Canada Lynx [*Lynx Canadensis*]) (see Appendix A). No threatened or endangered terrestrial species were noted in the area of the Great Divide Sand Tailings Site. However, the area surrounding the ski area is known to provide important habitat for Grey Wolf (*Canis lupus*), Grizzly Bear (*Ursus arctos horribilis*), Black Bear, (*Ursus americanus*) and Wolverine (*Gulo gulo luscus*). Additionally, the area surrounding the ski area is important summer range for elk and deer.

### 2.1.2 Historic or Archaeologically Significant Features

Cultural inventory, determinations of eligibility, effects to historic properties, and completion of Section 106 with the Montana State Historic Preservation Office (SHPO) is required. The SHPO must concur if the action will have "no effect," "no adverse effect," or "adverse" effect to cultural properties. In order to mitigate any loss of these resources, an approved mitigation plan must be developed with SHPO.

In 1994, the BLM conducted an initial Cultural Resource Inventory of the original sand tailings repository. Several sites were located in and around the project area. Two sites, 24LC993 and 24LC1145, were found to be "not eligible" for listing on the National Register of Historic Places. A third site (24LC1146) may be a "contributing element," either whole or in parts, to the Empire-Marysville road.

Since 24LC993 and 24LC1145 were found "not eligible," removal of the sand tailings would have "no adverse effect" on those properties. The third site (24LC1146) is outside the Area of Potential Effect; therefore, the compliance requirements for this project under Section 106 of the National Historic Preservation Act have been completed.

### 2.1.3 Land Use and Population

Primary land uses for the area surrounding the Great Divide Sand Tailings Site are recreation, timber harvest, livestock grazing and mining. The majority of the recreation use occurs in the winter ski season from the Great Divide Ski Area. Additional recreation activities include hiking, all terrain vehicle (ATV) riding, biking, and hunting.

The town of Marysville is located approximately 0.5 miles to the east of the Great Divide Sand Tailings Site. Approximately 90 residents live year-round at Marysville, with additional cabins in the vicinity of the town used seasonally.

### 2.1.4 Climate

Like most of southwestern Montana, the area is subject to a cool and dry, continental-dominated climate. The region's temperature is generally low and marked by wide seasonal and daily variations. During winter, the temperature often drops to 0 degrees Fahrenheit ($^{o}$F) with occasional periods of temperatures lower than 20$^{o}$F below zero. During summer months, many days are fairly warm, but due to the generally arid climate and elevation (6,100 feet amsl), temperatures decrease rapidly at nightfall. Precipitation is relatively abundant in the region, averaging 21 inches annually. A significant portion of the annual precipitation falls as snow during winter, with 122 inches average annual snowfall at Marysville, and heavier accumulations at the higher elevations. Snowfall is intensified at the Great Divide Ski Area with the addition of artificial snow during the winter ski season. Stormy weather usually brings the first snows during September. By mid-October, the area is usually covered with snow by either artificial or natural means. Heavy snows are frequent in the winter, as are periods of melting and refreezing in spring. Snow pack at the site generally remains in the area for six months or longer, with spring thaws occurring in May or June.

The area is subject to a distinct spring/summer rainy season with May and June usually being the wettest months of the year. On average, May and June each receive approximately three inches of precipitation. The frost-free period (32$^{o}$F or more) averages 83 days annually, from mid-June to mid-September.

### 2.1.5 Geology

#### 2.1.5.1 <u>Regional Setting</u>

The Great Divide Sand Tailings Site is located near the Continental Divide, northwest of Helena. The area is part of the overthrust belt that extends from northern Utah into Canada along the Rocky Mountains. The regional geology is comprised mainly of folded and faulted Precambrian metasediments and Paleozoic sedimentary units. These were intruded, in Cretaceous to Tertiary time, by granitic igneous bodies of various sizes. One of the largest of these is the Boulder Batholith, which extends from Helena, southward to the Butte area (Ross et.al. 1955). The regional structural geology is complex and includes eastward overthrust faulting as well as multiple high angle faults, strike-slip faults, and fracture zones. Mineralization occurs in many locations along the overthrust belt, primarily along contacts between sedimentary and igneous rocks and in altered fracture zones.

#### 2.1.5.2 Local Setting

The Great Divide Sand Tailings Site is located on the Marysville Stock, a Cretaceous quartz diorite igneous body that intruded into folded and faulted Precambrian metasediments (Walker, 1992). The stock is a medium-grained granitic intrusion of feldspar, quartz, biotite and hornblende. Mineralization occurs in veins within the stock and near its contacts with the Precambrian metasediments. Gold and silver were the main mining targets. Other associated minerals are sulfides, including galena and sphalerite (lead and zinc), fluorite and molybdenite. Sulfide concentrations increase with depth. Walker's map shows the nearest of these veins approximately 2,000 feet southwest of the sand tailings, near the Belmont Mine (see Figures 2-3 and 2-4 ).

Walker shows the quartz diorite's northern contact running east-southeast to west-northwest approximately 1,000 feet north of the tailings. North of this contact is the Helena formation, which is Precambrian limestone that weathers grey to brown and locally shows a "molar tooth" structure, where a more resistant quartz-calcite-mica matrix stands out in the more easily eroded limestone (Walker, 1992).

#### 2.1.5.3 Hydrogeology

The Marysville Mining District sits at the headwaters of Silver Creek, which flows to the east and southeast, into the Helena valley. The sand tailings are located in the approximately 54-acre drainage area of Jennie's Fork of Silver Creek. Snowmelt and storm water runoff from the upper slopes of the ski area merge together and are concentrated on the lower slope. The resultant flow across the surface of the tailings impoundment continues downgradient, eventually reaching Jennie's Fork near the south end of the parking lot area.

#### 2.1.5.4 Groundwater

There is no published hydrogeologic information specific to the Great Divide Sand Tailings Site. The conclusions regarding hydrogeologic conditions, are therefore, based on accepted hydrologic and geologic principals and local observations.

Groundwater recharge is by precipitation and snowmelt that feeds a complex bedrock aquifer. Groundwater flow within the bedrock is generally eastward, parallel to Jennie's Fork, with localized flows in various directions controlled by the orientations of fractures and faults.

The Montana Bureau of Mines and Geology (MBMG), Ground-Water Information Center (GWIC) database shows 8 well logs for Township 12 North, Range 6 West, Section 35. Total depths range from 24 to 400 feet, and published yields for the "domestic" wells range from 6 to 60 gallons per minute (gpm). The 2 wells closest to the sand tailings are listed as 24 feet and 400 feet deep; however, no geology or completion information was provided in the well logs. Some of the other wells do show lithologies and yields. All of those are completed in granitic bedrock. Decomposed granite was encountered in these borings within the upper 8 to 34 feet of drilling. The variation in yields is likely controlled by the degree of fracturing in the immediate areas and by well construction details.

The Great Divide Ski Area uses water from the 400-foot well located northeast of the ski chalet. This well produces 6 gpm (Kevin Taylor, March 31, 2006). A spring upgradient from the ski chalet and downgradient of the sand tailings that produced 20 to 30 gpm and was used for domestic water supplies prior to 1988. Flow from the spring stopped in 1988, and was abandoned because of concern about contamination from the sand tailings. Currently, a well used only for making snow is located near Jennie's Fork Creek and produces 35 gpm.

## 3.0 GREAT DIVIDE SAND TAILINGS SITE DATA COLLECTION

The following sections specifically address field activities conducted at the Great Divide Sand Tailings Site. Each environmental medium (background soil, solid media waste sources, groundwater and surface water) is discussed individually and includes available sample locations, descriptions, and analytical results. Figure 3-1 illustrates samples (background, tailings, sediment, surface water, and groundwater) that were collected during field activities associated with previous investigations and the investigations conducted for this EEE/CA.

### 3.1 PREVIOUS INVESTIGATIONS

Groundwater was sampled by Peccia & Associates on September 15, 1989 as part of the Marysville area investigation completed by the Montana Abandoned Mine Reclamation Bureau (AMRB).

Chen-Northern collected soil samples during October 1991 for total metals analysis as part of a removal site investigation. Additional samples were collected for mercury-only analysis during June 1992. During August 1993, Pioneer collected additional tailings and background soil samples for total metals analysis under a statewide inventory contract with the DEQ/MWCB. Results of the previous soils investigations were published in the *Great Divide Sand Tailings Reclamation Project Removal Site Evaluation* (USACE/BLM-Chen Northern, 1994), and are included in Table B-1 (previous soil data) in Appendix B.

### 3.2 SUPPLEMENTAL FIELD INVESTIGATIONS

Based upon Pioneer's review of existing data, additional soil and water data were required from the site for preparing this EEE/CA. During the summer of 2006, Pioneer personnel conducted supplemental field investigations in accordance with the *Final Field Sampling Plan for the Great Divide Sand Tailings Site Project* (USACE/BLM-Pioneer, 2006a).

The purpose of the supplemental sampling was to collect additional data at the site to perform a risk assessment and prepare a detailed analysis of reclamation alternatives. Additional data required to support this EEE/CA included the following:

- Characterization of heavy metal concentrations in the sand tailings at the site;
- Evaluation of physical and chemical properties for the source material that may affect contaminant migration including the following: leaching properties, pH, buffering capacity, organic carbon content, and particle size distribution;
- Contaminant concentration variations and leaching characteristics of the sand tailings at the site (porosity, hydraulic conductivity, and Toxicity Characteristic Leaching Procedure [TCLP] data);
- Physical and construction characteristics of the sand tailings and underlying native soils;
- Generation of volume and surface area estimates of the sand tailings;
- Detailed topographic and location mapping of the site; and

- Revegetation parameters for the sand tailings including soil texture and grain size, percent organic matter, liming requirements, native vegetation determination, and fertilizer recommendation analyses.

The supplemental sampling included investigating the sand tailings, sediment and surface water from the Jennie's Fork of Silver Creek, groundwater from wells in the vicinity of the site, and background soils. A geotechnical investigation was also completed to determine the structural properties of the tailings and underlying native soils relative to its bearing capacity of the existing ski towers located within the tailings impoundment boundary. This information was necessary to determine the effects of any future reclamation activities on the existing ski tower foundations. Sample analyses results are discussed in the following sections. General information regarding supplemental samples is provided in Table 3-1.

### 3.2.1 Background Samples

Two background soil samples were collected from the area surrounding the Great Divide Sand Tailings Site to further evaluate natural background concentrations. Analytical results are provided in Table B-6 of Appendix B.

Sample GD-BG-1-071106 was a 12-point composite sample collected upgradient and to the west of the tailings area. Sample GD-BG-2-071106 was a 15-point composite sample taken upgradient and to the north of the tailings area. Concentrations of arsenic, copper, lead, manganese, and zinc are elevated in the second sample when compared to the first.

### 3.2.2 Sand Tailings Samples

A total of 23 locations within the tailings boundary were sampled on July 10-11, 2006 using a track-mounted Geoprobe® equipped with a 3-inch diameter drill casing and 2-inch diameter sample tubes. Ten locations (DH01 to DH10) were sampled within the lower slope surficial tailings area and 13 locations (DH11 to DH-23) were sampled within the upper slope consolidated tailings area. Three composite samples were submitted from DH01 to DH10, and 3 composite samples were submitted from DH11 to DH23. Each set of 3 samples represented the surficial material (0 to 6 inches), subsurface tailings, and underlying native soil for each tailings area. One additional surficial tailings composite sample was collected from the upper, middle and lower parking lot tiers located directly below the chalet. Tables B-6 (total metals), B-7 ABA/SMP, B-8 (TCLP), B-9 (physical properties) and B-10 (Agronomics) present the analytical results (see Appendix B). Logs for each drill hole sample location are provided in Appendix C.

#### 3.2.1.1 <u>Lower Slope Surficial Tailings Area</u>

Three composite samples from the lower slope surficial tailings area were prepared for metals and (ABA/SMP) analyses based on visual observation of texture and color changes. Sample DH1A-071006 represented the 0- to 6-inch surface interval; Sample DH1B-071006 represented the subsurface tailings interval; and Sample DH1C-071006 represented the underlying native soils. Depths to the underlying native soil ranged from 1.2 to 3.8 feet within this area.

# TABLE 3-1
# GREAT DIVIDE SAND TAILINGS SITE
# SUPPLEMENTAL SAMPLING SUMMARY

| SOURCE | SAMPLE ID | MATRIX | DATE | TAL[1] | TCLP | ABA | AGRONOMIC PROPERTIES | PHYSICAL PROPERTIES |
|---|---|---|---|---|---|---|---|---|
| Lower Slope Surficial Tailings | DH1A-071006 | Solid | JUL-06 | Table B-6 | Table B-8 | Table B-7 | Table B-10 | Table B-9 |
| | DH1B-071006 | Solid | JUL-06 | Table B-6 | | | | |
| | DH1C-071006 | Solid | JUL-06 | Table B-6 | | | Table B-10 | Table B-9 |
| Upper Slope Consolidated Tailings | DH2A-071006 | Solid | JUL-06 | Table B-6 | Table B-8 | Table B-7 | Table B-10 | Table B-9 |
| | DH2B-071006 | Solid | JUL-06 | Table B-6 | | | | |
| | DH2C-071006 | Solid | JUL-06 | Table B-6 | | | Table B-10 | Table B-9 |
| Parking Lot Tiers | GD-PL-1-071106 | Solid | JUL-06 | Table B-6 | Table B-8 | | | |
| Background | GD-BG-1-071106 | Solid | JUL-06 | Table B-6 | | | | |
| | GD-BG-2-071106 | Solid | JUL-06 | Table B-6 | | | | |
| Stream Sediments | GD-SD01-050206 | Water | MAY-06 | Table B-5 | | | | |
| | GD-SD02-050206 | Water | MAY-06 | Table B-5 | | | | |
| | GD-SD03-050206 | Water | MAY-06 | Table B-5 | | | | |
| | | | | | | | | |
| **SOURCE** | **SAMPLE ID** | **MATRIX** | **SAMPLE DATE** | **TRM** | **WET CHEM.** | | | |
| Surface Water | GD-SW01-050206 | Water | MAY-06 | Table B-2 | Table B-4 | | | |
| | GD-SW02-050206 | Water | MAY-06 | Table B-2 | Table B-4 | | | |
| | GD-SW03-050206 | Water | MAY-06 | Table B-2 | Table B-4 | | | |
| Groundwater | GD-GW01-080306 | Water | AUG-06 | Table B-3 | | | | |
| | GD-GW02-080306 | Water | AUG-06 | Table B-3 | | | | |
| | GD-GW03-080306 | Water | AUG-06 | Table B-3 | | | | |

[1] TAL = Target Analyte List (Total Metals) – Short List
TCLP = Toxicity Characteristic Leaching Procedure –Metals
ABA = Acid-Base Accounting, Sulfur Fractions, SMP Buffering Capacity, and Dollhopf Lime Requirements
Agronomic = Organic Matter Content, Nutrient Content, and Cation Exchange Capacity
Physical = Soil Texture, USDA Classification, Particle Size Distribution, Specific Gravity, Atterberg Limits, Field Capacity, and Wilting Point
TRM = Total Recoverable Metals (Dissolved Concentrations)
Wet Chemistry = Hardness, Total Dissolved Solids, Sulfates, and Chloride Analyses

The lower slope surficial tailings are located entirely on land administered by the BLM. The volume has been estimated at 11,500 cy based on the depth to the underlying native soil horizon encountered at each sample location, and adding an over-excavation factor of 1 foot. Concentrations of mercury are significantly (>3 times) elevated above background in the surficial (DH1A-071006) tailings sample; and concentrations of copper, lead, and silver are significantly elevated in the subsurface tailings (DH1B-071006) sample. The ABA/SMP buffering capacity results for the subsurface tailings sample indicate that the lower slope tailings are not considered a potential acid producer.

According to the TCLP data for the subsurface tailings sample (DH1B-071006), the concentrations of elements measured in laboratory-generated leachate are below the regulatory limits for hazardous waste classification. As a result, the lower slope tailings are not considered a Resource Conservation and Recovery Act (RCRA) characteristic hazardous waste.

Physical properties were analyzed for the surficial and underlying soil material. Results classify the surficial material as a loam with available moisture content of 1.9%. The underlying native soil is classified as loamy sand with available moisture content of 1.5%.

Fertilizer recommendation analyses provided the following results for the surficial material (0- to 6-inch interval): 2 pounds Nitrogen (N); 18 pounds of phosphorus ($P_2O_5$); and 300 pounds of potassium ($K_2O$) are required per acre. For the underlying native soils, fertilizer recommendations are as follows: 4 pounds N; 92 pounds of $P_2O_5$; and 272 pounds of $K_2O$ required per acre. Organic amendment of the surficial and underlying soil material is advised due to the low organic matter contents (1% and 0.5%, respectively). In addition to providing temporary stabilization of the disturbed erodible surfaces, application of wheat or barley straw mulch would assist in providing necessary organic material to help promote successful revegetation. The breakdown of the revegetation requirements, as presented above, should be considered preliminary at this time (for planning purposes only).

#### 3.2.1.2 Upper Slope Consolidated Tailings Area

Three composite samples from the upper slope consolidated tailings area were prepared for metals and (ABA/SMP) analyses based on visual observation of texture and color changes. Sample DH2A-071006 represented the 0- to 6-inch surface interval; Sample DH2B-071006 represented the subsurface tailings interval; and Sample DH2C-071006 represented the underlying native soils. Depths to the underlying native soil ranged from 3.2 to 9.5 feet within this area.

The upper slope consolidated tailings are located entirely on land administered by the BLM. The volume has been estimated at 29,500 cy based on the depth to the underlying native soil horizon encountered at each sample location, and adding an over-excavation factor of 1 foot. Concentrations of silver are significantly (>3 times) elevated above background in the surficial (DH2A-071006) tailings sample; concentrations of copper, lead, and silver are significantly elevated in the subsurface tailings (DH2B-071006) sample; and concentrations of mercury are significantly elevated in the underlying native soil (DH2C-071006) sample. The ABA/SMP buffering capacity results for the subsurface tailings sample indicate that the upper slope tailings are not considered a potential acid producer.

According to the TCLP data for the subsurface tailings sample (DH2B-071006), the concentrations of elements measured in laboratory-generated leachate are below the regulatory limits for hazardous waste classification. As a result, the upper slope tailings are not considered a RCRA characteristic hazardous waste.

Physical properties were analyzed for the surficial and underlying soil material. Results classify the surficial material as a sandy loam with available moisture content of 2.1%. The underlying native soil is also classified as a sandy loam with available moisture content of 2.1%.

Fertilizer recommendation analyses provided the following results for the surficial material (0- to 6-inch interval): 2 pounds N; 14 pounds of $P_2O_5$; and 208 pounds of $K_2O$ are required per acre. For the underlying native soils, fertilizer recommendations are as follows: 7 pounds N; 164 pounds of $P_2O_5$; and 508 pounds of $K_2O$ are required per acre. Organic amendment of the surficial and underlying soil material is advised due to the low organic matter contents (0.7% and 1.6%, respectively). In addition to providing temporary stabilization of the disturbed erodible surfaces, application of wheat or barley straw mulch would assist in providing necessary organic material to help promote successful revegetation. The breakdown of the revegetation requirements, as presented above, should be considered preliminary at this time (for planning purposes only).

#### 3.2.1.3 Parking Lot Tiers

A 25-point composite sample (GD-PL-1-071106) was collected from the surface of the upper, middle, and lower parking lot tiers and submitted for metals and TCLP analyses. The sample was collected based on visual observation of tailings present on the parking lot surface.

The surficial parking lot tailings are located entirely on land owned by the Great Divide Skiing Company. The volume has been estimated at 1,000 cy based on the 1 foot tailings depth. Silver is significantly (>3 times) elevated above background in this sample.

According to the TCLP data for the parking lot sample (GD-PL-1-071106), the concentrations of elements measured in laboratory-generated leachate are below the regulatory limits for hazardous waste classification. As a result, the parking lot tailings are not considered a RCRA characteristic hazardous waste.

### 3.2.3 Stream Sediment Samples

Three in-stream sediment samples were collected May 2, 2006 (high flow) from Jennie's Fork in the vicinity of the Great Divide Sand Tailings Site. Samples included 1 upstream sample (GD-SD03-050206) and 2 downstream samples (GD-SD01-050206 and GD-SD02-050206). Each sediment sample was submitted to the laboratory for metals analysis. Analytical results are included in Table B-5 provided in Appendix B.

Elevated contaminant concentrations were noted in sediment samples collected downstream from the site sources when compared to criteria found in the *National Sediment Quality Survey* (EPA, 2004). Elevated concentrations of lead and silver were most notable at the downstream sample location closest to the site sources (GD-SD02-050206). The concentration of silver was also elevated at the furthest downstream location (GD-SD01-050206).

### 3.2.4 Surface Water Samples

Three surface water samples were collected during a high-flow runoff event in May 2006 from Jennie's Fork in the vicinity of the Great Divide Sand Tailings Site (see Figure 3-1). Samples included 1 upstream sample (GD-SW03-050206) and 2 downstream samples (GD-SW01-050206 and GD-SW02-050206). Each surface water sample was analyzed for total metals and wet chemistry parameters. Analytical results are provided in Table B-2 (total metals) and Table B-4 (wet chemistry) provided in Appendix B.

Elevated contaminant concentrations of copper and silver were noted in the downstream surface water sample taken closest to the site sources (GD-SW02-050206), when compared to the Circular DEQ-7 standards (DEQ, 2006). No elevated concentrations were noted in the sample taken furthest downstream (GD-SW01-050206) or in the upstream sample (GD-SW03-050206).

### 3.2.5 Groundwater Samples

Three groundwater samples were collected on August 3, 2006 from wells located in the vicinity of the Great Divide Sand Tailings Site (see Figure 3-1). Sample GD-GW01-080306 was collected from the kitchen faucet in the chalet, and represents a well located directly upgradient from the chalet. Sample GD-GW02-080306 was collected directly from an unused well located approximately 60 yards downgradient of the parking lot area. Sample GD-GW02T-080306 was a duplicate sample for Quality Assurance/Quality Control (QA/QC) purposes, also collected from the unused downgradient well. Analytical results are presented in Table B-3 of Appendix B.

No elevated contaminant concentrations were noted, and no Circular DEQ-7 standards (DEQ, 2006) were exceeded for the groundwater samples. Groundwater was not found within any tailings deposits during the site investigation.

### 3.2.6 Geotechnical Foundation Investigation

The geotechnical foundation investigation was conducted on May 23 and 24, 2006. The purpose of the geotechnical investigation was to determine the extent of tailings in the area surrounding Ski Towers #5 and #6 located within the tailings boundary area (see Figure 3-1). Additionally, strength parameters for the in-place soils were evaluated to determine slope stability for possible excavation around the towers in the event total removal of all tailings is selected as the preferred alternative. Results of the investigation were presented in the *Final Geotechnical Investigation Report for the Great Divide Sand Tailings Site* (USACE/BLM-Pioneer, 2006b), and are provided electronically in Appendix D.

No tailings were encountered in the vicinity of Ski Tower #5. Tailings were encountered to a depth of 2.5 feet surrounding Ski Tower #6. The investigation concluded that the relatively shallow tailings around Ski Tower #6 could be safely removed and replaced with compacted granular backfill. However, any cut slopes extending to a depth below the tower foundations should not encroach within 30 feet. Cut slopes surrounding the towers must not exceed 2H:1V around Ski Tower #5, and 3H:1V around Ski Tower #6.

## 4.0 SUMMARY OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)

Section 121(d)(2) of CERCLA, 42 United States Code (USC) § 9621(d)(2), certain provisions of the current NCP, 40 CFD Part 300 (1990), and guidance policy issued by the EPA require that Remedial Actions (RAs) taken pursuant to CERCLA authority shall require or achieve compliance with substantive provisions of ARARs, criteria, or limitations from the State environmental and facility citing laws, and from Federal environmental laws at the completion of RA, and/or during implementation of the RA, unless a waiver is granted. These requirements are threshold standards that any selected remedy must meet. The EPA calls standards, requirements, criteria, or limitations identified pursuant to Section 121(d) "ARARs."

Two general types of cleanup actions are recognized under CERCLA: removal actions and RAs. A removal action is an action to abate, prevent, minimize, stabilize, mitigate, or eliminate a release or threat of release. This action is often temporarily taken to alleviate the most acute threats or to prevent future spread of contamination until more comprehensive action can be taken. A Remedial Investigation (RI) is a thorough investigation, evaluation of alternatives, and determination and implementation of a comprehensive and fully protective remedy for the site.

The ARARs are either applicable or relevant and appropriate. Applicable requirements are those standards, requirements, criteria, or limitations promulgated under Federal or State environmental or facility citing laws that specifically address a hazardous substance, pollutant or contaminant, RA, location, or other circumstances found at a CERCLA site. Relevant and appropriate requirements are those standards, requirements, criteria, or limitations promulgated under Federal environmental or State environmental of facility citing laws that, while not "applicable" to hazardous substances, pollutants, contaminants, RAs, locations, or other circumstances found at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site such that their use is well suited to the particular site. Factors that may be considered in making this determination are presented in 40 CFR § 300.400(g)(2). Compliance with both ARARs is mandatory.

Each ARAR or group of related ARARs identified here is followed by a specific statutory or regulatory citation, a classification describing whether the ARAR is applicable or relevant and appropriate and a description that summarizes the requirements, and addresses how and when compliance with the ARAR will be measured. Some ARARs will govern the conduct of the RA, some will define the measure of success of the RA, and some will do both. The descriptions given here are provided to allow the user a reasonable understanding of the requirements without having to refer constantly to the statute of regulation itself. However, in the event of any inconsistency between the law and the summary provided in this document, the ARAR is ultimately the requirement stated in law, rather than any paraphrase of the law provided here. Finally, this list contains a non-exhaustive list of other legal provision or requirements that should be complied with. The ARARs are divided into contaminant-specific, location-specific, and action-specific requirements, as described in the NCP and EPA guidance. Contaminant-specific ARARs are listed according to appropriate media.

Contaminant-specific ARARs include those laws and regulations governing the release to the environment of materials possessing certain chemical or physical characteristics or containing specific chemical compounds. Contaminant-specific ARARs generally set health or risk-based numerical values or methodologies which when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment.

Location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of cleanup activities because they are in specific locations. Location-specific ARARs relate to the geographic or physical position of the site, rather than to the nature of the site contaminants. Action-specific ARARs are usually technology- or activity-based requirements on limitations or actions taken with respect to hazardous substances.

Many requirements here are promulgated as identical or nearly identical requirements in both Federal and State law, usually pursuant to delegated environmental programs administered by the EPA and State, such as the requirements of the Federal Clean Water Act and the Montana Water Quality Act. The preamble to the new NCP states that such a situation results in citation to the state provision as the appropriate standard, but treatment of the provision as a Federal requirement. The ARARs and other laws that are unique to State law are identified separately by the State of Montana.

Appendix E provides detailed descriptions of potential Federal and State ARARs. The description of the Federal and State ARARs that follow includes summaries of legal requirements that in many cases attempt to set out the requirement in a simple fashion useful in evaluating compliance with the requirement. In the event of any inconsistency between the law and the summaries in this section, the ARAR is ultimately the requirement as stated in the law, rather than any paraphrase presented here. Table 4-1 presents quick-reference summaries of preliminary Federal ARARs and Table 4-2 presents quick-reference summaries of preliminary State ARARs for the Great Divide Sand Tailings Site.

## Table 4-1. Summary of Preliminary Federal Applicable or Relevant and Appropriate Requirements.

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| **FEDERAL CONTAMINANT-SPECIFIC** | | | |
| Safe Drinking Water Act | 40 USC § 300 | | Relevant and Appropriate |
| National Primary Drinking Water Standards | 40 CFR Part 141 | Establishes health-based standards maximum contaminant levels (MCLs) for public water systems. | Relevant and Appropriate |
| National Secondary Drinking Water Standards | 40 CFR Part 143 | Establishes aesthetic-based standards (secondary MCLs) for public water systems. | Relevant and Appropriate |
| Clean Water Act | 33 USC. § 1251-1376 | | Relevant and Appropriate |
| Water Quality Standards | 40 CFR Part 131 Quality Criteria for Water 1976, 1980, 1986 | Sets criteria for water quality based on toxicity to aquatic organisms and human health. | Relevant and Appropriate |
| National Pollutant Discharge Elimination System (NPDES) | 40 CFR Part 122 | General permits for discharge from construction. | Relevant and Appropriate |
| Clean Air Act | 42 USC § 7409 | | |
| National Primary and Secondary Ambient Air Quality Standards | 40 CFR Part 50 | Air quality levels that protect public health. | Applicable |
| Resource Conservation and Recovery Act | 42 USC § 6901 | | |
| Lists Of Hazardous Waste | 40 CFR Part 261, Subpart D | Defines those solid wastes that are subject to regulation as hazardous wastes under 40 CFR Parts 262-265 and Parts 124, 270 and 271. | Applicable |

## Table 4-1. Summary of Preliminary Federal Applicable or Relevant and Appropriate Requirements (continued)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| **FEDERAL LOCATION-SPECIFIC** | | | |
| National Historic Preservation Act | 16 USC § 470; 36 CFR Part 800; 40 CFR 6.310(b) | Requires Federal Agencies to take into account the effect of any Federally-assisted undertaking or licensing on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register of Historic Places and to minimize harm to any National Historic Landmark adversely or directly effected by an undertaking. | Applicable |
| Archaeological and Historic Preservation Act | 16 USC § 469; 40 CFR § 6.301(c) | Establishes procedures to provide for preservation of historical and archaeological data which might be destroyed through alteration of terrain as a result of a Federal construction project or a Federally licensed activity or program. | Applicable |
| Protection of Wetlands Order | 40 CFR Part 6, Appendix A, Executive Order No. 11,990 | Avoid adverse impacts associated with destruction or loss of wetlands and avoid support of new construction in wetlands if a practicable alternative exists. | Applicable |
| Historic Sites, Buildings and Antiquities Act<br>Appendix A, Executive Order No. 11, 990 | 16 USC §§ 461-467; 40 CFR § 6.301(a) | Requires Federal agencies to consider the existence and location of landmarks on the National Registry of Natural Landmarks to avoid undesirable impacts on such landmarks. | Applicable |
| Fish and Wildlife Coordination Act | 16 USC §§ 2901-2912; 40 CFR Part 6.302(g) | Requires consultation when Federal department or agency proposes or authorizes any modification of any stream or other water body and adequate provision for protection of fish and wildlife resources. | Applicable |
| Floodplain Management Order | 40 CFR Part 6 | Requires Federal agencies to evaluate the potential effects of actions they may take in a floodplain to avoid the adverse impacts associated with direct development of a floodplain. | Applicable |

## Table 4-1. Summary of Preliminary Federal Applicable or Relevant and Appropriate Requirements (continued)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Endangered Species Act | 16 USC §§ 1531-1543; 40 CFR 6.302(h); 50 CFR Part 402 | Activities may not jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify a critical habitat. | Applicable |
| Bald Eagle Protection Act | 16 USC §§ 668 | Requires consultation with the USFWS during reclamation design and reclamation construction to ensure that any cleanup of the site does not unnecessarily adversely affect the Bald Eagle or Golden Eagle. | Applicable |
| Migratory Bird Treaty Act | 16 USC §§ 703 | Establishes a federal responsibility for the protection for the international migratory bird resource and requires consultation with the USFWS during reclamation design and reclamation construction to ensure the cleanup of the site does not unnecessarily impact migratory birds. Specific mitigative measures may be identified for compliance with this requirement. | Applicable |

### Table 4-1. Summary of Preliminary Federal Applicable or Relevant and Appropriate Requirements (continued)

| FEDERAL ACTION-SPECIFIC | | | |
|---|---|---|---|
| **Standard, Requirement Criteria Or Limitation** | **Citation** | **Description** | **ARAR Status** |
| Clean Water Act | 33 USC § 1342 | | Relevant and Appropriate |
| NPDES | 40 CFR Part 122 | Requires permits for the discharge of pollutants from any point source into waters of the United States. | Relevant and Appropriate |
| Surface Mining Control and Reclamation Act | 30 USC §§ 1201-1328 | Protects the environment from effects of surface mining activities. | Relevant and Appropriate |
| | 30 CFR Part 784 | Governs underground mining permit applications and minimum requirements for reclamation and operations plans. | Relevant and Appropriate |

## Table 4-1. Summary of Preliminary Federal Applicable or Relevant and Appropriate Requirements (continued)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Surface Mining Control and Reclamation Act (continued) | 30 CFR Part 816 | Outlines permanent program performance standards for surface mining activities. | Relevant and Appropriate |
| Hazardous Materials Transportation Act | 49 USC §§ 1801-1813 | | Relevant and Appropriate |
| Standards Applicable to Transporters of Hazardous Waste | 40 CFR Part 263 | Regulates transportation of hazardous waste. | Relevant and Appropriate |
| Resource Conservation and Recovery Act | | | |
| Land Disposal | 40 CFR Part 268 | Establishes a timetable for restriction of burial of wastes and other hazardous materials. | Applicable |
| Criteria for Classification of Solid Waste Disposal Facilities and Practices | 40 CFR Part 257 | Establishes criteria for use in determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on health or the environment and thereby constitute prohibited open dumps. | Applicable |
| Standards for Transporters of Hazardous Waste | 40 CFR Part 263 | Establishes standards which apply to persons transporting hazardous waste within the U.S. if the transportation requires a manifest under 40 CFR Part 262. | Applicable |
| Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities | 40 CFR Part 264 | Establishes minimum national standards which define the acceptable management of hazardous waste for owners and operators of facilities which treat, store, or dispose of hazardous waste. | Applicable |

## Table 4-1. Summary of Preliminary Federal Applicable or Relevant and Appropriate Requirements (continued)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Occupational Safety And Health Act | 29 USC § 655 | | |
| Hazardous Waste Operations And Emergency Response | 29 CFR 1910.120 | Defines standards for employee protection during initial site characterization and analysis, monitoring activities, materials handling activities, training & ER. | Applicable |

## Table 4-2. Summary of Preliminary State Applicable or Relevant and Appropriate Requirements

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| **STATE CONTAMINANT-SPECIFIC** | | | |
| Montana Water Quality Act | 75-101 et seq., MCA | Laws to prevent, abate, and control the pollution of state waters. | Applicable |
| Regulations Establishing Ambient Surface Water Quality Standards | ARM 16.20.604-624 | Provides the water use classification for various streams and imposes specific water quality standards per classification. | Applicable |
| Regulations Establishing Ambient Surface Water Quality Nondegradation Standards | ARM 16.20.707-714 | Applies nondegradation requirements to any activity which could cause a new or increased source of pollution to State waters and outlines review procedures. | Applicable |
| Regulations Establishing Waste Treatment Standards | ARM 16.20.631-633 | Imposes waste treatment requirements to restore and maintain the quality of surface waters to applicable water use categories. Treatment standards are based on the State's policy of nondegradation, and present and anticipated beneficial uses of the receiving waters. | Applicable |
| | ARM 16.20.925 | Technology-based treatment for MPDES permits. | Applicable |
| Montana Groundwater Pollution Control System Regulations | ARM 16.20.1002 | Classifies groundwater into Classes I through IV based on the present and future most beneficial uses of the groundwater and states groundwater is to be classified to actual quality or actual use, whichever places the groundwater in a higher class. | Applicable |
| | ARM 16.20.1003 | Establishes groundwater quality standards for groundwater classification, and should be consulted. | Applicable |

## Table 4-2. Summary of Preliminary State Applicable or Relevant and Appropriate Requirements (continued)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Montana Groundwater Pollution Control System Regulations (continued) | ARM 16.20.1011 | Requires that any groundwater whose existing quality is higher than the standard for its classification must be maintained at that high quality unless degradation is allowed under the principles established in 75-3-303 MCA, and the nondegradation rules at ARM 16.20.706 et.seq. | Applicable |
| Public Water Supplies Act | 75-6-101, MCA | Establishes public policy of MT to "protect, maintain, and improve the quality and potability of water for public water supplies and domestic uses". | Relevant and Appropriate |
| Public Water Supply Regulations | ARM 16.20.204 | Establishes maximum contaminant levels (MCLs) for inorganic chemicals in community water systems. | Relevant and Appropriate |
| | ARM 16.20.205 | Establishes the maximum turbidity contaminant levels for public water supply systems which use surface water in whole or in part. | Relevant and Appropriate |
| | ARM 16.20.922 | Adopts and incorporates language for toxic pollutant effluent standards found in 40 CFR Part 129. | Relevant and Appropriate |
| | ARM 16.20.923 | Adopts and incorporates language for effluent limitations and standards of performance found in 40 CFR Subpart N (except 40 CFR Part 403). | Relevant and Appropriate |

## Table 4-2. Summary of Preliminary State Applicable or Relevant and Appropriate Requirements (continued)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Clean Air Act Of Montana | 75-2-102, MCA | It's Montana's policy is to achieve and maintain such levels of air quality as will protect human health and safety and, to the greatest degree practicable, prevent injury to plant and animal life and property. | |
| Air Quality Regulations | ARM 16.8.815 | No person shall cause or contribute to concentrations of lead in the ambient air which exceed the following 90-day average: 1.5 micrograms per cubic meter of air. | Applicable |
| | ARM 16.8.818 | No person shall cause or contribute to concentrations of particulate matter in the ambient air such that the mass of settled particulate matter exceeds the following 30-day average: 10 grams per square meter. | Applicable |
| | ARM 16.8.821 | No person may cause or contribute to concentrations of PM-10 in the ambient air which exceed the following standard: 1) 24-hr. avg.: 150 micrograms per cubic meter of air, with no more than one expected exceedance per year; 2) Annual avg.: 50 micrograms per cubic meter of air. | Applicable |
| | ARM 16.8.1302 | Lists certain wastes that may not be disposed of by open burning, including oil or petroleum products, RCRA hazardous wastes, chemicals, and treated lumber and timbers. | Relevant and Appropriate |

## Table 4-2. Summary of Preliminary State Applicable or Relevant and Appropriate Requirements (continued)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Air Quality Regulations (continued) | ARM 16.8.1401 | States "no person shall cause or authorize the production, handling, transportation or storage of any material unless reasonable precautions to control emissions of airborne particulate matter are taken." | Applicable |
| | ARM 16.8.1404 | States no person shall cause opacity of 20% over 6 minutes. | Applicable |
| | ARM 16.8.1424 | Sets forth emission standards for hazardous air pollutants. | Applicable |
| | ARM 26.4.761 | Requires a fugitive dust control program be implemented in reclamation operations. | Relevant and Appropriate |
| Occupational Health Act of Montana | 50-70-101, MCA | The purpose of this act is to achieve and maintain such conditions of the work place as will protect human health and safety. | Applicable |
| Occupational Air Contaminants Requirements | ARM 16.42.102 | Establishes maximum threshold limit values for air contaminants believed that nearly all workers may be repeatedly exposed day after day without adverse health effects. | Applicable |
| Occupational Noise Regulations | ARM 16.42.101 | Addresses occupational noise levels and provides that no worker shall be exposed to noise levels in excess of specified levels. | Applicable |

## Table 4-2. Summary of Preliminary State Applicable or Relevant and Appropriate Requirements (continued)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| **STATE LOCATION-SPECIFIC** | | | |
| Floodplain and Floodway Management Act | 76-5-401, MCA | Limits the uses permissible in a floodway and generally prohibits permanent structures, fill, or permanent storage of materials or equipment. | Applicable |
| | 76-5-402 MCA | Lists the permissible uses within the floodplain but outside of floodway. | Applicable |
| | 76-5-403, MCA | Lists certain uses which are prohibited in a designated floodway, including any change that will cause water to be diverted from the established floodway, cause erosion, obstruct the natural flow of water, or reduce the carrying capacity of the floodway, or the concentration or permanent storage of an object subject to flotation or movement during flood level periods. | Applicable |
| Floodplain Management Regulations | ARM 36.15.216 | The factors to consider in determining whether a permit should be issued to establish or alter an artificial obstruction or nonconforming use in the floodplain or floodway are set forth in this section. | Applicable |
| | ARM 36.15.601 | Open space uses allowed in the floodway without a permit. | Applicable |
| | ARM 36.15.602 | Uses allowed in the floodway, which require a permit. | Applicable |

## Table 4-2. Summary of Preliminary State Applicable or Relevant and Appropriate Requirements (continued)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Floodplain Management Regulations (continued) | ARM 36.15.603 | Proposed diversions or changes in place of diversions must be evaluated by DNRC to determine whether they may significantly affect flood velocities. | Applicable |
| | ARM 36.15.604 | Prohibits new artificial obstructions or nonconforming uses that will significantly increase the upstream elevation of the base flood 0.5 feet or significantly increase flood velocities. | Applicable |
| | ARM 36.15.605 | Identifies artificial obstructions and nonconforming uses that are prohibited within the designated floodway except as allowed by permit and includes "a structure or excavation that will cause water to be diverted from the established floodway, cause erosion, obstruct the natural flow of water, or reduce the carrying capacity of the floodway...". Solid waste disposal and storage of highly toxic, flammable, or explosive materials are also prohibited. | Applicable |
| | ARM 36.15.606 | Identifies flood control works that are allowed with designated floodways pursuant to permit and certain conditions including: flood control levies and flood walls, riprap, channelization projects, and dams. | Applicable |
| | ARM 36.15.701 | Describes allowed uses in the flood fringe. | Applicable |

## Table 4-2. Summary of Preliminary State Applicable or Relevant and Appropriate Requirements (continued)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Floodplain Management Regulations (continued) | ARM 36.15.703 | Prohibited uses within the flood fringe including solid and hazardous waste disposal and storage of toxic, flammable, or explosive materials. | Applicable |
|  | ARM 36.15.801 | Allowed uses where the floodway is not designated or where no flood elevations are available. | Applicable |
| Natural Streambed and Land Preservation Standards | 87-5-501, 502, and 504, MCA | Fish and wildlife resources are to be protected and no construction project or hydraulic project shall adversely affect game or fish habitat. | Applicable |
|  | ARM 36.2.404 | Proposed projects are to be evaluated by the appropriate conservation district based on criteria : 1) whether the project will pass anticipated sediment loads without creating harmful flooding or erosion problems upstream or downstream; 2) whether the project will minimize the amount of stream channel alteration; 3) whether the project will be as permanent a solution as possible and whether the method used will create a reasonably permanent and stable situation; 4) whether the project will minimize effects of fish and aquatic habitat; 5) whether the project will minimize turbidity or other water pollution problems; and , 6) whether the project will minimize adverse effects on the natural beauty of the area. | Applicable |

## Table 4-2. Summary of Preliminary State Applicable or Relevant and Appropriate Requirements (continued)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Antiquities Act | 22-3-424, MCA | Heritage and paleontological sites are given appropriate consideration. | Relevant and Appropriate |
| | 22-3-433, MCA | Evaluation of environmental impacts include consultation with State Historic Preservation Officer (SHPO). | Relevant and Appropriate |
| | 2-3-435, MCA | A heritage or paleontological site is to be reported to the SHPO. | Relevant and Appropriate |
| Cultural Resource Regulations | ARM 12.8.503-508 | Procedures to ensure adequate consideration of cultural values. | Relevant and Appropriate |
| | | **STATE ACTION SPECIFIC** | |
| Montana Water Quality Act | 75-5-605, MCA | Pursuant to this section, it is unlawful to cause pollution of any state waters, to place any wastes in a location where they are likely to cause pollution of any state waters, to violate any permit provision, to violate any provision of the Montana Water Quality Act, to construct, modify, or operate a system for disposing of waste (including sediment, solid waste and other substances that may pollute state waters) which discharge into any state waters without a permit or discharge waste into any state waters. | Applicable |
| Montana Surface Water Quality Regulations | ARM 16.20.631 | Industrial waste must receive treatment equivalent to the best practicable available control technology. | Applicable |
| | ARM 16.20.604-624 | Provides for classification of state waters. | Applicable |

## Table 4-2. Summary of Preliminary State Applicable or Relevant and Appropriate Requirements (continued)

| **Standard, Requirement Criteria Or Limitation** | **Citation** | **Description** | **ARAR Status** |
|---|---|---|---|
| Montana Surface Water Quality Regulations (continued) | ARM 16.20.625 | Technology-based treatment for MPDES permits. | Applicable |
|  | ARM 16.20.633 | Requires that the State's surface waters be free from, among other things, substances that will create concentrations or combinations of materials that are harmful to human, animal, plant, or aquatic life. Moreover, no waste may be discharged and no activities may be conducted that can reasonably be expected to violate any of the standards. | Applicable |
| Nondegradation of Water Quality | ARM 16.20.708-714 | Applies nondegradation requirements to any activity which would cause a new or increased source of pollution to state waters and outlines review procedures. | Applicable |
| <u>Montana Groundwater Act</u> |  |  |  |
| Montana Groundwater Pollution Control System Regulations | ARM 16.20.1011 | Requires that any ground water whose existing quality is higher than the standard for its classification must be maintained at that high quality in accordance with 75-5-303, MCA, and ARM 16.2.701 <u>et.seq</u>. | Applicable |
|  | ARM 16.20.1002 | Classifies groundwater into Classes I through IV based on the present and future most beneficial uses of the groundwater and states groundwater, and states that groundwater is to be classified to actual quantity or actual use, which ever places the groundwater in a higher class. | Applicable |

**Table 4-2. Summary of Preliminary State Applicable or Relevant and Appropriate Requirements (continued)**

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Montana Groundwater Pollution Control System Regulations (continued) | ARM 16.20.1003 | Establishes groundwater quality standards for groundwater classification. | Applicable |
| Clean Air Act Of Montana | 75-2-102, MCA | It's Montana's policy is to "achieve and maintain such levels of air quality as will protect human health and safety and, to the greatest degree practicable, prevent injury to plant and animal life and property, foster the comfort and convenience of the people, promote the economic and social development of this state, and facilitate the enjoyment of the natural attractions of this state". | Applicable |
| Air Quality Requirements | ARM 16.8.815 | No person shall cause or contribute to concentrations of lead in the ambient air which exceed the following 90-day average: 1.5 micrograms per cubic meter of air. | Applicable |
|  | ARM 16.8.1302 | Lists certain wastes that may not be disposed of by open burning. | Applicable |
|  | ARM 16.8.1401 and 1404 | No person shall cause or authorize the production, handling, transportation or storage of any material unless reasonable precautions to control emissions of airborne particulate matter are taken. | Applicable |
| Montana Solid Waste Management Act | 75-10-201 et.seq., MCA | Public policy is to "control solid waste management systems to protect the public health and safety and to conserve natural resources whenever possible". | Applicable |

## Table 4-2. Summary of Preliminary State Applicable or Relevant and Appropriate Requirements (continued)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Solid Waste Management Regulations | ARM 16.14.505 and 508-509 | The standards for solid waste disposal are set forth in this provision and include: preclusion against location of solid waste disposal sites in a 100-year floodplain, a requirement that sites be located only in areas that will prevent the pollution of ground and surface waters and public and private water supplies, a requirement for drainage structures to be installed where necessary to prevent surface runoff from entering disposal areas and a requirement that sites be located to allow for reclamation. The standards also provide the process for applying for a solid waste management system license and operation and maintenance plan requirements. | Applicable |
|  | ARM 16.14.520-521 | General operational and maintenance requirements for solid waste management facilities. | Applicable |
|  | ARM 16.14.523 | Solid waste must be transported in such a manner as to prevent its discharge, dumping, spilling or leaking from the transport vehicle. | Applicable |
| Montana Hazardous Waste Act and Underground Storage Tank Act | 5-10-402, MCA | It's the policy of the State to "protect the public health and safety, the health of living organisms, and the environment from the effects of the improper, inadequate, or unsound management of hazardous wastes". | Applicable |

### Table 4-2. Summary of Preliminary State Applicable or Relevant and Appropriate Requirements (continued)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Montana Hazardous Waste Regulations | ARM 17.54.701-705 | By reference to federal regulatory requirements, these sections establish standards for all permitted hazardous waste management facilities.<br>1) 40 CFR 264.11 (incorporated by reference in ARM 17.54.702) establishes that hazardous waste management facilities must be closed in such a manner as to minimize the need for further maintenance and to control, minimize or eliminate, to the extent necessary to protect public health and the environment, post-closure escape of hazardous wastes, hazardous constituents, leachate, contaminated runoff or hazardous waste decomposition products to the ground or surface waters or the atmosphere.<br>2) 40 CFR 264.228(a) (incorporated by reference by ARM 17.54.702) requires that at closure, free liquids must be removed or solidified, the wastes stabilized and the waste management unit covered.<br>3) 40 CFR 264.228 and 310 (incorporated by reference by ARM 17.54.702) requires that surface impoundments and landfill caps must: (a) provide long-term minimization of migration of liquids through the unit; (b) function with minimum maintenance; (c) promote drainage and minimize erosion or abrasion of the final cover; | Relevant and Appropriate |

## Table 4-2. Summary of Preliminary State Applicable or Relevant and Appropriate Requirements (continued)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Montana Hazardous Waste Regulations (continued) | ARM 17.54.701-705 (continued) | d) accommodate settling and subsidence; and (e) have a permeability less than or equal to the permeability of the natural subsoil present.<br>4) 40 CFR 264.119 (incorporated by reference in ARM 17.54.702) requires that, no later than 60 days after certification of closure of each hazardous waste disposal unit, the owner or operator submit a record of the type, location, and quantity of hazardous waste disposed in each unit. The regulation also gives time limits for recording a deed restriction, in accordance with state law, that will, in perpetuity, notify potential purchasers that the property has been used for waste disposal and that its use is restricted. | |
| | ARM 17.54.111-119 | Establishes permit conditions, duration of permits, schedules of compliance, and requirements for recording and reporting. | |
| | ARM 17.54.130-131 | Establishes contents of permit application. | |
| Montana Strip and Underground Mine Reclamation Act | 82-4-231, MCA | Sets forth objectives that require the operator to reclaim and revegetate the land affected by his operation. | Relevant and Appropriate |

## Table 4-2. Summary of Preliminary State Applicable or Relevant and Appropriate Requirements (continued)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Montana Strip and Underground Mine Reclamation Act (continued) | 82-4-233, MCA | Requires that after the operation has been backfilled, graded, topsoiled and approved, the operator shall establish a vegetative cover on all impacted lands. | Relevant and Appropriate |
| | | Specifications for the vegetative cover and performance are provided. | Relevant and Appropriate |
| Backfilling and Grading Requirements | ARM 26.4.501 | Gives general backfilling and grading requirements. | Relevant and Appropriate |
| | ARM 26.4.501A | Final grading requirements. | Relevant and Appropriate |
| | ARM 26.4.504 | Provides that permanent impoundments may be retained under certain circumstances. | Relevant and Appropriate |
| | ARM 26.4.514 | Gives contouring requirements. | Relevant and Appropriate |
| | ARM 26.4.519 | The operator may be required to monitor settling of regraded areas. | Relevant and Appropriate |
| | ARM 26.4.520 | Spoil material may be disposed of on-site in accordance with requirements of this section. Contains specific requirements for siting, surface runoff, construction of underdrains and revegetation. | Relevant and Appropriate |
| Hydrology Requirements | ARM 26.4.631 | Reclamation operations must be planned and conducted to minimize disturbance to the prevailing hydrologic balance and to prevent material damage to the prevailing hydrologic balance. | Relevant and Appropriate |

## Table 4-2. Summary of Preliminary State Applicable or Relevant and Appropriate Requirements (continued)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Hydrology Requirements (continued) | ARM 26.4.633 | Specifies that sediment controls must be maintained until the disturbed area has been restored and revegetation established. | Relevant and Appropriate |
| | ARM 26.4.634 | Drainage design shall emphasize channel and floodplain premining configuration that blends with the undisturbed drainage system above and below, and will meander naturally, remain in dynamic equilibrium with the system, improve unstable premining condition, provide for floods, provide for long term stability of landscape, and establish a premining diversity of aquatic habitats and riparian vegetation. | Relevant and Appropriate |
| | ARM 26.4.635-637 | Sets forth requirements for temporary and permanent diversions. | Relevant and Appropriate |
| | ARM 26.4.638 | Sediment control measures shall be designed using the best technology currently available to prevent additional sediment to stream flows, meet the more stringent of federal or state effluent limitation, and minimize erosion. | Relevant and Appropriate |
| | ARM 26.4.640 | Provides that discharge from sedimentation ponds, permanent and temporary impoundments, and diversions shall be controlled by energy dissipaters, riprap channels, and other devices, where necessary, to reduce erosion, prevent deepening or enlargement of stream channels, and to minimize disturbance of the hydrologic balance. | Relevant and Appropriate |

## Table 4-2. Summary of Preliminary State Applicable or Relevant and Appropriate Requirements (continued)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Hydrology Requirements (continued) | ARM 26.4.641 | Sets forth methods for prevention of drainage from acid-and toxic-forming spoils into ground and surface waters. | Relevant and Appropriate |
| | ARM 26.4.642 | Prohibits permanent impoundments with certain exceptions, and sets standards for temporary and permanent impoundments. | Relevant and Appropriate |
| | ARM 26.4.643-646 | Provide for groundwater protection, groundwater recharge protection, and surface and groundwater monitoring. | Relevant and Appropriate |
| | ARM 26.4.649 | Prohibits the discharge, diversion, or infiltration of surface and groundwater into existing underground mine workings. | Relevant and Appropriate |
| | ARM 26.4.650 | All permanent sedimentation ponds, diversions, impoundments, and treatment facilities must be renovated postmining, to meet criteria specified in the design plan. All such temporary structures shall be regraded to the approximate original contour. | Relevant and Appropriate |
| Top Soiling, Revegetation, and Protection of Wildlife and Air Resource Regulations | ARM 26.4.701-702 | Requirements for stockpiling soil. | Relevant and Appropriate |
| | ARM 26.4.703 | Materials other than, or along with, soil for final surfacing of spoils or other disturbances must be capable of supporting the approved vegetation and postmining land use. | Relevant and Appropriate |

## Table 4-2. Summary of Preliminary State Applicable or Relevant and Appropriate Requirements (continued)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Top Soiling, Revegetation, and Protection of Wildlife and Air Resource Regulations (continued) | ARM 26.4.711 | The section requires "a diverse, effective, and permanent vegetative cover of the same seasonal variety native to the area affected and capable of meeting the criteria set forth in 82-4-233 shall be established on all areas of land affected except water areas and surface areas of roads". | Relevant and Appropriate |
| | ARM 26.4.713 | Specifies that seeding and planting of disturbed areas must be conducted during the first appropriate period for favorable planting after final seedbed preparation; but not longer than 90 days after top soil placement. | Relevant and Appropriate |
| | ARM 26.4.714 | According to this section, as soon as practical, a mulch or cover crop must be used on all regraded and resoiled areas to control erosion, to promote germination of seeds, and to increase moisture retention of soil until permanent cover is established. | Relevant and Appropriate |
| | ARM 26.4.716 | Establishes the required method of revegetation and provides that introduced species may be substituted for native species as part of an approved plan. | Relevant and Appropriate |
| | ARM 26.4. 717 | Whenever tree species are necessary, trees adapted for local site conditions and climate shall be used. | Relevant and Appropriate |

**Table 4-2. Summary of Preliminary State Applicable or Relevant and Appropriate Requirements (continued)**

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Top Soiling, Revegetation, and Protection of Wildlife and Air Resource Regulations (continued) | ARM 26.4.718 | Soil amendments must be used as necessary to aid in the establishment of permanent vegetation. Irrigation, management, fencing, or other measures may also be used after review and approval by the department. | Relevant and Appropriate |
| | ARM 26.4.719 | Livestock grazing on reclaimed land is prohibited until revegetation is established and can sustain managed grazing. | Relevant and Appropriate |
| | ARM 26.4.720 | Sets annual department inspection requirements. | Relevant and Appropriate |
| | ARM 26.4.721 | Section specifies that rills and gullies greater than 9 inches which form on the reclaimed area must be filled, graded or otherwise stabilized and the area reseeded. | Relevant and Appropriate |
| | ARM 26.4.723 | Monitoring of vegetation, soils and wildlife. | Relevant and Appropriate |
| | ARM 26.4.724 | Success of revegetation shall be measured on the basis of unmined reference areas. | Relevant and Appropriate |
| | ARM 26.4.725 | Sets periods of responsibility and evaluation. | Relevant and Appropriate |
| | ARM 26.4.726 | Sets means of measuring productivity. | Relevant and Appropriate |
| | ARM 26.4.728 | Sets requirements for composition of vegetation. | Relevant and Appropriate |

## Table 4-2. Summary of Preliminary State Applicable or Relevant and Appropriate Requirements (continued)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Top Soiling, Revegetation, and Protection of Wildlife and Air Resource Regulations (continued) | ARM 26.4.730-731 | Revegetated area must furnish palatable forage in comparable quantity and quality during the same grazing period as the reference area. | Relevant and Appropriate |
| | ARM 26.4.733 | Sets requirements and measurement standards for trees, shrubs, and half-shrubs. | Relevant and Appropriate |
| | ARM 26.4.751 | Section requires that site activities must be conducted so as to avoid or minimize impacts to important fish and wildlife species, including critical habitat and any threatened and endangered species identified at the site. | Relevant and Appropriate |
| | ARM 26.4.761 | Section requires fugitive dust control measures for site preparation and reclamation operations. | Relevant and Appropriate |

# 5.0 BASELINE HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENTS

The baseline human health risk assessment performed for the Great Divide Sand Tailings Site follows the Federal Remedial Investigation/Feasibility Study (RI/FS) process for CERCLA (Superfund) sites (EPA, 1988). The baseline human health risk assessment examines the effects of taking no further actions at the site. This abbreviated assessment involves two steps: hazard identification and risk characterization. These tasks are accomplished by evaluating available data and selecting Contaminants of Concern (COCs), comparing those concentrations to previously derived standards or risk-based benchmarks, and characterizing overall risk by integrating the results of the comparison. This risk assessment is performed to determine whether waste materials at the Great Divide Sand Tailings Site could adversely impact human health or the environment.

## 5.1 HUMAN HEALTH RISK ASSESSMENTS

### 5.1.1 Hazard Identification

The initial task of the risk assessment is to select the COCs at the site to identify those that may pose significant potential human health risks. Standard criteria for this selection include: 1) those contaminants that are associated with and are present at the site; 2) contaminants in waste sources with concentrations significantly above background levels; and 3) contaminants with acceptable Quality Assurance/Quality Control (QA/QC) results applied to the data.

Waste materials at the Great Divide Sand Tailings Site were analyzed for a list of 12 elements. Four of these analytes are present at the site at concentrations significantly above background (greater than 3 times the average background concentration): copper, lead, mercury, and silver. These four COCs are retained for detailed evaluation in the human health risk assessment.

### 5.1.2 Exposure Scenarios

The following section describes the exposure scenarios assumed for the Great Divide Sand Tailings Site. The exposure assessment identifies the potentially exposed population(s) and exposure pathways and estimates exposure point concentrations and contaminant intakes. Previously derived risk-based cleanup goals were calculated using two exposure scenarios: a recreational use scenario (Tetra Tech, 1996) and a residential use scenario (EPA Region IX, 2004).

The residential use risk-based concentrations involve residential occupation of the site. The residential scenario, while unlikely to occur at this site, is evaluated as a reasonable maximum exposure (RME). These risk-based concentrations were derived for this worst-case residential exposure scenario by EPA Region IX (updated in 2004) as preliminary remediation goals (PRGs). The soil ingestion and dust inhalation exposure routes assumed the upper 95th percentile concentrations from the waste samples collected during the 2006 site investigation. The drinking water ingestion route was evaluated using groundwater samples collected at the site. Characterization data used in the human health risk assessment are presented in Table 5-1.

**TABLE 5-1**
**CHARACTERIZATION DATA USED FOR**
**THE HUMAN HEALTH RISK ASSESSMENT**

| Contaminant of Concern | Solid Media – Upper 95th %ile (mg/kg) | Residential Drinking Water (μg/L) | Recreational Drinking Water (μg/L) |
|---|---|---|---|
| Copper | 92.2 | 20 | 30 |
| Lead | 140 | 5 (<10) | 40 |
| Mercury | 2.05 | 0.05 (<0.1) | 0.6 |
| Silver | 25.5 | 2.5 (<5) | 8 |

mg/kg – milligrams per kilogram
μg/L – micrograms per Liter

The EPA does not have risk-based benchmark concentrations developed for recreational exposures, relying instead on site-specific exposure assessments. The Montana DEQ/MWCB has performed a comprehensive measure of the health risks to recreational populations exposed to mine wastes in a report titled "*Risk-based Cleanup Guidelines for Abandoned Mine Sites*" (Tetra Tech, 1996). These risk-based guidelines were developed using a risk assessment that assumed four types of recreation populations: fishermen, hunters, gold panners/rockhounds and ATV/motorcycle riders.

The maximum exposures calculated for the DEQ recreational scenarios were used to assess overall site risks. These recreational guidelines have been updated to reflect current (2006) reference dose (RfD) values and carcinogenic slope factors (SF) found in the EPA's Integrated Risk Information System (IRIS) and Heath Effects Assessment Summary Tables (HEAST) databases. The soil ingestion/dust inhalation exposure route assumed a concentration equal to the upper 95th percentile concentration in waste samples collected at the site. The water ingestion route was evaluated using the maximum downstream surface water concentration measured at the site. The maximum concentration occurred at the sample location closest to the site (GD-SW02).

### 5.1.3 Toxicity Assessment

The toxicity assessment examines the potential for the COCs to cause adverse effects in exposed individuals and provides an estimate of the dose-response relationship between the extent of exposure to a particular contaminant and adverse effects. Adverse effects include both non-carcinogenic and carcinogenic health effects in humans. Sources of toxicity data include the EPA's IRIS, Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profiles, HEAST, and EPA criteria documents. Individual toxicity profiles for each COC are not presented here; however, they are provided in the reference documents (EPA Region IX, 2004; Tetra Tech, 1996). The existing risk-based concentrations that were used to characterize risks from exposure to the COCs for each exposure scenario are presented in Tables 5-2 (residential scenario) and 5-3 (recreational scenario). The concentrations listed correspond to hazard quotients (HQ) equal to 1.0.

### TABLE 5-2
### RISK-BASED CONCENTRATIONS (PRGs) FOR CONTAMINANTS OF CONCERN FOR THE RESIDENTIAL SCENARIO (EPA Region IX, 2004)

| Contaminant of Concern | Residential Soil Concentration (All Routes Combined) (mg/kg) | Residential Water Ingestion (µg/L) |
|---|---|---|
| Copper | 3,100 | 1,500 |
| Lead | 400 | 15* |
| Mercury | 23 | 11 |
| Silver | 390 | 180 |

PRGs – Preliminary Remediation Goals
mg/kg – milligrams per kilogram
µg/L – micrograms per Liter
*Lead in drinking water derived from EPA recommendations, not PRG table.

### TABLE 5-3

### RISK-BASED CONCENTRATIONS FOR CONTAMINANTS OF CONCERN FOR THE RECREATIONAL SCENARIO (TETRA TECH, 1996*)

| Contaminant Of Concern | Recreational Soil Concentration Mill Tailings (mg/kg) | Recreational Water Ingestion µg/L |
|---|---|---|
| Copper | 104,000 | 20,400 |
| Lead | 3,920 | 220 |
| Mercury | 738 | 153 |
| Silver | NA | NA |

* updated with 2006 Reference Dose and Slope Factor changes.
NA = Not Applicable, concentration is more than unity.
mg/kg – milligrams per kilogram
µg/L – micrograms per Liter

### 5.1.4 Risk Characterization

#### 5.1.4.1 Residential Land Use Scenario

The residential exposure assumptions utilized to estimate contaminant intakes were compared to the risk-based benchmarks (PRGs) in Table 5-2. These data were used to calculate resultant human health non-carcinogenic HQs for each COC. The COC-specific HQs were generated by dividing the on-site waste concentration by available benchmark concentrations. The results of the risk calculations for the residential land use scenario at the Great Divide Sand Tailings Site are summarized in Table 5-4.

**TABLE 5-4**
**GREAT DIVIDE SAND TAILINGS SITE**
**SUMMARY OF NONCARCINOGENIC HAZARD QUOTIENTS (HQ)**
**FOR THE RESIDENTIAL LAND USE SCENARIO**

| Contaminant Of Concern | Total HQ – Great Divide Sand Tailings Site | HQ – Background |
|---|---|---|
| Copper | 0.0432 | 0.0213 |
| Lead | 0.6845 | 0.4210 |
| Mercury | 0.3865 | 0.0977 |
| Silver | 0.0793 | 0.0203 |
| **Total HQ - Non-Carcinogenic** | 1.1935 | 0.5604 |

The total HQ value for the residential land use scenario is slightly more than 1.0 and only twice the background HQ. However, none of the individual HQs for the COCs at the site exceeds 1.0. The HQ values greater than 1.0 indicate the potential for harmful effects by a COC via the specified pathway. Soil exposure to lead and mercury comprise the majority of the potential residential risk at the site, but this risk is not above benchmarks for residential exposures.

#### 5.1.4.2 Recreational Land Use Scenario

The recreational exposure assumptions utilized to estimate contaminant intakes were compared to the risk-based concentrations in Table 5-3. These data were used to calculate resultant human health non-carcinogenic HQs for each COC. The COC-specific HQs were generated by dividing the on-site waste concentration by available benchmark concentrations. The results of the risk calculations for the recreational land use scenario at the Great Divide Sand Tailings Site are summarized in Table 5-5.

## TABLE 5-5
## GREAT DIVIDE SAND TAILINGS SITE
## SUMMARY OF NONCARCINOGENIC HAZARD QUOTIENTS (HQ) FOR THE RECREATIONAL LAND USE SCENARIO

| **Contaminant of Concern** | **Total HQ – Great Divide Sand Tailings Site** | **HQ – Background** |
|---|---|---|
| Copper | 0.0024 | 0.0005 |
| Lead | 0.2176 | 0.0317 |
| Mercury | 0.0067 | 0.0010 |
| Silver | 0.0000 | 0.0000 |
| **Total HQ - Non-Carcinogenic** | 0.2267 | 0.0332 |

Inspection of the HQs in Table 5-5 yields the following observations. First, HQ values do not exceed 1.0 for any COC or any exposure route. The HQ values greater than 1.0 indicate the potential for harmful effects by a COC via the specified pathway(s). The total HQ of 0.23 indicates a low likelihood of any adverse human health effects for the recreational scenario.

### 5.1.5 Human Health Risk Assessment Summary

The residential land use exposure scenario yields a total non-carcinogenic HQ value of 1.19; however, none of the individual COCs exceed 1.0. The total HQ for the residential exposure is slightly more than 1.0, indicating that the cumulative effect of the COCs (primarily mercury and lead) may have a slight impact for residential exposures. Waste concentrations are below benchmark concentrations for residential occupation.

The recreational land use exposure scenario indicates that non-carcinogenic HQ values are less than 1.0 for all COCs and pathways evaluated. This indicates that waste concentrations are not likely to cause adverse health effects for recreational activities at the site.

## 5.2 ECOLOGICAL RISK ASSESSMENT

A screening level ecologic risk assessment was performed for the Great Divide Sand Tailings Site following Federal RI/FS guidance for CERCLA (Superfund) sites (EPA, 1988a). The key guidance documents used were EPA's *Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual* (EPA, 1989a), and Ecological Assessment of Hazardous Waste Sites (EPA, 1989b). Due to the sparse and indirect nature of the ecological risk data available for the site, this evaluation is intended as a screening-level ecological risk assessment, and the results are of a qualitative nature.

The ecological risk assessment estimates the effects of taking no action at the site and involves four steps: 1) identification of contaminants and ecological receptors of concern; 2) exposure assessment; 3) ecological effects assessment; and 4) risk characterization. These four tasks are accomplished by evaluating available data and selecting contaminants, species and exposure routes of concern, estimating exposure point concentrations and intakes, assessing ecological toxicity of the COCs, and characterizing overall risk by integrating the results of the toxicity and exposure assessments. This ecological risk evaluation is performed to determine whether concentrations of chemicals in accessible waste materials on-site could adversely impact ecologic receptors.

### 5.2.1 Contaminants and Receptors of Concern

As in the human health risk assessment, contaminants that are significantly above background concentrations and are associated with the site are retained as COCs. Four of the 12 elements analyzed are present at the site at concentrations significantly above background levels: copper, lead, mercury, and silver. These four constituents are selected for evaluation because they are present in significant concentrations in wastes onsite (greater than 3 times the average background concentration). However, several of these constituents have no ecological toxicity data with which to evaluate potential effects.

Three groups of ecological receptors have been identified as potentially affected by site contamination. The first group is associated with the Jennie's Fork drainage and its receiving stream Silver Creek, and includes fisheries and aquatic life. Although the Jennies Fork tributary probably does not support a viable fishery, it discharges to Silver Creek which is a recreational fishery.

The second group includes native terrestrial mule deer which may use the site. They are of concern because they may be impacted by site wastes due to their small body weight and constant local habitation. These receptors have the one of the lower benchmark concentrations for wildlife, and are assumed to be a more conservative estimate of exposure for transient larger mammals and birds of prey, which were not evaluated separately.

The third group of receptors are native terrestrial plant communities, which are visibly impaired or non-existent at the site. They are of concern because native vegetation has not become well established since the previous reclamation was completed on the wastes, which would help reduce the potential for release of wastes and reduce exposure to the wastes by human and wildlife receptors.

### 5.2.2 Exposure Assessment

The three exposure scenarios can be semi-quantitatively assessed. The surface water-aquatic life, mule deer, and plant-phytotoxicity scenarios can be compared directly to toxicity standards (water) or benchmarks that apply to the respective environmental media.

### 5.2.3 Surface Water/Sediment - Aquatic Life Scenario

Ecologic exposures via this pathway are threefold: direct exposure of aquatic organisms to surface water concentrations that exceed toxicity thresholds; ingestion of aquatic species (e.g., insects) that have bioaccumulated contaminants to the extent that they are toxic to the predator (e.g., fish); and exposure of aquatic organisms (e.g., fish embryos) to sediment pore water environments that are toxic due to elevated contaminant concentrations in the sediments. Data used for this assessment were collected in Jennie's Fork of Silver Creek (sediment and surface water) during 2006. Selected water quality and sediment concentration data are presented in Table 5-6.

**TABLE 5-6**
**GREAT DIVIDE SAND TAILINGS SITE**
**DOWNSTREAM CONTAMINANT CONCENTRATIONS**
**IN SURFACE WATER (µg/L) AND STREAM SEDIMENT (mg/kg)**

| | Copper | Lead | Mercury | Silver |
|---|---|---|---|---|
| Surface Water –Jennie's Fork | 30 | 40 | 0.60 | 8.0 |
| Stream Sediment – Jennie's Fork | 125 | 169 | <1.0 | 35.2 |

Sample Location: GD-SW02/SD02
µg/L – micrograms per Liter
mg/kg – milligrams per kilogram

#### 5.2.3.1 Mule Deer Scenario

This scenario involves the potential exposure of mule deer that have high localized activity on the wastes. These receptors have a higher exposure than many other species due to their grazing behavior and low relative body weight. Table 5-7 summarizes concentrations measured in surface waste materials onsite during the 2006 investigation.

**TABLE 5-7**
**GREAT DIVIDE SAND TAILINGS SITE**
**SOLID MEDIA CONCENTRATIONS (mg/kg)**

| | Copper | Lead | Mercury | Silver |
|---|---|---|---|---|
| Maximum Waste Concentration | 92.2 | 140 | 2.05 | 25.5 |

mg/kg – milligrams per kilogram

### 5.2.3.2 Plant - Phytotoxicity Scenario

This scenario involves the limited ability of various plant species to grow in soils or wastes with high concentrations of site-related contaminants. Table 5-7 (above) summarizes concentrations measured in surface waste materials onsite during the 2006 investigation.

### 5.2.4 Ecological Effects Assessment

The potential effects of the site COCs are available from several literature sources and are referenced in following sections. No site-specific toxicity tests were performed to support the ecologic risk assessment, either *in-situ* or at a laboratory. Only existing and proposed toxicity-based criteria and standards were used for this ecological effects assessment. These benchmark concentrations are presented in Table 5-8 for their respective media and location.

**TABLE 5-8**
**BENCHMARK CONCENTRATIONS**

| Criteria | Copper | Lead | Mercury | Silver |
|---|---|---|---|---|
| Surface Water (µg/L) – Acute Criteria @ 96 mg/L hardness | 13.5 | 77.5 | 1.7 | 3.8 |
| Sediment Criteria – T50 (mg/kg) | 157 | 161 | 0.87 | 2.45 |
| Mule Deer RMC (mg/kg) | 102 | 106 | 9 | -- |
| Phytotoxicity - Median LOEL (mg/kg) | 100 | 500 | 32 | 2 |

LOEL – Lowest Observed Effects Level
mg/kg – milligrams per kilogram
RMC – Risk Management Criteria
T50 – Modeled effects response of 50%
µg/L – micrograms per Liter

Surface Water/Sediment - Aquatic Life Scenario

Freshwater acute (1-hour average) water quality criteria have been promulgated by DEQ for the COCs. Three of these criteria are calculated as a function of water hardness and one is a numerical standard. The water quality standards that apply to surface waters at and downstream from the site are presented in Table 5-8, both numerical and those that are a function of water hardness.

Presently, the EPA has not finalized sediment quality criteria. The benchmark concentrations used for this assessment utilized the Freshwater Sediment – T50 concentration (median response concentration; EPA, 2004) which are presented in Table 5-8.

#### 5.2.4.1 Mule Deer Scenario

Soil concentrations derived for mule deer exposures are from Ford (2004). This report presents risk management criteria for the mule deer benchmark listed in Table 5-8.

#### 5.2.4.2 Plant - Phytotoxicity Scenario

Information is available on phytotoxicity for three of the four COCs (Lockheed Martin, 1997) and these are listed in Table 5-8, above. The availability of contaminants to plants and the potential for plant toxicity depends on many factors including soil pH, soil texture, nutrients, and plant species.

### 5.2.5 Risk Characterization

This section combines the ecological exposure estimates and concentrations presented in Section 5.2.2 and the ecological effects data presented in Section 5.2.3 to provide a screening level estimate of potential adverse ecological impacts for the scenarios evaluated. This was accomplished by generating ecological impact quotients (EQs), analogous to the human health HQs calculated for human exposures. The COC-specific EQs were generated by dividing the particular intake estimate or concentration by available ecological effect values or concentrations. As with HQs, if EQs are less than 1.0, adverse ecological impacts are not expected at the Great Divide Sand Tailings Site.

The calculated EQs can be used to assess whether the ecological receptors evaluated are exposed to potentially harmful concentrations of site-related chemicals via the four ecologic pathways evaluated. The site-specific EQs for the four ecologic exposure pathways are presented in Table 5-9, estimating a combined ecological EQ for each pathway and each COC.

**TABLE 5-9**
**GREAT DIVIDE SAND TAILINGS SITE**
**SUMMARY OF ECOLOGIC IMPACT QUOTIENT (EQ) VALUES**

| Contaminant Of Concern | Aquatic Life-Surface Water | Aquatic Life-Sediment | Mule Deer | Plant Toxicity | Total |
|---|---|---|---|---|---|
| Copper | **2.23** | 0.80 | 0.90 | 0.92 | 4.85 |
| Lead | 0.52 | **1.05** | **1.32** | 0.28 | 3.17 |
| Mercury | 0.35 | 0.57 | 0.23 | 0.06 | 1.21 |
| Silver | **2.11** | **14.37** | NC | **12.75** | 29.23 |
| **Total EQ** | 5.21 | 16.79 | 2.45 | 14.01 | 38.46 |

NC = Not Calculated because no applicable standard exists.

The aquatic life scenario results in EQs greater than 2.0 for surface water (copper and silver), and as high as 14 in sediment (silver), in Jennie's Fork downstream from the Great Divide Sand Tailings Site. The mule deer scenario results in EQs as high as 1.3 (lead). The plant toxicity EQs are as high as 12 (silver). These EQs demonstrate that COCs evaluated at the site are probably adversely affecting ecologic receptors via the surface water and sediment exposure scenario and justify appropriate cleanup. Lead, silver and copper are the primary COCs, and aquatic life is the primary ecologic receptor of concern.

# 6.0 RECLAMATION OBJECTIVES AND GOALS

## 6.1 ARAR-BASED RECLAMATION GOALS

### 6.1.1 Surface Water

The Acute Aquatic Life Standards (AALS) and Human Health Standards (HHSs) are common ARARs for the surface water medium. The more stringent of the two standards is identified as the ARAR-based remediation goal; acute rather than chronic aquatic life standards are appropriate since long-term monitoring data are not available. The surface water is being primarily evaluated for aquatic life use rather than for a current or potential source of drinking water; however, the drinking water ARARs are included for completeness. The only COCs at the site are copper, lead, mercury, and silver. Table 6-1 presents the ARAR-based reclamation goals for surface water.

**TABLE 6-1**
**ARAR-BASED RECLAMATION GOALS FOR**
**SURFACE WATER (µg/L)**

| CONTAMINANT OF CONCERN | TYPE | CONCENTRATION |
|---|---|---|
| Copper | AALS | 13.5 µg/L @ 96 mg/L hardness |
| Copper | HHS-SW | 1,300 µg/L |
| Lead | AALS | 77.5 µg/L @ 96 mg/L hardness |
| Lead | HHS-SW | 15 µg/L |
| Mercury | AALS | 1.7 µg/L |
| Mercury | HHS-SW | 0.05 µg/L |
| Silver | AALS | 3.8 µg/L @ 96 mg/L hardness |
| Silver | HHS-SW | 100 µg/L |

*Source*: AALS - Freshwater Acute Aquatic Life Standards (DEQ, 2006).
HHS-SW – Human Health Standard for Surface Water (DEQ, 2006).
µg/L – micrograms per Liter
mg/L – milligrams per Liter

### 6.1.2 Groundwater

The ARAR-based reclamation goals for groundwater are most often the Maximum Contaminant Levels (MCLs), non-zero maximum contaminant level goals (MCLGs), or State drinking water standards (HHSs), whichever are more stringent. Groundwater was sampled and did not exceed any standards and is probably not impacted by wastes at the site, so groundwater reclamation goals would not apply at this site.

### 6.1.3 Soil

Chemical-specific ARARs are not available at this time for the soil medium.

## 6.2 RISK-BASED CLEANUP GOALS

Previously calculated risk-based cleanup goals are applied for two land-use scenarios at the Great Divide Sand Tailings Site, recreational and residential. These concentrations were derived using exposure assumptions contained in other documents (Residential-EPA Region IX, 2004; Recreational-TetraTech, 1996) and are the same as those presented in Section 5.1. Both sets of cleanup goals attempt to reduce the non-carcinogenic health HQ to less than 1.0 and are presented in Table 6-2.

**TABLE 6-2**
**PROPOSED SOLID MEDIA CLEANUP GOALS**
**FOR THE GREAT DIVIDE SAND TAILINGS SITE**

| Contaminant of Concern | Recreational Soil Tailings mg/kg | Residential Soil (soil conc.) mg/kg |
|---|---|---|
| Copper | 104,000 | 3,100 |
| Lead | 3,920 | 400 |
| Mercury | 738 | 23 |
| Silver | NA | 390 |

NA = Not Applicable, concentration is more than unity.
mg/kg – milligrams per kilogram

Risk reduction required to attain non-carcinogenic human health and ecologic reclamation goals for each COC (by each pathway) is shown in Table 6-3.

# TABLE 6-3
# RISK REDUCTION NECESSARY TO ATTAIN HUMAN HEALTH AND ECOLOGIC CLEANUP GOALS FOR THE GREAT DIVIDE SAND TAILINGS SITE

| PATHWAY | RISK REDUCTION REQUIRED (%) | | | |
|---|---|---|---|---|
| | **Copper** | **Lead** | **Mercury** | **Silver** |
| **Human Health Exposure Pathways:** | | | | |
| Residential Soil/Water | -- | -- | -- | -- |
| Recreational Soil/Water | -- | -- | -- | -- |
| **Ecologic Exposure Pathways:** | | | | |
| Surface Water | 55 | -- | -- | 53 |
| Sediments | -- | 5 | -- | 93 |
| Mule Deer – Soil | -- | 24 | -- | -- |
| Phytotoxicity – Soil | -- | -- | -- | 92 |

-- = Risk reduction not required for the contaminant for that pathway.

# 7.0 DEVELOPMENT AND SCREENING OF RECLAMATION ALTERNATIVES

The contaminated waste sources present at the Great Divide Sand Tailings Site consist of mill tailings. Mill tailings are generally uniform, finely ground rock particles from which most of the commercial ore has been extracted in the benefication and extraction process. Dry or alternately wet and dry tailings tend to contain oxidized forms of metals at significantly higher concentrations than those found in waste rock. These oxidized metals are easily mobilized during precipitation (infiltration) or high runoff events.

## 7.1 IDENTIFICATION OF RECLAMATION TECHNOLOGIES AND PROCESS OPTIONS

The purpose of identifying and screening technology types and process options is to eliminate those technologies that are not feasible while retaining potentially effective options. General response actions are progressively refined into technology types and process options. The process options are screened and those retained are used to develop reclamation alternatives. General response actions, technology types, and process options potentially applicable to the waste sources present at the Great Divide Sand Tailings Site are briefly discussed in this section.

General response actions and process options are evaluated for the solid mine wastes (mill tailings). There has been no evaluation conducted for surface water, groundwater, or stream sediments. This decision was based primarily on the presumption that reclamation of the contamination at the source(s) would subsequently reduce/eliminate the problems associated with these other environmental media. General response actions potentially capable of meeting the reclamation objectives are identified in Table 7-1. Response actions for the solid mine wastes include No Action, Institutional Controls, Engineering Controls, Excavation and Treatment, and *In-situ* Treatment. Table 7-2 contains the screening rationale that was used to eliminate or retain the various remedial process options for potential application at the Great Divide Sand Tailings Site.

In Section 7.2, feasible technologies are presented as reclamation alternatives and are subjected to an initial/preliminary screening based on effectiveness, implementability, and cost. The purpose of the initial screening of alternatives is to identify those alternatives appropriate for a subsequent, detailed analysis. The initial screening also helps identify technology (process option) specific data needs for detailed site characterization as well as needs for possible treatability studies. Alternatives that pass the initial screening process are evaluated in detail in Section 8.0.

# TABLE 7-1
# GREAT DIVIDE SAND TAILINGS SITE
# GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS FOR CONTAMINATED SOLID MEDIA

| General Response Action | Technology Type | Process Options |
|---|---|---|
| No Action | Not Applicable | Not Applicable |
| Institutional Controls | Access Restrictions | Fencing |
| | | Land Use Control |
| Engineering Controls | Containment | Soil Cover |
| | | Multimedia Cover |
| | | Asphalt/Concrete Cover |
| | Surface Controls | Consolidation |
| | | Grading |
| | | Revegetation |
| | | Erosion Protection |
| | | Run-on/Runoff Control |
| | On-Site Disposal | Fully Encapsulated Repository |
| | | Other Repository |
| | Off-Site Disposal | Hazardous Waste Landfill |
| | | Solid Waste Landfill |
| | | Permitted Tailings Facility |
| Excavation and Treatment | Fixation/Stabilization | Pozzolan/Cement Based |
| | Reprocessing | Milling/Smelting |
| | Physical/Chemical Treatment | Soil Washing |
| | | Acid Extraction |
| | | Alkaline Leaching |
| | Thermal Treatment | Fluidized Bed Reactor |
| | | Rotary Kiln |
| | | Multi-Hearth Kiln |
| | | Vitrification |
| *In-Situ* Treatment | Physical/Chemical Treatment | Stabilization/Solidification |
| | | Soil Flushing |
| | Thermal Treatment | Vitrification |

## TABLE 7-2
## GREAT DIVIDE SAND TAILINGS SITE
## REMEDIAL TECHNOLOGY SCREENING SUMMARY

| GENERAL RESPONSE ACTIONS | REMEDIAL TECHNOLOGY | PROCESS OPTIONS | DESCRIPTION | SCREENING COMMENT |
|---|---|---|---|---|
| NO ACTION | None | Not Applicable | No Action | |
| INSTITUTIONAL CONTROLS | Access Restrictions | Fencing | Security fences installed around contaminated areas to limit access. | Potentially effective in conjunction with other technologies. Readily implementable. |
| | | Land Use Control | Restrictions to control current and future land use. | Potentially effective in conjunction with other process options. Readily implementable. |
| ENGINEERING CONTROLS | Containment | Soil Cover | Application of soil and establishment of vegetative cover to stabilize surface of contamination source. | Surface infiltration and runoff potential would be reduced, but not prevented. Readily implementable. |
| | | Multilayered Cap | Compacted clay or synthetic membrane covered with soil/vegetation over areas of surface contamination. | Potentially effective for some waste sources in conjunction with regrading. Readily implementable. |
| | | Asphalt/Concrete Cover | Application of layer of asphalt or concrete over areas of surface contamination. | Limited feasibility due to remoteness of area and steep slopes. Would require extensive grading aud compaction. |
| | Surface Controls | Consolidation | Combining similar waste types in a common area. | Potentially effective in conjunction with other process options. Involves removing wastes from particularly sensitive areas (e.g. floodplain). Readily implementable. |
| | | Grading | Level out waste piles to reduce slopes for managing surface water infiltration, runoff, and erosion. | Potentially effective in conjunction with other process options. Readily implementable. |
| | | Revegetation | Adding amendments to waste and seeding with appropriate vegetative species to establish an erosion resistant ground surface. | Potentially effective in arid climates if waste does not contain high concentrations of phytotoxic contaminants. Readily implementable. |
| | | Erosion Protection/Runon Control | Erosion resistant materials/fabrics placed directly on waste sources to reduce surface erosion. Surface water diversion structures constructed to direct runoff away from waste source(s). | Potentially effective at reducing contaminant mobility. Readily implementable. |
| | On-site Disposal | Engineered Repository | Excavated contaminated soil deposited on-site in an engineered repository. | Potentially effective and readily implementable. Depends on site-specific groundwater characteristics (i.e., depth to groundwater). |
| | Off-site Disposal | Permitted Landfill | Wastes permanently disposed of in a permitted facility. | Potentially effective and implementable, but generally cost prohibitive due to high disposal costs in conjunction with significant transportation costs. |
| | | Permitted Tailings Disposal Facility | Depositing tailings in a permitted off-site impoundment. | Potentially effective if facility with adequate capacity is willing to accept waste. Potentially implementable, but cost-prohibitive due to liability considerations. |

Legend

▨ - Technologies/Process options that are screened out.

### TABLE 7-2 (Cont'd.)
### GREAT DIVIDE SAND TAILINGS SITE
### REMEDIAL TECHNOLOGY SCREENING SUMMARY

| GENERAL RESPONSE ACTIONS | REMEDIAL TECHNOLOGY | PROCESS OPTIONS | DESCRIPTION | SCREENING COMMENT |
|---|---|---|---|---|
| EXCAVATION AND TREATMENT | Fixation/Stabilization | Pozzolan/Cement Based | Hazardous constituents are incorporated into non-leachable cement or pozzolan solidifying agents. | Extensive treatability testing required. Proper disposal of stabilized product would be required. Potentially implementable, but cost-prohibitive. |
| | Reprocessing | Milling/Smelter | Shipping wastes to existing milling/smelter facility for economic extraction of metals. | Potentially effective if a facility is located and willing to accept waste. Potentially implementable, but cost-prohibitive due to liability considerations. |
| | Physical/Chemical Treatment | Soil Washing | Separate hazardous constituents from solid media via dissolution and subsequent precipitation. | Effectiveness is questionable. Potential exists to increase mobility by providing partial dissolution of contaminants. More difficulty encountered with wider range of contaminants. |
| | | Acid Extraction | Mobilize hazardous constituents via acid leaching and recover by subsequent precipitation. | Effectiveness is questionable. Sulfides would be acid soluble only under extreme conditions of temperature and pressure. |
| | | Alkaline Leaching | Use alkaline solution to leach contaminants from solid media in a heap, vat, or agitated vessel. | Effectiveness not well-documented for arsenic. |
| | Thermal Treatment | Fluidized Bed Reactor/Rotary Kiln/Multi-Hearth Kiln | Concentrate hazardous constituents into a small volume by volatilization of metals and formation of metallic oxides as particulates. | Further treatment is required to treat process by-products. Potentially implementable, but cost-prohibitive. |
| | | Vitrification | Extremely high temperature used to melt and/or volatilize all components of the solid media. The molten material containing contaminants is cooled and, in the process, vitrified into a non-leachable form. | Further treatment is required to treat process by-products. Potentially implementable, but cost-prohibitive. |
| *IN SITU* TREATMENT | Physical/Chemical Treatment | Stabilization | Waste constituents stabilized in place when combined with injected stabilizing agents. | Extensive treatability testing required. Potentially implementable, but cost-prohibitive. |
| | | Solidification | Solidifying agents used in conjunction with deep soil mixing techniques to facilitate a physical or chemical change in mobility of the contaminants. | Extensive treatability testing required. Potentially implementable, but cost-prohibitive. |
| | | Soil Flushing | Acid/base reagent or chelating agent injected into solid media to solubilize metals. Solubilized reagents are subsequently extracted using dewatering techniques. | Effectiveness not certain. Innovative process currently in its pilot stage. |
| | Thermal Treatment | Vitrification | Contaminated solid media subjected to extremely high temperature in-place. During cooling, material is vitrified into non-leachable form. | Expect difficulties to be encountered in establishing adequate process control. Potentially implementable, but cost-prohibitive. |

Legend

▨ - Technologies/Process options that are screened out.

### 7.1.1 No Action

Under the No Action Alternative, no further remediation or monitoring would occur at the site. The site would remain "as-is" and conditions could potentially worsen over time. The No Action Alternative is a stand-alone response that is used as a baseline against which candidate reclamation alternatives are compared.

### 7.1.2 Institutional Controls

Potentially applicable Institutional Controls consist of land use and access restrictions. Land use restrictions would limit the potential future uses for the land. Limitations may be applicable in the case of No Action, on-site disposal, capping in place, or other reclamation alternatives that would result in leaving contaminated material on-site that could be compromised by future activities (i.g., grazing, recreation, etc.).

Institutional Controls involve implementing access restrictions, such as fencing, and land use control. These restrictions are implemented to preclude the future development of impacted areas or to protect an implemented remedy. This type of action does not, in itself, achieve a specific cleanup goal. However, Institutional Controls will be considered as adjacent technologies to accompany other reclamation alternatives. Institutional Controls that are developed as part of an alternative are enforced by the local government. Therefore, the local government must be involved in the development and eventual implementation of an Institutional Control.

### 7.1.3 Engineering Controls

Engineering Controls are used primarily to reduce the mobility of contaminants by creating a barrier that prevents the transport of wastes from the contaminated source to the surrounding environment. Engineering Controls do not reduce the volume or toxicity of the hazardous material. Engineering Controls typically applied include containment/capping, revegetation, run-on/runoff control, and/or disposal.

### 7.1.4 Containment

Containment technologies are used as source control measures to isolate surface water from the contaminated media, to minimize infiltration (and subsequent formation of leachate) of surface water/precipitation into the underlying contaminated media by increasing evapotranspiration processes, and to reduce the potential health risk that may be associated with exposure (direct contact or airborne releases of particulate) to the contaminated media. The cap or cover design is a function of the degree of hazard posed by the contaminated media and may vary in complexity from a simple vegetated soil cover to a multi-layered RCRA cap. The RCRA cap performance standards are included in 40 CFR 264.310, which addresses RCRA landfill closure requirements. These performance standards may not always be appropriate, particularly in instances where the toxicity of the contaminated media is relatively low, where the cap is intended to be temporary, where there is very low precipitation, or where the waste is not leached by infiltrating rain water. Specific cap construction is partially driven by the desired land use following cap construction.

Capping is appropriate whenever contaminated materials are left in place at a site, such as when total excavation and removal or treatment would be cost prohibitive. Capping is considered to be a standard construction practice. Equipment and construction methods associated with capping are readily available, and design methods and requirements are well understood.

### 7.1.5 Surface Controls

Similar to containment, surface control measures are used primarily to reduce contaminant mobility. Surface controls may be appropriate in more remote areas where direct human contact is not a primary concern (human receptors are not living or working directly on or near the site). Surface control process options include consolidation, grading, revegetation, and erosion protection. These process options are usually integrated as a single reclamation alternative.

Consolidation involves grouping similar waste types in a common area for subsequent management or treatment. Consolidation is especially applicable when multiple waste sources are present at a site and one or more of the sources require removal from particularly sensitive areas (i.e., floodplain, residential area, or heavy traffic area) or when treating one large combined waste source in a particular location rather than several smaller waste sources dispersed throughout an area.

Grading is the general term for techniques used to reshape the ground surface to reduce slopes, manage surface water infiltration and runoff, and to aid in erosion control. The spreading and compaction steps used in grading are routine construction practices. The equipment and methods used in grading are similar for all surfaces but will vary slightly depending on the waste type and the surrounding terrain (i.e., steepness). Periodic maintenance and regrading may be necessary to eliminate depressions formed as a result of settlement/subsidence or erosion.

Revegetation involves adding soil amendments and/or topsoil to the waste's surface to provide nutrients, organic material, and neutralizing agents and/or to improve the water storage capacity of the contaminated media, as necessary. This action is used to establish native vegetative species to provide an erosion-resistant ground surface that helps protect the ground surface from surface water and wind erosion and reduces net infiltration through the contaminated media by increasing evapotranspiration processes. In general, revegetation includes the following steps: 1) selecting appropriate plant species; 2) preparing the seed bed, which may require deep application (tilling) of soil amendments as necessary; 3) seeding/planting; 4) mulching and/or chemical stabilization; and 5) fertilizing and maintenance.

Erosion protection includes using erosion resistant materials, such as mulch, natural or synthetic fabric mats, riprap, and/or surface water diversion ditches to reduce the erosion potential at the contaminated media's surface. The erosion resistant materials are placed in areas susceptible to surface water erosion (concentrated flow or overland flow) or wind erosion. Proper erosion protection design requires knowledge of drainage area characteristics, average slopes, soil texture, vegetation types and abundance, and precipitation data.

### 7.1.6 On-Site Disposal

Permanent, on-site disposal is used as a source control measure. On-site disposal involves placing the contaminated media in an engineered containment facility located within the site boundary. On-site disposal options may be applied to pre-treated or untreated contaminated materials depending upon the chemical characteristics of the material. The design configuration of an on-site containment facility depends on the toxicity and type of material requiring disposal. The design could range in complexity from a relatively simple, unlined and covered impoundment to a double-lined impoundment equipped with double leachate collection systems and RCRA-type cap. Materials failing to meet the TCLP criteria may require disposal in a repository conforming to the performance standards for a RCRA landfill closure.

### 7.1.7 Off-Site Disposal

Off-site disposal involves placing excavated contaminated material in an engineered containment facility located outside the site boundary. Off-site disposal options may be applied to pre-treated or untreated contaminated materials and would depend on TCLP results. Materials failing to meet the TCLP criteria would require disposal in a RCRA-permitted treatment, storage, and disposal (TSD) facility. Conversely, less toxic materials could possibly be disposed of in an off-site permitted sanitary landfill or tailings disposal facility in compliance with other applicable laws. Off-site disposal is most attractive when dealing with relatively small quantities of wastes located relatively near the disposal facility.

#### 7.1.7.1 Excavation and Treatment

Excavation and treatment incorporates the removal of contaminated media and subsequent treatment via a specific treatment process that chemically, physically, or thermally results in a reduction of contaminant toxicity and/or volume. Treatment processes have the primary objective of either: 1) concentrating the metal contaminants for additional treatment or recovery of valuable contaminants; or 2) reducing the toxicity of the hazardous contaminants.

Excavation can be completed using conventional earth moving equipment and accepted hazardous materials handling procedures. Precautionary measures, such as stream diversion or isolation, would be necessary for excavating materials contained in the floodplain of a stream. Containment and/or treatment of water encountered during excavation may also be necessary.

#### 7.1.7.2 Fixation/Stabilization

Fixation/stabilization technologies are used to treat materials by physically encapsulating them in an inert matrix (stabilization) and/or chemically altering them to reduce the mobility and/or toxicity of their contaminants (fixation). These technologies generally involve mixing materials with binding agents under prescribed conditions to form a stable matrix. Fixation/stabilization is an established technology for treating inorganic contaminants. The technology incorporates a reagent or combination of reagents to facilitate a chemical and/or physical reduction of the mobility of contaminants in the solid media. Lime/fly ash-based treatment processes and pozzolan/cement-based treatment processes are potentially applicable fixation/stabilization technologies.

#### 7.1.7.3 Reprocessing

Reprocessing involves excavating and transporting the waste materials to an existing permitted mill or smelter facility for processing and economic recovery of target metals. Applicability of this option depends on the willingness of an existing permitted facility to accept and process the material and dispose of the waste. Although reprocessing at active facilities has been conducted in the past, permit limitations, CERCLA liability, and process constraints all limit the feasibility of this process option. In addition to these limitations, costs associated with this alternative are very high (transportation costs in addition to processing costs). In order for a milling facility or smelter to accept the material, pre-concentration of the target metals would likely be required, and the by-product waste resulting from pre-concentrating would still contain elevated metals concentrations requiring proper disposal.

#### 7.1.7.4 Physical/Chemical Treatment

Physical treatment processes use physical characteristics to concentrate contaminants into a relatively small volume for disposal or further treatment. Chemical treatment processes treat contaminants through adding a chemical reagent that removes or fixes the contaminants. The net result of chemical treatment processes is a reduction of toxicity and/or mobility of contaminants in the solid media. Chemical treatment processes often work in conjunction with physical processes to wash the contaminated media with water, acids, bases, or surfactants. Potentially applicable physical/chemical treatment process options include: soil washing, acid extraction, and alkaline leaching.

Soil washing is an innovative treatment process, which consists of washing the contaminated media with water in a heap, vat, or agitated vessel to dissolve water-soluble contaminants. Soil washing requires that contaminants be readily soluble in water and sized sufficiently small so that dissolution can be achieved in a practical retention time. Dissolved metal contaminants contained in the wash solution are precipitated as insoluble compounds, and the treated solids are dewatered before additional treatment or disposal. The precipitates form a sludge, which requires additional treatment such as dewatering or stabilization prior to disposal.

Acid extraction applies an acidic solution to the contaminated media in a heap, vat, or agitated vessel. Depending on temperature, pressure, and acid concentration varying quantities of the metal contaminants present in the contaminated media would be solubilized. A broader range of contaminants can be expected to be acid soluble at ambient conditions using acid extraction versus soil washing; however, sulfide compounds may only be acid soluble under extreme conditions of temperature and pressure. Dissolved contaminants are subsequently precipitated for additional treatment and/or disposal.

Alkaline leaching is similar to acid extraction in which a leaching solution (in this case ammonia, lime, or caustic soda) is applied to the contaminated media in a heap, vat, or agitated vessel.

Alkaline leaching is potentially effective for leaching the majority of metals from the contaminated media; however, the removal of arsenic is not well documented.

#### 7.1.7.5 Thermal Treatment

Under thermal treatment technologies, heat is applied to the contaminated media to volatilize and oxidize metals and render them amenable to additional processing and/or to vitrify the contaminated media into a glass-like, non-toxic, and non-leachable matrix. Potentially applicable moderate temperature thermal processes that volatilize metals and form metallic oxide particulates include the fluidized bed reactor, the rotary kiln, and the multi-hearth kiln. Potentially applicable high temperature thermal treatment processes include vitrification. All components of the contaminated media are melted and/or volatilized under high temperature vitrification. Volatile contaminants and gaseous oxides of sulfur are driven off as gases in the process, and the non-volatile, molten material containing contaminants is cooled and, in the process, vitrified.

Thermal treatment technologies can be applied to wet or dry contaminated media; however, the effectiveness may vary somewhat with variable moisture content and particle size. Crushing may be necessary as a pre-treatment step, especially for large and/or variable particle sizes, such as in waste rock dumps. Moderate temperature thermal processes should only be considered as pre-treatment for other treatment options. This process concentrates the contaminants into a highly mobile (and potentially more toxic) form. High temperature thermal processes immobilize most metal contaminants into a vitrified slag, which would have to be disposed of properly. The volatile metals would be removed and/or concentrated into particulate metal oxides, which would likely require disposal as hazardous waste. Thermal treatment costs are extremely high compared to other potentially applicable remedial technologies.

### 7.1.8 *In-Situ* Treatments

*In-situ* treatment involves treating the contaminated media in place. *In-situ* technologies reduce the mobility and toxicity of the contaminated media and may reduce worker exposure to the contaminated materials; however, *in-situ* technologies allow a lesser degree of control, in general, than *ex-situ* treatment options.

#### 7.1.8.1 Physical/Chemical Treatment

Potentially applicable *in-situ* physical/chemical treatment technologies include stabilization/ solidification, soil flushing, and dewatering.

*In-situ* stabilization/solidification is similar to conventional stabilization in that a solidifying agent (or combination of agents) is used to create a chemical or physical change in the mobility and/or toxicity of the contaminants. The *in-situ* process uses deep mixing techniques to allow maximum contact of the solidifying agents with the contaminated media.

Soil flushing is an innovative process that injects an acidic or basic reagent or chelating agent into the contaminated media to solubilize metals. The solubilized metals are extracted using established dewatering techniques, and the extracted solution is then treated to recover metals or is disposed as aqueous waste. Low permeability materials may hinder proper circulation, flushing solution reaction, and the ultimate recovery of the solution. Currently, soil flushing has only been demonstrated at pilot scale.

Dewatering is a common pre-treatment process used to extract water from contaminated solid media. Common dewatering options include well-field extraction, extraction trenches, surface water diversion, and gravity draining of stockpiled saturated materials. Dewatering is most effective in conjunction with additional remedial technologies that reduce contaminant toxicity, mobility, or volume.

#### 7.1.8.2 Thermal Treatment

*In-situ* vitrification is an innovative process used to melt contaminated solid media in place to immobilize metals into a glass-like, inert, and non-leachable solid matrix. Vitrification requires significant energy to generate sufficient current to force the solid media to act as a continuous electrical conductor. This technology is seriously inhibited by high-moisture content. Gases generated by the process must be collected and treated in an off-gas treatment system. *In-situ* vitrification has only been demonstrated at pilot scale, and treatment costs are extremely high compared to other treatment technologies.

## 7.2 IDENTIFICATION OF RECLAMATION ALTERNATIVES

In this section, the remedial technology types and associated process options that passed the initial screening are assembled into reclamation alternatives. Table 7-3 presents the preliminary reclamation alternatives that have been identified for the solid mine waste materials at the Great Divide Sand Tailings Site.

Treatment of the surface water in Jennie's Fork is not considered because it is assumed that reclamation of the tailings located upgradient of the creek will improve the sedimentation and surface water quality problems that may exist during high runoff events. In this EEE/CA, only solid media alternatives are developed and evaluated in detail. A preferred solid media alternative will be selected and discussed to determine if the action will be effective enough to meet reclamation goals for both the solids and surface water in Jennie's Fork. Therefore, this EEE/CA is focused specifically on the development, evaluation, and selection of solid media reclamation alternatives.

## TABLE 7-3
## GREAT DIVIDE SAND TAILINGS SITE
## RECLAMATION ALTERNATIVES FOR THE WASTE MATERIALS

| ALTERNATIVE | ACTION |
|---|---|
| Alternative 1 | No Action |
| Alternative 2 | Institutional Controls |
| Alternative 3a | Maintenance |
| Alternative 3b | Maintenance with New Surface Water Control Ditches |
| Alternative 4a | In-place Containment with a Cover Soil Cap |
| Alternative 4b | Consolidation and In-place Containment with a Cover Soil Cap |
| Alternative 5a | Consolidation in an Off-Site Repository with Cover Soil Cap |
| Alternative 5b | Consolidation in an Off-Site Repository with Multi-Layered Cap |
| Alternative 5c | Consolidation in an Off-Site Modified RCRA Repository |
| Alternative 6 | Consolidation in the Bald Butte DEQ Repository |

## 7.3 PRELIMINARY EVALUATION AND SCREENING OF ALTERNATIVES

The alternatives identified in Section 7.2 are described, developed, and then subjected to a preliminary evaluation and screening in this section. The evaluation and screening at this stage is based on the anticipated effectiveness, implementability, and relative costs of the alternatives. The preliminary screening has been conducted to identify those alternatives that are obviously not as cost effective or implementable as other alternatives that would provide a similar degree of risk reduction, thereby reducing the number of reclamation alternatives requiring detailed evaluation.

The evaluation of effectiveness includes determining the ability of an alternative to effectively reduce adverse human health or environmental impacts sufficiently to achieve the reclamation goals. The reclamation goals include overall protection of human health and the environment, compliance with ARARs, and short- and long-term effectiveness and/or performance related to reducing toxicity, mobility, and/or volume of contaminants. The effectiveness screening criteria includes consideration of the nature and extent of the contamination, as well as site-specific conditions such as geology, hydrology, hydrogeology, climate, current land use, and potential future land use.

The implementability of each alternative is evaluated to consider the technical and administrative feasibility of constructing, operating, and maintaining each reclamation alternative. Technical feasibility considerations include applicability of the alternative to the waste source(s), availability of the required equipment, and expertise to execute the alternative and overall reliability of the alternative. Administrative feasibility considerations include logistical and scheduling constraints. The evaluation of implementability also considers appropriate combinations of alternatives with respect to site-specific conditions.

Cost screening consists of developing conservative order-of-magnitude cost estimates for each reclamation alternative based on similar sets of assumptions. Costs have been developed by analyzing data available from screening and implementing reclamation alternatives at similar sites, particularly past abandoned mine reclamation activities conducted by the BLM/USACE and DEQ/MWCB. Unit and total costs presented in the cost evaluations are structured to account for contaminated materials handling, adverse site conditions, and contingency. Total costs were derived by applying estimated unit costs to assumed volumes of contaminated solid media. Cost estimates are based on the following volumes of waste material:

- Approximately 11,500 cy of surficial tailings located on the lower slope;
- Approximately 29,500 cy of consolidated tailings located on the upper slope; and
- Approximately 1,000 cy of surficial tailings located on the parking lot tiers.

These estimated volumes are based on survey data and sampling conducted by Pioneer during the summer of 2006.

A screening summary is presented after evaluating each alternative to identify alternatives retained for further consideration (detailed evaluation/analysis) and to offer rationale for exclusion of those alternatives that will not be considered further.

Due to site constraints, a sufficient supply of on-site soil is not available for use as a vegetative cover. Therefore, each alternative that includes incorporation of a soil cover also includes an assumption that cover soil will be obtained from a suitable borrow source located within six miles of the Great Divide Sand Tailings Site.

### 7.3.1 Alternative 1: No Action

The No Action Alternative means that no further reclamation activities will occur at the site to control contaminant migration or to reduce toxicity or volume. No repair of the existing erosion-damaged cap or plugged drainage ditches would take place.

***Effectiveness*** - Protection of the environment would not be achieved under the No Action Alternative. The contaminant sources present at the Great Divide Sand Tailings Site would continue to erode from the damaged areas and potentially impact surface water via sedimentation from precipitation runoff. Site conditions are expected to worsen over time due to continued disturbance of the existing cap by burrowing animals, livestock grazing and ski area maintenance work. Toxicity, mobility, and volume of contaminants would not be reduced under the No Action Alternative.

***Implementability*** - Technical and administrative feasibility evaluation criteria do not apply to this alternative.

***Cost Screening*** - No capital or operating costs would be incurred under this alternative.

***Screening Summary*** - This alternative has been retained for further evaluation as a base line comparison.

### 7.3.2 Alternative 2: Institutional Controls

The Institutional Control Alternative includes erecting fences at the Great Divide Sand Tailings Site to restrict access to contaminated sources and implementing land use restrictions to prevent land development on or near the affected areas. No repair of the existing erosion-damaged cap or plugged drainage ditches would take place.

***Effectiveness*** - This alternative is not protective of environmental resources. As with the No Action alternative, the contaminant sources would continue to erode from the damaged areas and potentially impact surface water via sedimentation from precipitation runoff. Site conditions are expected to worsen over time due to continued disturbance of the existing cap by burrowing animals and ski area maintenance work. Toxicity, mobility, and volume of the contaminated media would not be reduced under this alternative.

***Implementability*** - Institutional Controls are implementable but not desirable based on the criteria of applicability, availability, and reliability. This alternative is considered applicable for restricting future inappropriate land development; however, because the site is currently being used as a ski slope, installation of fencing may interfere with the intended land use. Reliability of this alternative for its intended purpose is considered poor due to the potential continued erosion and migration of wastes outside of the controlled area and into surface water receptors. Due to the logistical simplicity of implementing Institutional Controls, administrative feasibility is considered good.

***Cost Screening*** - Costs associated with Institutional Controls would be relatively low compared to other reclamation measures. Capital costs associated with construction of an access control fence would total approximately $13,915 (assuming no consolidation of contaminated materials) and a fencing requirement of approximately 2,500 linear feet (lf) at approximately $4.40 per lf. Maintenance costs would likely range from $0 to $500 per year. Table F-1 (Appendix F) presents the cost details associated with implementing this alternative.

***Screening Summary*** - Institutional Controls will not be considered further as a stand-alone reclamation alternative due to poor applicability and reliability.

### 7.3.3 Alternative 3a: Maintenance

Alternative 3a involves repair of the existing engineered controls currently in place at the Great Divide Sand Tailings Site. Repair includes regrading the head cut which has eroded through the existing cover soil cap above Ski Tower #6, placing riprap on the regraded area to reduce future erosion, and revegetating the disturbed during construction. The existing runoff control ditch below Ski Tower #6 would also be cleaned and repaired to reduce future erosion of the lower slope surficial tailings.

***Effectiveness*** - The purpose of this alternative is to reduce further erosion and migration of contaminants downgradient onto the lower slope, parking areas, and into surface water receptors. While this alternative would mitigate existing damage done to the cap, site conditions are expected to revert to a damaged condition over time due to excessive surface water run-on, future disturbance of the existing cap by burrowing animals, grazing, and ski area maintenance work. The toxicity or volume of the wastes would not be reduced under this alternative since no actual treatment of the contaminants would be conducted.

***Implementability*** - This alternative is both technically and administratively feasible. Regrading, riprap armoring, ditch repair, and revegetation are readily implementable technologies that utilize conventional construction techniques. Necessary construction equipment and methods are readily available and widely used. However, because this alternative does not include additional surface water run-on controls above the site, continued monitoring and maintenance of the existing cover soil cap and runoff control ditch is anticipated and the long-term reliability of the engineered controls is expected to be poor.

***Cost Screening*** - The total capital cost for this alternative has been estimated at $19,133.00 which represents the repair of existing engineered controls at the Great Divide Sand Tailings Site. Table F-2 (Appendix F) presents the cost details associated with implementing this alternative.

***Screening Summary*** - This alternative has not been retained for detailed analysis since long-term effectiveness and reliability are considered to be poor.

### 7.3.4 Alternative 3b: Maintenance with New Surface Water Control Ditches

Alternative 3b involves regrading the head cut which has eroded through the existing cover soil cap above Ski Tower #6 and placing riprap on the regraded area to reduce future erosion. Alternative 3b also includes construction of 3 new drainage control ditches to mitigate surface water run-on above the site, and control runoff from the lower slope (see Figure 7-1). All areas disturbed during construction would be revegetated.

#### ***Conceptual Design and Assumptions***

Run-on control would consist of constructing approximately 700 lf of ditch to divert runoff generated above the upper slope of consolidated tailings. Surface water would be collected and routed across the slope away from the tailings, significantly reducing the amount of surface water flow reaching the downgradient tailings areas. The run-on control ditch would be lined with riprap to protect against erosion.

Two runoff control ditches would be constructed across the lower slope surficial tailings area. Approximately 300 lf of ditch would be constructed midway across the lower slope to collect upgradient runoff and further protect the downgradient slope. The ditch would be lined with an impermeable barrier (poly lining) and riprap to prevent potential erosion into the subsurface tailings.

A second runoff control ditch approximately 400 lf in length would be constructed at the toe of the lower slope. The primary purpose of the second ditch would be to prevent any remaining upgradient runoff from eroding the area directly above the chalet or further eroding the parking lot area, therefore significantly reducing the amount of sediment reaching Jennie's Fork. The lower ditch would be lined with riprap and a culvert would be installed under the existing access road directly south of the chalet.

***Effectiveness*** – As with Alternative 3a, the purpose of this alternative is to reduce further erosion of the upper consolidated tailings and the subsequent migration of contaminants downgradient onto the lower slope, parking areas, and into surface water receptors. However, the surficial contaminant sources resultant from past erosion will remain in place and continue to be susceptible to future erosion and transport to surface water receptors due to lack of vegetation and continued disturbance from burrowing animals, grazing, and ski area maintenance work. The toxicity or volume of the wastes would not be reduced under this alternative since no actual treatment of the contaminants would be conducted.

***Implementability*** - Regrading, riprap armoring, construction of run-on and runoff control ditches, and revegetation are technically and administratively feasible under this alternative. The implementation of additional run-on and runoff controls significantly increases the long-term reliability and effectiveness of the engineered controls, with no adverse impact to the intended land use. Although more effective surface water controls would be in place, continued monitoring and maintenance of the engineered controls are anticipated under this alternative.

***Cost Screening*** - The total capital cost for this alternative has been estimated at $62,965.00 which includes the repair of the existing erosion and construction of new surface water controls. Table F-3 (Appendix F) presents the cost details associated with implementing this alternative.

***Screening Summary*** - This alternative has not been retained for detailed analysis since long-term effectiveness and reliability are expected to be poor.

### 7.3.5 Alternative 4a: In-Place Containment with Cover Soil Cap

Alternative 4a involves In-Place Containment of all solid mine waste material at the Great Divide Sand Tailings Site by applying additional cover soil and amendments (organics and fertilizer), and establishing increased vegetation on the surface of the cap material. The purpose of establishing vegetation is to stabilize the surface (provide erosion protection) and to decrease net infiltration through the waste by increasing evapotranspiration. Three improved drainage control ditches would be constructed in order to minimize potential erosion of the cover soil cap (see Figure 7-1).

#### ***Conceptual Design and Assumptions***

The conceptual design for Alternative 4a involves applying a 2-foot layer of cover soil over the upper slope consolidated tailings and lower slope surficial tailings areas, and establishing vegetation through incorporating the necessary organic and fertilizer amendments in the cover soil. Run-on and runoff control ditches would be constructed to minimize erosion and sediment transport.

Based on the available data and the above considerations, the conceptual design of Alternative 4a includes:

- Improving approximately one mile of the existing access road from Ottawa Gulch to the ski area by blading/regrading to facilitate safe access by heavy equipment and construction crews;
- Improving approximately one mile of existing site access roads leading to the Great Divide Sand Tailings Site;
- Excavating a proposed borrow source located approximately 6 miles from the Great Divide Sand Tailings Site to obtain approximately 17,000 cy of clean cover material for reclamation work;
- Placing a 2-foot amended cover soil cap over the entire tailings areas (approximately 5.3 acres);
- Constructing approximately 1,400 lf of new surface water control ditches to route upgradient storm water away from contaminated solid media and protect the integrity of the cover soil cap; and
- Revegetating and mulching all disturbed areas upon completion of construction activities (temporary roads, staging areas, cover soil application areas, etc.).

The current access road to the ski area is in fair condition and is regularly maintained up to Ottawa Gulch. The approximate one-mile stretch between Ottawa Gulch and the ski area will initially require minor grading, with occasional regrading during reclamation activities to maintain a suitable surface. The currently unimproved access roads leading to the tailings site will require upgrading by blading/regrading to facilitate suitable equipment access.

Two feet of amended cover soil would be placed over the entire tailings area to establish vegetation over the entire area. Minor grading of the slope would be required to minimize the slope steepness to no greater than 3 horizontal (H): 1 vertical (V). The surficial parking lot tailings materials would be capped with 1-foot of road base-type gravel.

Run-on/runoff controls would be designed as an integral part of the in-place containment scheme. Run-on control would consist of constructing approximately 700 lf of ditch to divert runoff generated upgradient of the reclaimed sources around those sources. The run-on control ditch would be lined with riprap to minimize potential erosion and sediment transport to Jennie's Fork.

Runoff controls would consist of two ditches constructed across the lower slope reclaimed area. Approximately 300 lf of ditch would be constructed midway across the lower slope to collect upgradient runoff and further protect the downgradient slope. The ditch would be lined with an impermeable barrier (poly lining) and riprap to prevent potential erosion into the subsurface tailings. A second runoff control ditch approximately 400 lf in length would be constructed at the toe of the lower slope. The primary purpose of the second ditch would be to prevent any remaining upgradient runoff from eroding the area directly above the chalet or further eroding the parking lot area, thus significantly reducing the amount of sediment reaching Jennie's Fork. The lower ditch would be lined with riprap and a culvert would be installed under the existing access road directly south of the chalet.

Seeding of disturbed and reclaimed areas would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats would be applied to promote temporary protection of the highly erodible surfaces.

***Effectiveness*** - The purpose of establishing vegetation on a waste source is to limit the mobility of the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. An improved cover soil cap and vegetation would minimize the potential for contaminants to reach surface water receptors via erosion. The improved cover soil cap is expected to better withstand future impacts from burrowing animals and grazing, but would continue to be susceptible to damage caused by ski area maintenance work. The toxicity or volume of the wastes would not be reduced under this alternative since no actual treatment of the contaminants would be conducted. The overall effectiveness of the containment/revegetation program would be enhanced by carefully selecting appropriate native plant species that are adapted to existing site conditions.

***Implementability*** - This alternative is both technically and administratively feasible. Incorporation of soil cover, amendments, implementing surface water controls, and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Cover soil would be obtained off-site and the borrow area graded and revegetated. Design methods and requirements have been thoroughly tested and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation.

***Cost Screening*** - The total capital cost for this alternative has been estimated at $621,652.00 which represents the reclamation of the entire tailings area at the Great Divide Sand Tailings Site. Table F-4 (Appendix F) presents the cost details associated with implementing this alternative.

The following primary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- The cost of grading the access road to the ski area can be completed for a single lump sum of $825 (1 mile);
- The cost of upgrading the access roads to the tailings area can be completed for a single lump sum of $825 (1 mile);
- The cost to strip, stockpile, and replace 2,400 cy of topsoil at the borrow area can be completed for an estimated $13,200 ($5.50 per cy);

- The cost to excavate and stockpile 17,000 cy of cover soil at the borrow area can be completed for an estimated $93,500 ($5.50 per cy);
- The cost to cover the tailings areas with approximately 17,000 cy of cover soil, which will be obtained from a borrow source located within 6 miles from the site, can be completed for an estimated $149,600 ($8.80 per cy);
- Approximately 720 dry tons of organic amendment will be required to amend the cover soil at an estimated cost of $158,400 ($220 per dry ton);
- The total surface area at the Great Divide Sand Tailings Site and associated borrow area requiring revegetation via drill seeding (when applicable), broadcast seeding and mulching is approximately 11 acres (excluding contractor access road spurs, staging areas, etc.) and can be completed for an estimated $24,200 ($2,200 per acre);
- To collect surface water run-on and runoff, 3 open channels (total length of approximately 1,400 lf) are necessary at the site, which can be constructed for an estimated $9,240 ($6.60 per lf);
- Approximately 400 square yards (sy) of poly lining will be required to line the mid-slope surface water channel at an estimated cost of $1,760 ($4.40 per sy); and
- Approximately 550 cy of angular riprap will be required to armor the surface water channels at an estimated cost of $21,175 ($38.50 per cy).

***Screening Summary*** - This alternative has been retained for detailed analysis.

### 7.3.6 Alternative 4b: Consolidation and In-Place Containment with Cover Soil Cap

Alternative 4b is very similar to Alternative 4a in that it involves on-site containment of waste sources present at the site. However, Alternative 4b involves excavating and hauling approximately 12,000 cy of the lower slope surficial tailings, and surficial tailings located on the parking lot tiers, from their current locations to the upper slope consolidated tailings area (see Figure 7-1).

As specified in Alternative 4a, the upper consolidated tailings area would remain in place and receive a 2-foot thick amended cover soil cap; however, the lower slope surficial tailings area would only require a 1-foot thick layer of amended cover soil for revegetation purposes following tailings removal to the upper consolidation area.

Ditch construction and revegetation tasks would be completed in the same manner as specified in Alternative 4a, except the mid-slope runoff control ditch would not require a poly lining since the subsurface tailings would be removed from that area under this alternative.

Under this alternative, several utilities within the lower slope surficial tailings area would require relocation and replacement in order to facilitate tailings excavation at depths approaching 4.5 feet. Utilities anticipated to be in conflict include the slope lighting circuit, a tower communications line, a telephone line, and the water and power lines for the snow making system.

### *Conceptual Design and Assumptions*

The conceptual design for Alternative 4b involves consolidating the lower slope surficial tailings, and the surficial tailings from the parking lot tiers, at the upper slope consolidated tailings area prior to capping. A 2-foot thick cover soil cap would be placed over the upper slope consolidated tailings, and a 1-foot layer of cover soil would be placed on the excavated lower slope area. Vegetation would be established over the entire area by incorporating the necessary organic and fertilizer amendments in the cover soil. Run-on and runoff control ditches would be constructed to minimize erosion and sediment transport.

The general construction steps for implementing Alternative 4b, as conceptualized, are as follows:

- Improving approximately one mile of the existing access road from Ottawa Gulch to the ski area by blading/regrading to facilitate safe access by heavy equipment and construction crews;
- Improving approximately one mile of existing site access roads leading to the Great Divide Sand Tailings Site;
- Excavating a proposed borrow source located approximately 6 miles from the Great Divide Sand Tailings Site to obtain approximately 13,000 cy of clean cover material for reclamation work;
- Excavating and consolidating lower slope surficial tailings, and parking lot surficial tailings, at the upper slope consolidated tailings area;
- Relocating and replacing utilities in conflict within the lower slope excavated area;
- Placing a two-foot amended cover soil cap over the upper slope consolidated tailings area;
- Placing a one-foot amended cover soil layer over the lower slope excavated area;
- Constructing approximately 1,400 lf of new surface water control ditches to route upgradient storm water away from contaminated solid media and protect the integrity of the cover soil areas; and
- Revegetating and mulching all disturbed areas upon completion of construction activities (temporary roads, staging areas, cover soil application areas, etc.).

The current access road to the ski area is in fair condition and is regularly maintained up to Ottawa Gulch. The approximate one mile stretch between Ottawa Gulch and the ski area will initially require minor grading, with occasional regrading during reclamation activities to maintain a suitable surface. The currently unimproved access roads leading to the tailings site will require upgrading by blading/regrading to facilitate suitable equipment access.

The lower surficial tailings and the parking lot surficial tailings would be excavated and placed at the consolidation area on the upper slope. Some grading would be required at the upper consolidation area to ensure that slope steepness does not exceed 3H:1V. The tailings materials removed from the parking lot would be replaced with road base type gravel.

Run-on/runoff controls would be designed as an integral part of the In-Place Containment scheme. Run-on controls would consist of constructing approximately 700 lf of ditch to divert runoff generated upgradient of the reclaimed sources to flow around the sources. The run-on control ditch would be lined with riprap to minimize potential erosion and sediment transport to Jennie's Fork.

Runoff controls would consist of two ditches constructed across the lower slope reclaimed area. Approximately 300 lf of ditch would be constructed midway across the lower slope to collect upgradient runoff and further protect the downgradient slope. The ditch would be lined with riprap to prevent potential erosion. A second runoff control ditch approximately 400 lf in length would be constructed at the toe of the lower slope. The primary purpose of the second ditch would be to prevent any remaining upgradient runoff from eroding the area directly above the chalet or further eroding the parking lot area; therefore, significantly reducing the amount of sediment reaching Jennie's Fork. The lower ditch would be lined with riprap and a culvert would be installed under the existing access road directly south of the chalet.

Seeding of disturbed and reclaimed areas would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats would be applied to promote temporary protection of the highly erodible surfaces.

***Effectiveness*** - The purpose of establishing vegetation on a waste source is to limit the mobility of the contaminants. A healthy stand of vegetation effectively stabilizes the surface against wind and surface water erosion and minimizes the potential for migration of vadose zone contaminants from water infiltration by increasing evapotranspiration and decreasing infiltration. An improved cover soil cap and vegetation would minimize the potential for contaminants to reach surface water receptors via erosion. The improved cover soil cap is expected to better withstand future impacts from burrowing animals and grazing, but would continue to be susceptible to damage caused by ski area maintenance work. The toxicity or volume of the wastes would not be reduced under this alternative since no actual treatment of the contaminants would be conducted; however, consolidation of the lower slope surficial tailings and surficial tailings from the parking lot tiers further reduces the potential for contaminant transport via erosion.

***Implementability*** - This alternative is both technically and administratively feasible. Consolidating wastes, incorporation of soil cover and amendments, implementing surface water controls, and establishing vegetation are readily implementable technologies that utilize conventional construction techniques. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending upon the complexity of the terrain and the required depth of amendment incorporation. Implementability of this alternative is more complex due to the utility relocation and replacement issues.

***Cost Screening*** - The total capital cost for this alternative has been estimated at $721,701 which represents the reclamation of the entire tailings area and parking lot tiers at the Great Divide Sand Tailings Site, including anticipated utility relocation and replacement expenses. Table F-5 (Appendix F) presents the cost details associated with implementing this alternative.

The following primary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- The cost of grading the access road to the ski area can be completed for a single lump sum of $825 (1 mile);
- The cost of upgrading the access roads to the tailings area can be completed for a single lump sum of $825 (1 mile);
- The cost to strip, stockpile, and replace 2,400 cy of topsoil at the borrow area can be completed for an estimated $13,200 ($5.50 per cy);
- The cost to excavate and stockpile 17,000 cy of cover soil at the borrow area can be completed for an estimated $93,500 ($5.50 per cy);
- The cost to cover the tailings areas with approximately 17,000 cy of cover soil, which will be obtained from a borrow source located within 6 miles from the site, can be completed for an estimated $149,600 ($8.80 per cy);
- Approximately 720 dry tons of organic amendment will be required to amend the cover soil at an estimated cost of $158,400 ($220 per dry ton);
- The total surface area at the Great Divide Sand Tailings Site and associated borrow area requiring revegetation via drill seeding (when applicable), broadcast seeding and mulching is approximately 11 acres (excluding contractor access road spurs, staging areas, etc.) and can be completed for an estimated $24,200 ($2,200 per acre);
- To collect surface water run-on and runoff, 3 open channels (total length of approximately 1,400 lf) are necessary at the site, which can be constructed for an estimated $9,240 ($6.60 per lf);
- Approximately 400 sy of poly lining will be required to line the mid-slope surface water channel at an estimated cost of $1,760 ($4.40 per sy);
- Approximately 550 cy of angular riprap will be required to armor the surface water channels at an estimated cost of $21,175 ($38.50 per cy);
- The cost to replace approximately 750 lf of underground cable for the slope lighting system is estimated to cost $11,550 ($15.40 per lineal foot); and the cost to relocate 3 light poles is estimated to cost $3,630 ($1,210.00 per pole);
- The cost to replace approximately 550 lf of underground tower communications line is estimated at $6,050 ($11.00 per lineal foot);
- The cost to replace approximately 600 lf of underground telephone cable is estimated to cost $6,600 ($11.00 per lineal foot); and the cost to install a new pedestal at the splice location is estimated at $770.00; and
- The cost to replace approximately 450 lf of water line for the snow making system is estimated to cost $10,890 ($24.20 per lineal foot); and the cost to replace approximately 400 lf of underground power cable for the system is estimated at $6,160 ($15.40 lf).

**Screening Summary**—this alternative has been retained for detailed analysis.

### 7.3.7 Alternative 5a: Consolidation in Off-Site Repository with Cover Soil Cap

Alternative 5a consists of excavating and disposing of all tailings materials from the Great Divide Sand Tailings Site in a constructed off-site repository consisting of a two-foot thick cover soil cap over the waste materials (see Figure 7-2).

Approximately 42,000 cy of tailings material would be disposed of in the repository, including the upper slope consolidated tailings, lower slope surficial tailings, and surficial tailings from the parking lot tiers. Following removal of the tailings, one foot of cover soil would be backfilled in the excavation areas, amended, seeded, and mulched.

Construction of three run-on/runoff control ditches would be completed in the same manner as specified in Alternative 4b in order to protect the reclaimed surfaces.

Under this alternative, utilities within the entire tailings area will require relocation and replacement in order to facilitate tailings excavation at depths approaching 10.5 feet. Utilities anticipated to be in conflict include the slope lighting circuit, a tower communications line, a telephone line, water and power lines for the snow making system, and a 2,400 volt (v) power main feeding the transformer located above the upper slope consolidated tailings area.

***Conceptual Design and Assumptions***

Based on the available data and the above considerations, the conceptual design for Alternative 5a includes the following:

- Improving approximately one mile of the existing access road from Ottawa Gulch to the ski area by blading/regrading to facilitate safe access by heavy equipment and construction crews;
- Improving approximately one mile of existing site access roads leading to the Great Divide Sand Tailings Site;
- Excavating a proposed borrow source located approximately 6 miles from the Great Divide Sand Tailings Site to obtain approximately 18,200 cy of clean cover material for reclamation work;
- Excavating and consolidating all Great Divide Sand Tailings to an off-site repository located within six miles of the site;
- Relocating and replacing utilities in conflict within the excavated area;
- Placing a two-foot amended cover soil cap over the off-site repository;
- Placing a one-foot amended cover soil layer over the entire excavated area;
- Constructing approximately 1,400 lf of new surface water control ditches to route upgradient storm water away from the cover soil areas; and
- Revegetating and mulching all disturbed areas upon completion of construction activities (temporary roads, staging areas, cover soil application areas, etc.).

The current access road to the ski area is in fair condition and is regularly maintained up to Ottawa Gulch. The approximate one-mile stretch between Ottawa Gulch and the ski area will initially require minor grading, with occasional regrading during reclamation activities to maintain a suitable surface. The currently unimproved access roads leading to the tailings site will require upgrading by blading/regrading to facilitate suitable equipment access.

All tailings present at Great Divide Sand Tailings Site would be excavated and placed at an off-site repository located within six miles of the site. Some grading would be required to ensure that slope steepness does not exceed 3H:1V within the excavation footprint. The tailings materials removed from the parking lot would be replaced with road base-type gravel.

Run-on control would consist of constructing approximately 700 lf of ditch to divert upgradient runoff around the reclaimed areas. The run-on control ditch would be lined with riprap to minimize potential erosion and sediment transport to Jennie's Fork.

Runoff controls would consist of two ditches constructed across the lower slope reclaimed area. Approximately 300 lf of ditch would be constructed midway across the lower slope to collect upgradient runoff and further protect the downgradient slope. The ditch would be lined with riprap to prevent potential erosion. A second runoff control ditch approximately 400 lf in length would be constructed at the toe of the lower slope. The primary purpose of the second ditch would be to prevent any remaining upgradient runoff from eroding the area directly above the chalet or further eroding the parking lot area; therefore, significantly reducing the amount of sediment reaching Jennie's Fork. The lower ditch would be lined with riprap and a culvert would be installed under the existing access road directly south of the chalet.

Seeding of disturbed and reclaimed areas would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats would be applied to promote temporary protection of the highly erodible surfaces.

***Effectiveness*** - This alternative would effectively reduce solid media contaminant mobility and availability at the site by removing the solid media contaminant sources and disposing of the wastes in a secure disposal facility. Contaminant toxicity and volume would not be reduced; however, the wastes would be rendered immobile in an engineered structure and physical location protected from erosion problems, grazing, and damage caused by ski area maintenance work. Long-term monitoring and control programs would be necessary at the repository and excavation site to ensure continual effectiveness.

***Implementability*** - This alternative is both technically and administratively feasible. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending on the complexity of the terrain.

***Cost Screening*** - The total capital cost for this alternative has been estimated at $1,582,205 which represents the reclamation of the entire tailings area and parking lot tiers at the Great Divide Sand Tailings Site, including consolidation of tailings in an offsite repository and anticipated utility relocation and replacement expenses. Table F-6 (Appendix F) presents the cost details associated with implementing this alternative.

The following primary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- The cost of grading the access road to the ski area can be completed for a single lump sum of $825 (1 mile);
- The cost of upgrading the access roads to the tailings area can be completed for a single lump sum of $825 (1 mile);

- The cost to strip, stockpile, and replace 2,400 cy of topsoil at the borrow area can be completed for an estimated $13,200 ($5.50 per cy);
- The cost to excavate and stockpile 18,200 cy of cover soil at the borrow area can be completed for an estimated $93,500 ($5.50 per cy);
- The cost to excavate and consolidate approximately 42,000 cy of tailings at the off-site repository located within 6 miles of the site can be completed for an estimated $369,600 ($8.80 per cy);
- To cover the excavated area with a 1-foot layer of cover soil, approximately 8,500 cy of cover soil will be obtained from a borrow source located within 6 miles of the site, which can be completed for an estimated $74,800 ($8.80 per cy);
- To cover the repository with a 2-foot amended soil cap, approximately 9,700 cy of cover soil will be required at an estimated cost of $85,360 ($8.80 per cy);
- Approximately 2,000 dry tons of organic amendment will be required to amend the cover soil areas and repository cap at an estimated cost of $440,000 ($220 per dry ton);
- The total surface area at the reclaimed Great Divide Sand Tailings Site and associated borrow area requiring revegetation via drill seeding (when applicable), broadcast seeding and mulching is approximately 11 acres (excluding contractor access road spurs, staging areas, etc.), and can be completed for an estimated $24,200 ($1,100 per acre);
- To collect surface water run-on and runoff, 3 open channels (total length of approximately 1,400 feet) are necessary at the site, which can be constructed for an estimated $9,240 ($6.60 per lineal foot);
- Approximately 550 cy of angular riprap will be required to armor the surface water channels at an estimated cost of $21,175 ($38.50 per cy);
- The cost to replace approximately 1,200 lf of underground cable for the slope lighting system is estimated to cost $18,480 ($15.40 per lineal foot), and the cost to relocate 3 light poles is estimated to cost $3,630 ($1,210 per pole);
- The cost to replace approximately 1,100 lf of underground tower communications line is estimated at $12,100 ($11.00 per lineal foot);
- The cost to replace approximately 600 lf of underground telephone cable is estimated to cost $6,600 ($11.00 per lineal foot); and the cost to install a new pedestal at the splice location is estimated at $770;
- The cost to replace approximately 1,000 lf of water line for the snow making system is estimated to cost $24,200 ($24.20 per lineal foot), and the cost to replace approximately 400 lf of underground power cable for the system is estimated at $6,160 ($15.40 per lineal foot); and
- The cost to replace approximately 500 lf of 2,400v underground power feed is estimated to cost $19,250 ($38.50 per lineal foot), and the cost to install a new junction box at the splice location is estimated at $1,540.

**Screening Summary**—This alternative has been retained for detailed analysis since complete consolidation and containment in an off-site repository may be an effective, feasible, and cost-effective remedy for the site.

### 7.3.8 Alternative 5b: Consolidation in Off-Site Repository with Multi-Layered Cap

Alternative 5b consists of excavating and disposing of all solid mine waste materials from the Great Divide Sand Tailings Site in an excavated off-site repository consisting of a multi-layered cap and no bottom liner (see Figure 7-3).

Tailings removal and consolidation would proceed in the same manner as specified in Alternative 5a. Approximately 42,000 cy of tailings material would be disposed of in the repository, including the upper slope consolidated tailings, lower slope surficial tailings, and surficial tailings from the parking lot tiers. Following removal of the tailings, one foot of cover soil would be backfilled in the excavation areas, amended, seeded, and mulched.

Construction of three run-on/runoff control ditches would be completed in the same manner as specified in Alternative 5a in order to protect the reclaimed surfaces.

Also as specified in Alternative 5a, utilities within the entire tailings area will require relocation and replacement in order to facilitate tailings excavation at depths approaching 10.5 feet. Utilities anticipated to be in conflict include the slope lighting circuit, a tower communications line, a telephone line, water and power lines for the snow making system, and a 2,400v power main feeding the transformer located above the upper slope consolidated tailings area.

***Conceptual Design and Assumptions***

Based on the available data and the above considerations, the conceptual design for Alternative 5b includes the following:

- Improving approximately one mile of the existing access road from Ottawa Gulch to the ski area by blading/regrading to facilitate safe access by heavy equipment and construction crews;
- Improving approximately one mile of existing site access roads leading to the Great Divide Sand Tailings Site;
- Excavating a proposed borrow source located approximately 6 miles from the Great Divide Sand Tailings Site to obtain approximately 18,200 cy of clean cover material for reclamation work;
- Excavating and consolidating all Great Divide Sand Tailings to an off-site repository located within six miles of the site;
- Relocating and replacing utilities in conflict within the excavated area;
- Placing geotextile filter fabric over the off-site repository;
- Placing geosynthetic clay liner over the off-site repository;
- Placing geonet drainage layer over the off-site repository;
- Placing a two-foot amended cover soil cap over the off-site repository;
- Placing a one-foot amended cover soil layer over the entire excavated area;
- Constructing approximately 1,400 lf of new surface water control ditches to route upgradient storm water away from the cover soil areas; and
- Revegetating and mulching all disturbed areas upon completion of construction activities (temporary roads, staging areas, cover soil application areas, etc.).

The current access road to the ski area is in fair condition and is regularly maintained up to Ottawa Gulch. The approximate one-mile stretch between Ottawa Gulch and the ski area will initially require minor grading, with occasional regrading during reclamation activities to maintain a suitable surface. The currently unimproved access roads leading to the tailings site will require upgrading by blading/regrading to facilitate suitable equipment access.

All tailings present at the Great Divide Sand Tailings Site would be excavated and placed at an off-site repository located within six miles of the site. Some grading would be required to ensure that slope steepness does not exceed 3H:1V within the excavation footprint. The tailings materials removed from the parking lot would be replaced with road base-type gravel.

Run-on control would consist of constructing approximately 700 lf of ditch to divert upgradient runoff around the reclaimed areas. The run-on control ditch would be lined with riprap to minimize potential erosion and sediment transport to Jennie's Fork.

Runoff controls would consist of two ditches constructed across the lower slope reclaimed area. Approximately 300 lf of ditch would be constructed midway across the lower slope to collect upgradient runoff and further protect the downgradient slope. The ditch would be lined with riprap to prevent potential erosion. A second runoff control ditch approximately 400 lf in length would be constructed at the toe of the lower slope. The primary purpose of the second ditch would be to prevent any remaining upgradient runoff from eroding the area directly above the chalet or further eroding the parking lot area; therefore, significantly reducing the amount of sediment reaching Jennie's Fork. The lower ditch would be lined with riprap, and a culvert would be installed under the existing access road directly south of the chalet.

Seeding of disturbed and reclaimed areas would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats would be applied to promote temporary protection of the highly erodible surfaces.

***Effectiveness*** - This alternative would effectively reduce solid media contaminant mobility and availability at the site by removing the solid media contaminant sources and disposing of the wastes in a secure disposal facility. Contaminant toxicity and volume would not be reduced; however, the wastes would be rendered immobile in an engineered structure and physical location protected from erosion problems, grazing, and damage caused by ski area maintenance work. Long-term monitoring and control programs would be necessary to ensure continual effectiveness of the repository cap.

***Implementability*** - This alternative is both technically and administratively feasible. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending on the complexity of the terrain.

***Cost Screening*** - The total capital cost for this alternative has been estimated at $1,863,983 which represents the reclamation of the entire tailings area and parking lot tiers at the Great Divide Sand Tailings Site, including consolidation of tailings in an off-site repository with multi-layered cap, and anticipated utility relocation and replacement expenses. Table F-7 (Appendix F) presents the cost details associated with implementing this alternative.

The following primary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- The cost of grading the access road to the ski area can be completed for a single lump sum of $825 (1 mile);
- The cost of upgrading the access roads to the tailings area can be completed for a single lump sum of $825 (1 mile);
- The cost to strip, stockpile, and replace 2,400 cy of topsoil at the borrow area can be completed for an estimated $13,200 ($5.50 per cy);
- The cost to excavate and stockpile 18,200 cy of cover soil at the borrow area can be completed for an estimated $93,500 ($5.50 per cy);
- The cost to excavate and consolidate approximately 42,000 cy of tailings at the off-site repository located within 6 miles of the site can be completed for an estimated $369,600 ($8.80 per cy);
- To cover the excavated area with a 1-foot layer of cover soil, approximately 8,500 cy of cover soil will be obtained from a borrow source located within 6 miles from the site, which can be completed for an estimated $74,800 ($8.80 per cy);
- To cover the repository with approximately 15,000 sy of geotextile filter fabric is estimated to cost of $57,750 ($3.85 per sy);
- To cover the repository with approximately 15,000 sy of geosynthetic clay liner is estimated to cost of $82,500 ($5.50 per sy);
- To cover the repository with approximately 15,000 sy of geonet drainage layer is estimated to cost of $82,500 ($5.50 per sy);
- To cover the repository with a 2-foot amended soil cap, approximately 9,700 cy of cover soil will be required at an estimated cost of $85,360 ($8.80 per cy);
- Approximately 2,000 dry tons of organic amendment will be required to amend the cover soil areas and repository cap at an estimated cost of $440,000 ($220 per dry ton);
- The total surface area at the reclaimed Great Divide Sand Tailings Site and associated borrow area requiring revegetation via drill seeding (when applicable), broadcast seeding and mulching is approximately 11 acres (excluding contractor access road spurs, staging areas, etc.), and can be completed for an estimated $24,200 ($1,100 per acre);
- To collect surface water run-on and runoff, 3 open channels (total length of approximately 1,400 feet) are necessary at the site, which can be constructed for an estimated $9,240 ($6.60 per lineal foot);
- Approximately 550 cy of angular riprap will be required to armor the surface water channels at an estimated cost of $21,175 ($38.50 per cy);
- The cost to replace approximately 1,200 lf of underground cable for the slope lighting system is estimated to cost $18,480 ($15.40 per lineal foot), and the cost to relocate 3 light poles is estimated to cost $3,630 ($1,210 per pole);
- The cost to replace approximately 1,100 lf of underground tower communications line is estimated at $12,100 ($11.00 per lineal foot);

- The cost to replace approximately 600 lf of underground telephone cable is estimated to cost $6,600 ($11.00 lf); and the cost to install a new pedestal at the splice location is estimated at $770;
- The cost to replace approximately 1,000 lf of water line for the snow making system is estimated to cost $24,200 ($24.20 per lineal foot), and the cost to replace approximately 400 lf of underground power cable for the system is estimated at $6,160 ($15.40 per lineal foot); and
- The cost to replace approximately 500 lf of 2,400v underground power feed is estimated to cost $19,250 ($38.50 per lineal foot), and the cost to install a new junction box at the splice location is estimated at $1,540.

**Screening Summary**—This alternative has been retained for detailed analysis since complete consolidation and containment in an off-site repository with multi-layered cap may be an effective, feasible, and cost-effective remedy for the site.

### 7.3.9 Alternative 5c: Consolidation in Off-Site Modified RCRA Repository

Alternative 5c consists of excavating and disposing all solid mine waste materials from the Great Divide Sand Tailings Site in an off-site modified RCRA repository consisting of a multi-layered cap, bottom liner and leachate collection system (see Figure 7-4).

Tailings removal and consolidation would proceed in the same manner as specified in Alternative 5b. Approximately 42,000 cy of tailings material would be disposed of in the repository, including the upper slope consolidated tailings, lower slope surficial tailings, and surficial tailings from the parking lot tiers. Following removal of the tailings, one foot of cover soil would be backfilled in the excavation areas, amended, seeded, and mulched.

Construction of three run-on/runoff control ditches would be completed in the same manner as specified in Alternative 5b in order to protect the reclaimed surfaces.

Also as specified in Alternative 5b, utilities within the entire tailings area will require relocation and replacement in order to facilitate tailings excavation at depths approaching 10.5 feet. Utilities anticipated to be in conflict include the slope lighting circuit, a tower communications line, a telephone line, water and power lines for the snow making system, and a 2,400v power main feeding the transformer located above the upper slope consolidated tailings area.

#### ***Conceptual Design and Assumptions***

Based on the available data and the above considerations, the conceptual design for Alternative 5c includes the following:

- Improving approximately one mile of the existing access road from Ottawa Gulch to the ski area by blading/regrading to facilitate safe access by heavy equipment and construction crews.
- Improving approximately one mile of existing site access roads leading to the Great Divide Sand Tailings Site.

- Excavating a proposed borrow source/repository located approximately 6 miles from the Great Divide Sand Tailings Site to obtain approximately 18,200 cy of clean cover material for reclamation work and allow consolidation of approximately 42,000 cy of tailings.
- Placing geotextile filter fabric, geosynthetic clay liner, leachate collection system and geonet drainage layer over the compacted subgrade in the bottom of the repository.
- The leachate collection/removal system would consist of a one-foot thick layer of washed, coarse gravel overlaying a bottom liner. PVC drainpipes would be installed in conjunction with the coarse gravel layer for leachate collection/removal. A geotextile filter fabric layer (to prevent potential clogging of the coarse gravel) would overlay the coarse gravel layer.
- Excavating and consolidating all Great Divide Sand Tailings to the off-site repository.
- Placing geotextile filter fabric, geosynthetic clay liner, and Geonet drainage layer over the off-site repository.
- Placing a two-foot amended cover soil cap over the off-site repository.
- Relocating and replacing utilities in conflict within the excavated area.
- Placing a one-foot amended cover soil layer over the entire excavated area.
- Constructing approximately 1,400 lf of new surface water control ditches to route upgradient storm water away from the cover soil areas.
- Revegetating and mulching all disturbed areas upon completion of construction activities (temporary roads, staging areas, cover soil application areas, etc.).

The current access road to the ski area is in fair condition and is regularly maintained up to Ottawa Gulch. The approximate one mile stretch between Ottawa Gulch and the ski area will initially require minor grading, with occasional regrading during reclamation activities to maintain a suitable surface. The currently unimproved access roads leading to the tailings site will require upgrading by blading/regrading to facilitate suitable equipment access.

All tailings present at the Great Divide Sand Tailings Site would be excavated and placed at an off-site repository located within six miles of the site. Some grading would be required to ensure that slope steepness does not exceed 3H:1V within the excavation footprint. The tailings materials removed from the parking lot would be replaced with road base-type gravel.

Run-on control would consist of constructing approximately 700 lf of ditch to divert upgradient runoff around the reclaimed areas. The run-on control ditch would be lined with riprap to minimize potential erosion and sediment transport to Jennie's Fork.

Runoff controls would consist of two ditches constructed across the lower slope reclaimed area. Approximately 300 lf of ditch would be constructed midway across the lower slope to collect upgradient runoff and further protect the downgradient slope. The ditch would be lined with riprap to prevent potential erosion. A second runoff control ditch approximately 400 lf in length would be constructed at the toe of the lower slope. The primary purpose of the second ditch would be to prevent any remaining upgradient runoff from eroding the area directly above the chalet or further eroding the parking lot area; therefore, significantly reducing the amount of sediment reaching Jennie's Fork. The lower ditch would be lined with riprap and a culvert would be installed under the existing access road directly south of the chalet.

Seeding the disturbed and reclaimed areas would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats would be applied to promote temporary protection of the highly erodible surfaces.

***Effectiveness*** - This alternative would effectively reduce solid media contaminant mobility and availability at the site by removing the solid media contaminant sources and disposing of the wastes in a secure disposal facility. Contaminant toxicity and volume would not be reduced; however, the wastes would be rendered immobile in an engineered structure and physical location protected from erosion problems, grazing, and damage caused by ski area maintenance work. Long-term monitoring and control programs would be necessary to ensure continual effectiveness of the repository cap and leachate collection system.

***Implementability*** - This alternative is both technically and administratively feasible. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending on the complexity of the terrain.

***Cost Screening*** - The total capital cost for this alternative has been estimated at $2,204,901 which represents the reclamation of the entire tailings area and parking lot tiers at the Great Divide Sand Tailings Site, including consolidation of tailings in an off-site modified RCRA repository with multi-layered cap, and anticipated utility relocation and replacement expenses. Table F-8 (Appendix F) presents the cost details associated with implementing this alternative.

The following primary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- The cost of grading the access road to the ski area can be completed for a single lump sum of $825 (1 mile);
- The cost of upgrading the access roads to the tailings area can be completed for a single lump sum of $825 (1 mile);
- The cost to strip, stockpile, and replace 2,400 cy of topsoil at the borrow area can be completed for an estimated $13,200 ($5.50 per cy);
- The cost to excavate and stockpile 18,200 cy of cover soil at the borrow area can be completed for an estimated $93,500 ($5.50 per cy);
- To grade and compact the repository subgrade in preparation for waste consolidation is estimated to cost $24,750 ($1.65 per sy);
- To line the repository with approximately 15,000 sy of geotextile filter fabric is estimated to cost of $57,750 ($3.85 per sy);
- To line the repository with approximately 15,000 sy of geosynthetic clay liner is estimated to cost of $82,500 ($5.50 per sy);
- To line the repository with approximately 15,000 sy of geonet drainage layer is estimated to cost of $82,500 ($5.50 per sy);
- The cost of the leachate collection/removal system is estimated to be $22,000 (lump sum);

- The cost to excavate and consolidate approximately 42,000 cy of tailings at the off-site repository located within 6 miles of the site can be completed for an estimated $369,600 ($8.80 per cy);
- To cover the excavated area with a 1-foot layer of cover soil, approximately 8,500 cy of cover soil will be obtained from a borrow source located within 6 miles from the site, which can be completed for an estimated $74,800 ($8.80 per cy);
- To cover the repository with approximately 15,000 sy of geotextile filter fabric is estimated to cost of $57,750 ($3.85 per sy);
- To cover the repository with approximately 15,000 sy of geosynthetic clay liner is estimated to cost of $82,500 ($5.50 per sy);
- To cover the repository with approximately 15,000 sy of geonet drainage layer is estimated to cost of $82,500 ($5.50 per sy);
- To cover the repository with a 2-foot amended soil cap, approximately 9,700 cy of cover soil will be required at an estimated cost of $85,360 ($8.80 per cy);
- Approximately 2,000 dry tons of organic amendment will be required to amend the cover soil areas and repository cap at an estimated cost of $440,000 ($220 per dry ton);
- The total surface area at the reclaimed Great Divide Sand Tailings Site and associated borrow area requiring revegetation via drill seeding (when applicable), broadcast seeding and mulching is approximately 11 acres (excluding contractor access road spurs, staging areas, etc.), and can be completed for an estimated $24,200 ($1,100 per acre);
- To collect surface water run-on and runoff, 3 open channels (total length of approximately 1,400 feet) are necessary at the site, which can be constructed for an estimated $9,240 ($6.60 per lineal foot);
- Approximately 550 cy of angular riprap will be required to armor the surface water channels at an estimated cost of $21,175 ($38.50 per cy);
- The cost to replace approximately 1,200 lf of underground cable for the slope lighting system is estimated to cost $18,480 ($15.40 per lineal foot), and the cost to relocate 3 light poles is estimated to cost $3,630 ($1,210 per pole);
- The cost to replace approximately 1,100 lf of underground tower communications line is estimated at $12,100 ($11.00 per lineal foot);
- The cost to replace approximately 600 lf of underground telephone cable is estimated to cost $6,600 ($11.00 per lineal foot), and the cost to install a new pedestal at the splice location is estimated at $770;
- The cost to replace approximately 1,000 lf of water line for the snow making system is estimated to cost $24,200 ($24.20 per lineal foot), and the cost to replace approximately 400 lf of underground power cable for the system is estimated at $6,160 ($15.40 per lineal foot); and
- The cost to replace approximately 500 lf of 2,400v underground power feed is estimated to cost $19,250 ($38.50 per lineal foot), and the cost to install a new junction box at the splice location is estimated at $1,540.

**Screening Summary**—This alternative has not been retained for detailed analysis since TCLP analysis indicates the waste material does not meet the requirements for placement in a modified RCRA repository. As a result, this alternative would not be a cost-effective remedy for the site.

### 7.3.10 Alternative 6: Consolidation in the Bald Butte DEQ Repository

Alternative 6 consists of excavating and disposing of all tailings materials from the Great Divide Sand Tailings Site to an off-site repository constructed by the DEQ. The centralized repository would be constructed for the purpose of consolidating waste materials from both the nearby Bald Butte reclamation project and the Great Divide Sand Tailings reclamation project.

Approximately 42,000 cy of tailings material would be disposed of in the repository, including the upper slope consolidated tailings, lower slope surficial tailings, and surficial tailings from the parking lot tiers. Following removal of the tailings, one foot of cover soil would be backfilled in the excavation areas, amended, seeded, and mulched.

Construction of three run-on/runoff control ditches would be completed in the same manner as specified in Alternative 5c in order to protect the reclaimed surfaces.

Also under this alternative, utilities within the entire tailings area will require relocation and replacement in order to facilitate tailings excavation at depths approaching 10.5 feet. Utilities anticipated to be in conflict include the slope lighting circuit, a tower communications line, a telephone line, water and power lines for the snow making system, and a 2,400v power main feeding the transformer located above the upper slope consolidated tailings area.

***Conceptual Design and Assumptions***

Based on the available data and the above considerations, the conceptual design for Alternative 6 includes the following:

- Improving approximately one mile of the existing access road from Ottawa Gulch to the ski area by blading/regrading to facilitate safe access by heavy equipment and construction crews;
- Improving approximately one mile of existing site access roads leading to the Great Divide Sand Tailings Site;
- Excavating and consolidating all Great Divide Sand Tailings to the Bald Butte DEQ repository;
- Relocating and replacing utilities in conflict within the excavated area;
- Placing one-foot of amended cover soil layer over the entire excavated area;
- Constructing approximately 1,400 lf of new surface water control ditches to route upgradient storm water away from the cover soil areas; and
- Revegetating and mulching all disturbed areas upon completion of construction activities (temporary roads, staging areas, cover soil application areas, etc.).

The current access road to the ski area is in fair condition, and is regularly maintained up to Ottawa Gulch. The approximate one mile stretch between Ottawa Gulch and the ski area will initially require minor grading, with occasional regrading during reclamation activities to maintain a suitable surface. The currently unimproved access roads leading to the tailings site will require upgrading by blading/regrading to facilitate suitable equipment access.

All tailings present at the Great Divide Sand Tailings Site would be excavated and placed at the central repository constructed by DEQ. Some grading would be required to ensure that slope steepness does not exceed 3H:1V within the excavation footprint. The tailings materials removed from the parking lot would be replaced with road base-type gravel.

Run-on control would consist of constructing approximately 700 lf of ditch to divert upgradient runoff around the reclaimed areas. The run-on control ditch would be lined with riprap to minimize potential erosion and sediment transport to Jennie's Fork.

Runoff controls would consist of two ditches constructed across the lower slope reclaimed area. Approximately 300 lf of ditch would be constructed midway across the lower slope to collect upgradient runoff and further protect the downgradient slope. The ditch would be lined with riprap to prevent potential erosion. A second runoff control ditch approximately 400 lf in length would be constructed at the toe of the lower slope. The primary purpose of the second ditch would be to prevent any remaining upgradient runoff from eroding the area directly above the chalet or further eroding the parking lot area; therefore, significantly reducing the amount of sediment reaching Jennie's Fork. The lower ditch would be lined with riprap and a culvert would be installed under the existing access road directly south of the chalet.

Seeding of disturbed and reclaimed areas would likely take place during the fall season. The seed mixture and fertilizer would be applied simultaneously to the prepared seedbeds by approved methods. Mulch or natural fabric mats would be applied to promote temporary protection of the highly erodible surfaces.

***Effectiveness*** - This alternative would effectively reduce solid media contaminant mobility and availability at the site by removing the solid media contaminant sources and disposing of the wastes in a secure disposal facility. Contaminant toxicity and volume would not be reduced; however, the wastes would be rendered immobile in an engineered structure and physical location protected from erosion problems, grazing, and damage caused by ski area maintenance work. Long-term monitoring and control programs would be necessary to ensure continual effectiveness of the repository cap.

***Implementability*** - This alternative is both technically and administratively feasible. Design methods and requirements have been thoroughly tested, and the necessary construction equipment and methods are readily available and widely used. Construction methods may vary depending on the complexity of the terrain.

***Cost Screening*** - The total capital cost for this alternative has been estimated at $960,761 which represents the reclamation of the entire tailings area and parking lot tiers at the Great Divide Sand Tailings Site, including consolidation of tailings in an off-site repository and anticipated utility relocation and replacement expenses. Table F-9 (Appendix F) presents the cost details associated with implementing this alternative.

The following primary assumptions are based on site data and engineering judgment and were used to calculate associated costs for this alternative:

- The cost of grading the access road to the ski area can be completed for a single lump sum of $825 (1 mile);
- The cost of upgrading the access roads to the tailings area can be completed for a single lump sum of $825 (1 mile);
- The cost to excavate and consolidate approximately 42,000 cy of tailings at the off-site DEQ repository can be completed for an estimated $369,600 ($8.80 per cy);
- To cover the excavated area with a 1-foot layer of cover soil, approximately 8,500 cy of cover soil will be obtained from the borrow source located at the repository, and can be completed for an estimated $74,800 ($8.80 per cy);
- Approximately 720 dry tons of organic amendment will be required to amend the cover soil areas at an estimated cost of $158,400 ($220 per dry ton);
- The total surface area at the reclaimed Great Divide Sand Tailings Site requiring revegetation via drill seeding (when applicable), broadcast seeding and mulching is approximately 6 acres (excluding contractor access road spurs, staging areas, etc.), and can be completed for an estimated $13,200 ($2,200 per acre);
- To control surface water run-on and runoff, 3 open channels (total length of approximately 1,400 feet) are necessary at the site, which can be constructed for an estimated $9,240 ($6.60 per lineal foot);
- Approximately 550 cy of angular riprap will be required to armor the surface water channels at an estimated cost of $21,175 ($38.50 per cy);
- The cost to replace approximately 1,200 lf of underground cable for the slope lighting system is estimated to cost $18,480 ($15.40 per lineal foot), and the cost to relocate 3 light poles is estimated to cost $3,630 ($1,210.00 per pole);
- The cost to replace approximately 1,100 lf of underground tower communications line is estimated at $12,100 ($11.00 per lineal foot);
- The cost to replace approximately 600 lf of underground telephone cable is estimated to cost $6,600 ($11.00 per lineal foot), and the cost to install a new pedestal at the splice location is estimated at $770.00;
- The cost to replace approximately 1,000 lf of water line for the snow making system is estimated to cost $24,200 ($24.20 per lineal foot), and the cost to replace approximately 400 lf of underground power cable for the system is estimated at $6,160 ($15.40 per lineal foot); and
- The cost to replace approximately 500 lf of 2,400v underground power feed is estimated to cost $19,250 ($38.50 per lineal foot), and the cost to install a new junction box at the splice location is estimated at $1,540.

**Screening Summary**—This alternative has been retained for detailed analysis since complete consolidation and containment in a central repository with the Bald Butte wastes may be an effective, feasible, and cost-effective remedy for the site.

## 7.4 ALTERNATIVES SCREENING SUMMARY

Table 7-4 summarizes the findings of the preliminary evaluation and screening. Costs generated and summarized on this table are capital costs.

# TABLE 7-4
# GREAT DIVIDE SAND TAILINGS SITE
# RECLAMATION ALTERNATIVES SCREENING SUMMARY

| ALTERNATIVE DESCRIPTION | ALTERNATIVE EFFECTIVENESS | ALTERNATIVE IMPLEMENTABLE | ESTIMATED COST | RETAINED FOR DETAILED ANALYSIS |
|---|---|---|---|---|
| Alt. 1: No Action | NA | NA | $0 | Yes |
| Alt. 2: Institutional Controls | Low | Yes | $13,915 | No |
| Alt. 3a: Maintenance | Low | Yes | $19,133 | No |
| Alt. 3b: Maintenance with New Surface Water Control Ditches | Low | Yes | $62,965 | No |
| Alt. 4a: In-place Containment with Cover Soil Cap | Moderate | Yes | $621,652 | Yes |
| Alt. 4b: Consolidation and In-place Containment with Cover Soil Cap | Moderate | Yes | $721,701 | Yes |
| Alt. 5a: Consolidation in Off-Site Repository with Cover Soil Cap | High | Yes | $1,582,205 | Yes |
| Alt. 5b: Consolidation in Off-Site Repository with Multi-Layered Cap | High | Yes | $1,863,983 | Yes |
| Alt. 5c: Consolidation in Off-Site Modified RCRA Repository | High | Yes | $2,204,901 | No |
| Alt. 6: Consolidation in Bald Butte DEQ Repository | High | Yes | $960,761 | Yes |

## 8.0 DETAILED ANALYSIS OF ALTERNATIVES

The purpose of the detailed analysis is to evaluate, in detail, reclamation alternatives for their effectiveness, implementability, and associated cost to control and reduce the toxicity, mobility, and/or volume of contaminated solid mine wastes at the Great Divide Sand Tailings Site. The reclamation alternatives that were retained after the preliminary evaluation and screening (as presented in Section 7.0) are included in this detailed analysis. For clarity, the retained alternative numbers are carried over from Section 7.0. The reclamation alternatives evaluated in detail are applicable to the contaminated solid media waste materials only. The rationale for not directly developing reclamation alternatives for surface water was based primarily on the presumption that reclaiming the solid media waste sources at the Great Divide Sand Tailings Site will subsequently reduce the potential problems associated with surface water sedimentation in Jennie's Fork at a significantly reduced cost.

As required by the CERCLA and the NCP, reclamation alternatives that were retained after the initial evaluation and screening have been evaluated individually against the following criteria:

- Overall protection of human health and the environment;
- Compliance with ARARs;
- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, or volume through treatment;
- Short-term effectiveness;
- Implementability; and
- Cost.

Supporting agency acceptance and community acceptance are additional criteria that will be addressed after the BLM and public have reviewed the evaluations presented herein. The analysis criteria have been used to address the CERCLA requirements and considerations with EPA guidance (EPA, 1988), as well as additional technical and policy considerations. These criteria serve as the basis for conducting the detailed analysis and subsequently selecting the preferred reclamation alternative. The criteria listed above are categorized into three groups, each with distinct functions in selecting the preferred alternative. These groups include:

- Threshold Criteria—overall protection of human health and the environment and compliance with ARARs.
- Primary Balancing Criteria—long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost.
- Modifying Criteria—supporting agency and community acceptance.

Overall protection of human health and the environment and compliance with ARARs are threshold criteria that must be satisfied for an alternative to be eligible for selection. Long-term effectiveness and permanence; reduction of toxicity, mobility, or volume; short-term effectiveness; implementability; and cost are the primary balancing factors used to weigh major trade-offs between alternative waste management strategies. Supporting agency and community acceptance are modifying considerations that are formally considered after public comment is received on the proposed plan (Federal Register, No. 245, 51394-50509, December 1988). Each criterion is briefly described in the following paragraphs.

***The overall protection*** criterion evaluates how the alternative, as a whole, protects and maintains human health and the environment. The overall assessment of protection is based on a combination of factors assessed under other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

***Compliance with ARARs*** criterion assesses how each alternative complies with applicable or relevant and appropriate standards, criteria, advisories, or other guidelines. Waivers will be identified, if necessary. The following factors will be addressed for each alternative during the detailed analysis of ARARs:

- Compliance with chemical-specific ARARs;
- Compliance with action-specific ARARs;
- Compliance with location-specific ARARs; and
- Compliance with appropriate criteria, advisories, and guidelines.

***Long-term effectiveness and permanence*** evaluates the alternative's effectiveness in protecting human health and the environment after response objectives have been met. The following components of the criterion will be addressed for each alternative:

- Magnitude of residual risk;
- Adequacy of controls; and
- Reliability of controls.

***The reduction of toxicity, mobility, or volume*** assessment evaluates anticipated performance of the specific treatment technologies. This evaluation focuses on the following specific factors for a particular reclamation alternative:

- The treatment process, the remedies they will employ, and the materials they will treat;
- The amount of hazardous materials that will be destroyed or treated, including how principal threat(s) will be addressed;
- The degree of expected reduction in toxicity, mobility, or volume measured as a percentage of reduction (or order of magnitude);
- Degree to which the treatment will be irreversible; and
- The type and quantity of treatment residuals (i.e., wastewater treatment sludges, spent reagents) that will remain following treatment.

***Short-term effectiveness*** evaluates an alternative's effectiveness in protecting human health and the environment during the construction and implementation period until the response objectives are met. Factors that will be considered under this criterion include:

- Protection of the surrounding community during reclamation actions;
- Protection of on-site workers during reclamation actions;
- Protection from environmental impacts; and

- Time until removal response objectives is achieved.

***Implementability*** evaluates the technical and administrative feasibility of alternatives and the availability of required resources. Analysis of this criterion will include the following factors and subfactors:

Technical Feasibility:

- Construction and operation;
- Reliability of technology;
- Ease of undertaking additional RA; and
- Monitoring considerations.

Administrative Feasibility:

- RCRA disposal restrictions;
- Institutional Controls; and
- Permitting requirements.

Availability of Services and Materials:

- Adequate off-site treatment, storage capacity, and disposal service;
- Necessary equipment and specialists and provisions to ensure any necessary additional resources;
- Timing of the availability of technologies under consideration; and
- Services and materials.

***The cost assessment*** consists of developing conservative, order-of-magnitude cost estimates based on similar sets of site-specific assumptions. Cost estimates for each alternative will consider the following factors:

Capital Costs:

- Construction costs;
- Equipment costs;
- Land and site development costs;
- Disposal costs;
- Legal fees, license, and permit costs;
- Startup and troubleshooting costs; and
- Contingency allowances.

***Supporting Agency acceptance*** will evaluate the technical and administrative issues and concerns the agencies may have regarding each of the alternatives. Acceptance will also focus on legal issues and compliance with State of Montana statutes and regulations.

***Community acceptance*** will incorporate public concerns into the analyses of the alternatives.

The final step of this analysis is to conduct a comparative analysis of the alternatives. The analysis will include a discussion of the alternative's relative strengths and weaknesses with respect to each of the criteria and how reasonable key uncertainties could change expectations of their relative performance.

Once completed, this evaluation will be used to select the preferred alternative. A public meeting to present the alternatives will be conducted and relevant oral and written comments will be addressed in writing. At the conclusion of the 30-day public comment period, the selection of the preferred alternative will be documented in a Record of Decision (ROD) by the BLM.

## 8.1 QUANTITATIVE EVALUATION OF THRESHOLD CRITERIA

In the following detailed evaluations of the threshold criteria, each reclamation alternative contains quantitative estimates of risk reduction as well as estimating whether ARARs would be attained by implementing the alternative. To quantitatively assess the threshold criteria (overall protection of human health and the environment and attainment of ARARs), the exposure pathways of concern that were identified in the baseline risk assessment (human health and ecologic) were evaluated to determine the risk reduction required to achieve the desired residual risk level (Hazard Quotient $\leq 1$ and Ecologic Quotient $\leq 1$). Each alternative was then modeled to ascertain the degree of risk reduction achieved, either through reduced contaminant loadings to an exposure pathway or reduced surface area available for certain exposures. The resulting risk reduction estimates are then compared to one another to determine whether the relative risk reduction provided by a specific alternative is greater than another. These risk reductions are also compared to the reduction required to alleviate excess risk via the specific pathway or media, as determined in the risk assessments. The risk reduction models also estimate resultant contaminant concentrations in the various media, which are then compared to media- and contaminant-specific ARARs. The groundwater model uses an on-site, downgradient exposure point, while the surface water/sediment model uses the sample station location below the sources at the site on Jennie's Fork of Silver Creek as the evaluation point.

Modeling estimates and assumptions are used in an attempt to quantify risk reduction and determine whether ARARs would be attained. In the course of performing this quantitative analysis, several assumptions and estimates are necessarily employed. Some of the assumptions are based on standard CERCLA risk assessment guidance, while others are based on-site-specific observations and professional judgments. Many of the estimates are based on conservative (worst case) scenarios, but since alternatives are compared to one another on a relative basis, these assumptions are consistent. The evaluation findings should, therefore, not be considered absolute (e.g., ARARs); however, the relative risk reduction differences between alternatives are meaningful and can be used to evaluate these criteria.

The human health baseline risk assessment (Section 5.0) determined that no excess risk was found for the residential or recreational exposure at the Great Divide Sand Tailings Site and no further human health risk reduction is required at the site.

The ecologic risk assessment identified four exposure scenarios: Jennie's Fork aquatic life receptors exposed to copper and silver in surface water; exposure to lead and silver in sediment; deer ingestion exposure to lead; and plant phytotoxicity as a result of silver in soil. The aquatic life-water scenario requires a surface water loading reduction of 55% to achieve ambient water quality criteria standards (acute-copper). The aquatic life-sediment scenario requires a 93% reduction in additional sediment loading to the creek to achieve preliminary sediment quality criteria - median effect range (silver). The deer ingestion scenario requires a 24% reduction in surface concentrations or area to achieve no adverse effects to deer from lead. A 92% reduction in surface concentrations is necessary to achieve no adverse plant phytotoxicity effects due to silver.

The four exposure pathways were modeled to evaluate the relative risk reductions and attainment of ARARs afforded by each alternative. These calculations involved a combination of measured data collected at the site (waste and surface water concentrations), and modeled reductions to impacts (e.g., surface water loadings). A discussion of how the evaluations were performed and the assumptions used follows for each pathway.

The surface water pathway was modeled using a simple mathematical model. This model utilized two components: measured surface water concentrations above and below the site wastes; and an estimate of the relative increases in surface water loading provided by each source, based on relative contaminant concentrations in each source, the area of the source, and the proximity of each source to a surface water conveyance.

Assumptions used to evaluate surface water impacts (loadings) include the following: alternatives that employed a simple two-feet thick soil cover or cap with run-on/runoff controls were assigned a 65% long-term effectiveness for preventing erosion into surface water; sources placed in an on- or near-site repository with a multi-layered cap and run-on/runoff controls were assumed to have been 90% removed from exposures via this pathway; and sources moved off-site were assumed to have been 100% removed from exposures via this pathway.

The soil exposure pathways (deer ingestion and plant phytotoxicity) were empirically modeled using only reductions in surface area to estimate reduction in exposures. This pathway also assumed a 65% long-term effectiveness for maintaining adequate soil cover to prevent exposure due to the possibility of long-term deterioration of the clean soil cover. Sources placed in a repository with a multi-layered cap were assumed to have been 90% removed from exposures via this pathway; and sources moved off-site were assumed to have been 100% removed from exposures via this pathway.

## 8.2 ALTERNATIVE 1: NO ACTION

The No Action Alternative is required for analysis by CERCLA and the NCP when evaluating alternatives. The No Action Alternative is used to provide a baseline for comparing other alternatives. Under this alternative, no further reclamation activities would be implemented. The existing erosion-damaged cap and plugged drainage ditches would not be repaired.

Consequently, long-term environmental risks associated with the on-site contamination would remain unchanged, with the contaminant sources at the site continuing to pose a threat to environmental resources.

### 8.2.1 Overall Protection of Human Health and the Environment

Human health risk reduction is not required based on the risk assessment; however, this alternative provides no reduction in risk to the environment. It allows for the continued migration of contaminants from the damaged cap areas, resulting in further degradation of surface water quality.

The No Action Alternative provides no control of ecologic exposures to contaminated materials. Prevention of ecologic exposures via all the scenarios identified in the ecologic risk assessment would not occur: aquatic life exposure to copper and silver via surface water; lead and silver via sediment; deer ingestion exposure to lead; and plant phytotoxicity due to silver.

A risk reduction achievement matrix (Table 8-1) was developed to summarize whether the alternative affords sufficient protection to human health and the environment for the pathways and COCs identified in the ecological risk assessment. The conclusions presented in the table are based on worst-case modeling results subject to the limitations and assumptions used in the models.

**TABLE 8-1**
**GREAT DIVIDE SAND TAILINGS SITE**
**RISK REDUCTION ACHIEVEMENT MATRIX - ALTERNATIVE 1**

| Alternative 1 | Copper | Lead | Silver | Overall |
|---|---|---|---|---|
| Human Health Exposure Pathways: | | | | |
| Soil Ingestion | -- | -- | -- | -- |
| Ecologic Exposure Pathways: | | | | |
| Surface Water | No | -- | No | No |
| Sediments | -- | No | No | No |
| Deer Ingestion | -- | No | -- | No |
| Phytotoxicity | -- | -- | No | No |

-- = Risk reduction not required for the contaminant for that pathway.

### 8.2.2 Compliance with ARARs

A comprehensive list of Federal and State ARARs has been developed for the Great Divide Sand Tailings Site and is summarized in Section 4.0 and presented in detail in Appendix E. The ARARs are divided into contaminant-specific, location-specific, and action-specific requirements. Contaminant-specific ARARs are waste-related requirements which specify how a waste must be managed, treated, and/or disposed depending upon the classification of the waste material. Location-specific ARARs specify how the remedial activities must take place depending upon where the wastes are physically located (i.e., in a stream or floodplain, wilderness area, or sensitive environment, etc.), or where the wastes may be treated or disposed, and what authorizations (permits) may be required. Action-specific ARARs are technology- or activity-based requirements, or are limitations on actions taken with respect to hazardous substances. Action-specific ARARs do not determine the preferred reclamation alternative, but indicate how the selected alternative must be achieved.

Under the No Action Alternative, no contaminated materials would be treated, removed, or actively managed. Consequently, the No Action Alternative would not satisfy Federal or State ARARs. A water quality ARARs attainment matrix (Table 8-2) was developed to summarize whether the alternative will achieve ARARs for those contaminants and media where they are exceeded. The conclusions presented in the table are based on worst-case modeling results subject to the limitations and assumptions used in the models (see Section 8.1 for discussion).

**TABLE 8-2**
**GREAT DIVIDE SAND TAILINGS SITE**
**WATER QUALITY ARARs ATTAINMENT FOR ALTERNATIVE 1**

| Alternative 1 | Copper | Lead | Silver |
|---|---|---|---|
| On-site Surface water (ug/L) | 30 | 40 | 8.0 |
| On-site Surface Water ARARs | No | No | No |

Surface water ARARs are State HHSs or Acute AWQC, whichever is lower.
µg/L – micrograms per Liter

Onsite surface water would exceed water quality ARARs for lead (HHS), and copper and silver (Acute Ambient Water Quality Criteria [AWQC]).

### 8.2.3 Long-Term Effectiveness and Permanence

No controls or long-term measures would be placed on the contaminated materials at the site; consequently, all current and future risks would remain the same as described in the baseline risk assessment (Section 5.0). Site conditions are likely to worsen over time due to continued disturbance of the existing cap by burrowing animals, livestock grazing and ski area maintenance work. Therefore, the No Action Alternative would not be effective at minimizing risks from exposure to these materials. The time required until reclamation objectives are reached (by natural contaminant degradation and erosion) would be indefinite and would most likely be measured in terms of geologic time frames.

### 8.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The No Action Alternative would provide no reduction in toxicity, mobility, or volume of the contaminated materials.

### 8.2.5 Short-Term Effectiveness

In the short-term, the No Action Alternative would pose no additional threats to the community or the environment because the current site conditions would not be changed. The identical level of risk as identified in the risk assessment (see Section 5.0) would continue to exist in the short and long term.

### 8.2.6 Implementability

There would be no implementability concerns posed by the No Action Alternative since no action would be taken.

### 8.2.7 Costs

The cost for implementing this alternative would be zero since no action would be taken.

## 8.3 ALTERNATIVE 4a: IN-PLACE CONTAINMENT WITH COVER SOIL CAP

### 8.3.1 Protection of Human Health and the Environment

This alternative would partially stabilize the surfaces of the sources with respect to migration to surface water. However, while implementing this alternative would be an improvement over current site conditions, several waste sources would still be physically located along surface water conveyances and the potential for future contaminant releases to surface water, though reduced, would continue to exist. Consequently, the reduction in risk to the environment would not be sufficient to achieve the risk reductions dictated by the risk assessment. Human health risk reduction is not required based on the risk assessment.

Increased protection of the environment would be achieved under this alternative. However, prevention of ecologic exposures via all the scenarios identified in the ecologic risk assessment would not occur: aquatic life exposure to silver via surface water; silver via sediment; and plant phytotoxicity due to silver.

A risk reduction achievement matrix (Table 8-3) was developed to summarize whether the alternative affords sufficient protection to human health and the environment for the pathways and COCs identified in the human health risk assessment (Section 5.1) and the ecological risk assessment (Section 5.2). The conclusions presented in the table are based on worst-case modeling results subject to the limitations and assumptions used in the models (see Section 8.1 for discussion).

### TABLE 8-3
### GREAT DIVIDE SAND TAILINGS SITE
### RISK REDUCTION ACHIEVEMENT MATRIX - ALTERNATIVE 4a

| Alternative 4A | Copper | Lead | Silver | Overall |
|---|---|---|---|---|
| Human Health Exposure Pathways: | | | | |
| Soil Ingestion | -- | -- | -- | -- |
| Ecologic Exposure Pathways: | | | | |
| Surface Water | Yes | -- | No | No |
| Sediments | -- | Yes | No | No |
| Deer Ingestion | -- | Yes | -- | Yes |
| Phytotoxicity | -- | -- | No | No |

-- = Risk reduction not required for the contaminant for that pathway.

### 8.3.2 Compliance with ARARs

There are no ARARs that apply to in-place stabilization/containment of contaminated solid media. Water quality ARARs are not expected to be achieved under this alternative. A water quality ARARs attainment matrix (Table 8-4) was developed to summarize whether the alternative will achieve ARARs for those contaminants and media where they are exceeded. The conclusions presented in the table are based on worst-case modeling results subject to the limitations and assumptions used in the models (see Section 8.1 for discussion).

## TABLE 8-4
## GREAT DIVIDE SAND TAILINGS SITE
## WATER QUALITY ARARs ATTAINMENT FOR ALTERNATIVE 4a

| **Alternative 4a** | **Copper** | **Lead** | **Silver** |
|---|---|---|---|
| Onsite Surface water (µg/L) | 13 | 16 | 4.4 |
| Onsite Surface Water ARARs | Yes | No | No |

Surface water ARARs are State HHSs or Acute AWQC, whichever is lower.
µg/L – micrograms per Liter

Onsite surface water would exceed water quality ARARs for lead (HHS), and silver (Acute AWQC).

### 8.3.3 Long-Term Effectiveness and Permanence

Under this alternative, the tailings areas would be graded, capped with cover soil and revegetated. Generally, revegetated caps would stabilize these sources by providing a vegetated surface that would provide protection from surface water and wind erosion, and would reduce net infiltration through the contaminated media by increasing evapotranspiration processes. Soil covers are often subjected to severe surface water erosion problems when placed on slopes steeper than 3H:1V. Compaction may help reduce erosion problems, but may cause revegetation problems. Consequently, erosion control mats may be appropriate for application on the reclaimed waste sources.

Run-on controls and grading would reduce infiltration by directing upgradient flows around the area, as well as by eliminating ponding and promoting runoff from the caps. The caps and run-on controls would have to be maintained to ensure that they continue to perform as designed; and consequently, long-term monitoring and frequent inspection and maintenance would be required. The caps would be susceptible to possible settlement, erosion, and disruption of cover integrity by livestock grazing, ski area maintenance work, deep-rooting vegetation, burrowing animals, and potential steep slopes. However, the cover could be inspected and the required maintenance could be determined.

The long-term effectiveness of revegetation would be enhanced by installing proper erosion control materials, applying amendments, and selecting appropriate plant species adapted to short growing seasons and high altitudes (as opposed to selecting native species exclusively).

In the long term, the water quality and sediment environment (benthic community) in Jennie's Fork is expected to be somewhat improved by implementing this alternative. The long-term effectiveness should be monitored by frequent inspections of the caps (subsequent maintenance should be performed when necessary) and surface water and sediment monitoring in Jennie's Fork.

### 8.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The objective of this alternative is to provide a reduction in contaminant mobility. The volume or toxicity of the contaminants would not be reduced by successfully implementing this alternative. Covering and revegetating the mine waste sources would stabilize these sources and reduce contaminant mobility via surface water and wind erosion. Based on modeling results, this alternative is expected to reduce the mobility of the on-site contaminants to an extent that would result in an overall ecological risk reduction of 65%.

### 8.3.5 Short-Term Effectiveness

It is anticipated that the construction phase of this alternative would be accomplished in a relatively short time period (one field season); therefore, impacts associated with construction would be short term. Short-term impacts to the surrounding community are expected to be minimal due to the remote location of the project site and minimal resident population. Onsite workers would be adequately protected during the construction phase by utilizing appropriate personal protective equipment and by following proper operating and safety procedures. Control of fugitive dust emissions would be provided by applying water (via water truck) to surfaces receiving heavy vehicular traffic, or in excavation areas, etc.

Another potential short-term impact to the surrounding community would involve increased vehicle traffic (and associated safety hazards and dust generation) in the vicinity of private property along the main access road. Construction Best Management Practices (BMPs) would be employed to effectively reduce adverse impacts on surface water from the construction activities.

Storm water runoff from the general construction activities may also cause short-term adverse impacts to water quality in the creek. Construction BMPs would be employed to address these sources and reduce adverse impacts to surface water from the construction activities.

### 8.3.6 Implementability

This alternative is both technically and administratively feasible, and could be implemented in a relatively short period of time (one construction season). The road construction, grading, capping, and revegetation steps required are considered conventional construction practices and materials and construction methods are readily available. Also, design methods and requirements are well documented and well understood. However, the construction steps required to implement this alternative should only be performed by experienced contractors utilizing the appropriate equipment.

### 8.3.7 Costs

The total capital cost for this alternative has been estimated at $621,652. Table F-4 (Appendix F) presents the cost details associated with implementing this alternative.

## 8.4 ALTERNATIVE 4b: CONSOLIDATION AND IN-PLACE CONTAINMENT USING COVER SOIL CAP

### 8.4.1 Overall Protection of Human Health and the Environment

This alternative would further reduce the area of influence of the sources with respect to migration to surface water. However, while implementing this alternative would be an improvement over current site conditions, several waste sources would still be physically located along surface water conveyances and the potential for future contaminant releases to surface water, though reduced, would continue to exist. Consequently, the reduction in risk to the environment would not be sufficient to achieve the risk reductions dictated by the risk assessment. Human health risk reduction is not required based on the risk assessment.

Increased protection of the environment would be achieved under this alternative. However, prevention of ecologic exposures via all the scenarios identified in the ecologic risk assessment would not occur: aquatic life exposure to silver via surface water; silver via sediment; and plant phytotoxicity due to silver.

A risk reduction achievement matrix (Table 8-5) was developed to summarize whether the alternative affords sufficient protection to human health and the environment for the pathways and COCs identified in the human health risk assessment (Section 5.1) and the ecological risk assessment (Section 5.2). The conclusions presented in the table are based on worst-case modeling results subject to the limitations and assumptions used in the models (see Section 8.1 for discussion).

## TABLE 8-5
## GREAT DIVIDE SAND TAILINGS SITE
## RISK REDUCTION ACHIEVEMENT MATRIX - ALTERNATIVE 4b

| **Alternative 4B** | **Copper** | **Lead** | **Silver** | **Overall** |
|---|---|---|---|---|
| Human Health Exposure Pathways: | | | | |
| Soil Ingestion | -- | -- | -- | -- |
| Ecologic Exposure Pathways: | | | | |
| Surface Water | Yes | -- | No | No |
| Sediments | -- | Yes | No | No |
| Deer Ingestion | -- | Yes | -- | Yes |
| Phytotoxicity | -- | -- | No | No |

-- = Risk reduction not required for the contaminant for that pathway.

### 8.4.2 Compliance with ARARs

There are no ARARs that apply to in-place stabilization/containment of contaminated solid media. Water quality ARARs are not expected to be achieved under this alternative. A water quality ARARs attainment matrix (Table 8-6) was developed to summarize whether the alternative will achieve ARARs for those contaminants and media where they are exceeded. The conclusions presented in the table are based on worst-case modeling results subject to the limitations and assumptions used in the models (see Section 8.1 for discussion).

## TABLE 8-6
## GREAT DIVIDE SAND TAILINGS SITE
## WATER QUALITY ARARs ATTAINMENT FOR ALTERNATIVE 4b

| **Alternative 4b** | **Copper** | **Lead** | **Silver** |
|---|---|---|---|
| Onsite Surface water (μg/L) | 11 | 13 | 3.9 |
| Onsite Surface Water ARARs | Yes | Yes | No |

Surface water ARARs are State HHSs or Acute AWQC, whichever is lower.
μg/L – micrograms per Liter

Onsite surface water would exceed water quality ARARs for silver (acute AWQC).

### 8.4.3 Long-Term Effectiveness and Permanence

Under this alternative, the tailings areas would be consolidated, capped with cover soil and revegetated. Generally, revegetated caps would stabilize these sources by providing a vegetated surface that would provide protection from surface water and wind erosion, and would reduce net infiltration through the contaminated media by increasing evapotranspiration processes. Soil covers are often subjected to severe surface water erosion problems when placed on slopes steeper than 3H:1V. Compaction may help reduce erosion problems, but may cause revegetation problems. Consequently, erosion control mats may be appropriate for application on the reclaimed waste sources.

Run-on controls and grading would reduce infiltration by directing upgradient flows around the area, as well as by eliminating ponding and promoting runoff from the caps. The caps and run-on controls would have to be maintained to ensure that they continue to perform as designed and consequently, long-term monitoring and frequent inspection and maintenance would be required. The cap would be susceptible to possible settlement, erosion, and disruption of cover integrity by livestock grazing, ski area maintenance work, deep-rooting vegetation, burrowing animals, and potential steep slopes. However, the cover could be inspected and the required maintenance could be determined.

The long-term effectiveness of revegetation would be enhanced by installing proper erosion control materials, applying amendments, and selecting appropriate plant species adapted to short growing seasons and high altitudes (as opposed to selecting native species exclusively).

In the long term, the water quality and sediment environment (benthic community) in Jennie's Fork is expected to be somewhat improved by implementing this alternative. The long-term effectiveness should be monitored by frequent inspections of the caps (subsequent maintenance should be performed when necessary) and surface water and sediment monitoring in Jennie's Fork.

### 8.4.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The objective of this alternative is to reduce the area of influence and provide a reduction in contaminant mobility; the volume or toxicity of the contaminants would not be reduced by successfully implementing this alternative. Consolidating, covering, and revegetating the mine waste sources would stabilize these sources and reduce contaminant mobility via surface water and wind erosion. Based on modeling results, this alternative is expected to reduce the mobility of the onsite contaminants to an extent that would result in an overall ecological risk reduction of 75%.

### 8.4.5 Short-Term Effectiveness

It is anticipated that the construction phase of this alternative would be accomplished in a relatively short time period (one field season); therefore, impacts associated with construction would be short term. Short-term impacts to the surrounding community are expected to be minimal due to the remote location of the project site and minimal resident population.

However, short-term air quality impacts to the surrounding environment may occur due to the volumes of wastes requiring excavation and regrading. On-site workers would be adequately protected during the construction phase by utilizing appropriate personal protective equipment and by following proper operating and safety procedures. Control of fugitive dust emissions would be provided by applying water (via water truck) to surfaces receiving heavy vehicular traffic, or in excavation areas, etc.

Another potential short-term impact to the surrounding community would involve increased vehicle traffic (and associated safety hazards and dust generation) in the vicinity of private property along the main access road. Construction BMPs would be employed to effectively reduce adverse impacts on surface water from the construction activities.

Storm water runoff from the general construction activities may also cause short-term adverse impacts to water quality in the creek. Construction BMPs would be employed to address these sources and reduce adverse impacts to surface water from the construction activities.

### 8.4.6 Implementability

This alternative is both technically and administratively feasible, and could be implemented in a relatively short period of time (one construction season). The road construction, excavation, consolidation, grading, capping, and revegetation steps required are considered conventional construction practices and materials and construction methods are readily available. Also, design methods and requirements are well documented and well understood. However, the construction steps required to implement this alternative should only be performed by experienced contractors utilizing the appropriate equipment.

### 8.4.7 Costs

The total capital cost for Alternative 4b has been estimated at $721,701. Table F-5 (Appendix F) presents the cost details associated with implementing this alternative.

## 8.5 ALTERNATIVE 5a: CONSOLIDATION IN AN OFF-SITE REPOSITORY WITH COVER SOIL CAP

### 8.5.1 Overall Protection of Human Health and the Environment

This alternative would stabilize the surfaces of most sources with respect to migration to surface water. The reduction in risk to the environment would be sufficient to achieve the risk reductions dictated by the risk assessment. No reduction in human health risk is required based on the risk assessment. Alternative 5a would sufficiently mitigate the migration of contaminants and degradation of surface water quality.

Significant protection of the environment would be achieved under this alternative. Reduction of most ecologic exposures, via the scenarios identified in the ecologic risk assessment, would occur; however, aquatic life-sediment exposure and plant phytotoxicity due to silver would not be sufficiently reduced.

A risk reduction achievement matrix (Table 8-7) was developed to summarize whether the alternative affords sufficient protection to human health and the environment for the pathways and COCs identified in the human health risk assessment (Section 5.1) and the ecological risk assessment (Section 5.2). The conclusions presented in the table are based on worst-case modeling results subject to the limitations and assumptions used in the models (see Section 8.1 for discussion).

### TABLE 8-7
### GREAT DIVIDE SAND TAILINGS SITE
### RISK REDUCTION ACHIEVEMENT MATRIX - ALTERNATIVE 5a

| Alternative 5a | Copper | Lead | Silver | Overall |
|---|---|---|---|---|
| Human Health Exposure Pathways: | | | | |
| Soil Ingestion | -- | -- | -- | -- |
| Ecologic Exposure Pathways: | | | | |
| Surface Water | Yes | -- | Yes | Yes |
| Sediments | -- | Yes | No | No |
| Deer Ingestion | -- | Yes | -- | Yes |
| Phytotoxicity | -- | -- | No | No |

-- = Risk reduction not required for the contaminant for that pathway.

## 8.5.2 Compliance with ARARs

Water quality ARARs are expected to be achieved under this alternative. A water quality ARARs attainment matrix (Table 8-8) was developed to summarize whether the alternative will achieve ARARs for those contaminants and media where they are exceeded. The conclusions presented in the table are based on worst-case modeling results subject to the limitations and assumptions used in the models (see Section 8.1 for discussion).

## TABLE 8-8
## GREAT DIVIDE SAND TAILINGS SITE
## WATER QUALITY ARARs ATTAINMENT FOR ALTERNATIVE 5a

| Alternative 5a | Copper | Lead | Silver |
|---|---|---|---|
| Onsite Surface water (µg/L) | 9.4 | 11 | 3.6 |
| Onsite Surface Water ARARs | Yes | Yes | Yes |

Surface water ARARs are State HHSs or Acute AWQC, whichever is lower.
µg/L – micrograms per Liter

Onsite surface water would meet water quality ARARs.

### 8.5.3 Long-Term Effectiveness and Permanence

Under this alternative, all of the waste sources would be completely removed, transported to a different physical location, and managed under established regulatory programs and accepted waste management practices to ensure continued effectiveness. Removal of these waste sources would eliminate threats of disturbance at the site due to burrowing animals, livestock grazing, and ski area maintenance work. After the removal is completed, the excavated areas would be revegetated; consequently, the site problems associated with the solid media are expected to be permanently corrected.

Run-on controls and grading would reduce infiltration by directing upgradient flows around the repository, as well as by eliminating ponding and promoting runoff from the cap. The cap and run-on controls would have to be maintained to ensure that they continue to perform as designed; consequently, long-term monitoring and frequent inspection and maintenance of the repository would be required. Through the use of institutional controls, the cap would be protected from disruption of cover integrity by vehicles and livestock grazing, but could still be compromised by deep-rooting vegetation, and burrowing animals. However, the cover could be easily inspected and the required maintenance could be easily determined.

### 8.5.4 Reduction of Toxicity, Mobility, of Volume Through Treatment

The implementation of this alternative would result in eliminating the effects of toxicity, mobility, and volume from the site. Furthermore, contaminant mobility would be reduced through disposal in an engineered repository. Also, the wastes would be permanently transported to a different physical location where they can be managed under established regulatory programs to ensure continued effectiveness. Overall, the effects of toxicity, mobility, and volume of the wastes at the site would be reduced to such an extent that Alternative 5a would provide overall ecological risk reduction of 78%.

### 8.5.5 Short-Term Effectiveness

It is anticipated that the construction phase of this alternative would be accomplished in a relatively short time period (one field season); therefore, impacts associated with construction would be short term.

Short-term impacts to the surrounding community as a result of construction activities could occur. Short-term air quality impacts to the surrounding environment may occur due to the volumes of wastes requiring excavation and transportation. Efforts to minimize dust generation during excavation and hauling and control of loss of waste materials from the haul trucks during transport would be required to minimize these risks. On-site workers would be adequately protected during the construction phase by utilizing appropriate personal protective equipment and by following proper operating and safety procedures. Control of fugitive dust emissions would be provided by applying water (via water truck) to roads and surfaces receiving heavy vehicle traffic and in excavation areas, etc. Loss of materials from the loads could be minimized by requiring that all haul trucks be filled only to struck capacity and by covering loads as necessary.

Another potential short-term impact to the surrounding community would involve increased vehicle traffic (and associated safety hazards and dust generation) in the vicinity of private property along the access roads. Application of water and/or dust suppressants to the roads in these areas may become necessary if dust generation is significant. The main site access road would likely require improvements to provide access for heavy equipment. In addition to the increased dust and vehicle traffic hazards associated with the construction, the road construction may cause short-term impacts via storm water runoff related to the construction activities. Construction BMPs would be employed to reduce adverse impacts on surface water from the construction activities.

Under this alternative, all of the waste materials located at the Great Divide Sand Tailings Site would be removed. Storm water runoff from general construction activities may cause short-term adverse impacts to water quality in Jennie's Fork. Construction BMPs would be used to treat runoff prior to discharge to the mainstream flow.

### 8.5.6 Implementability

Alternative 5a is technically and administratively feasible and could be implemented in a relatively short period of time (one construction season). The excavation, consolidation, grading, capping, and revegetation steps required are considered conventional construction practices and materials and construction methods are readily available. Also, design methods and requirements are well documented and well understood. However, the construction steps required to implement this alternative should be performed by experienced contractors utilizing appropriately sized equipment. Inappropriate equipment and/or inexperienced contractors and crews would likely prolong the construction phase and may result in increased costs and/or compromised performance.

### 8.5.7 Cost

The total capital cost for Alternative 5a has been estimated at $1,582,205. Table F-6 (Appendix F) presents the cost details associated with implementing this alternative.

## 8.6 ALTERNATIVE 5b: CONSOLIDATION IN AN OFF-SITE REPOSITORY WITH MULTI-LAYERED CAP

### 8.6.1 Overall Protection of Human Health and the Environment

This alternative would stabilize the surfaces of most sources with respect to migration to surface water. The reduction in risk to the environment would be sufficient to achieve the risk reductions dictated by the risk assessment. No reduction in human health is required based on the risk assessment. Alternative 5b would sufficiently mitigate the migration of contaminants and degradation of surface water quality.

Significant protection of the environment would be achieved under this alternative. Reduction of most ecologic exposures, via the scenarios identified in the ecologic risk assessment, would occur; however, aquatic life-sediment exposure due to silver would not be sufficiently reduced.

A risk reduction achievement matrix (Table 8-9) was developed to summarize whether the alternative affords sufficient protection to human health and the environment for the pathways and COCs identified in the human health risk assessment (Section 5.1) and the ecological risk assessment (Section 5.2). The conclusions presented in the table are based on worst-case modeling results subject to the limitations and assumptions used in the models (see Section 8.1 for discussion).

**TABLE 8-9**
**GREAT DIVIDE SAND TAILINGS SITE**
**RISK REDUCTION ACHIEVEMENT MATRIX - ALTERNATIVE 5b**

| Alternative 5b | Copper | Lead | Silver | Overall |
|---|---|---|---|---|
| Human Health Exposure Pathways: | | | | |
| Soil Ingestion | -- | -- | -- | -- |
| Ecologic Exposure Pathways: | | | | |
| Surface Water | Yes | -- | Yes | Yes |
| Sediments | -- | Yes | No | No |
| Deer Ingestion | -- | Yes | -- | Yes |
| Phytotoxicity | -- | -- | Yes | No |

-- = Risk reduction not required for the contaminant for that pathway.

### 8.6.2 Compliance with ARARs

Water quality ARARs are expected to be achieved under this alternative. A water quality ARARs attainment matrix (Table 8-10) was developed to summarize whether the alternative will achieve ARARs for those contaminants and media where they are exceeded. The conclusions presented in the table are based on worst-case modeling results subject to the limitations and assumptions used in the models (see Section 8.1 for discussion).

**TABLE 8-10**
**GREAT DIVIDE SAND TAILINGS SITE**
**WATER QUALITY ARARs ATTAINMENT FOR ALTERNATIVE 5b**

| Alternative 5b | Copper | Lead | Silver |
|---|---|---|---|
| Onsite Surface water (µg/L) | 8.7 | 9.7 | 3.5 |
| Onsite Surface Water ARARs | Yes | Yes | Yes |

Surface water ARARs are State HHSs or Acute AWQC, whichever is lower.
µg/L – micrograms per Liter

Onsite surface water would meet water quality ARARs.

### 8.6.3 Long-Term Effectiveness and Permanence

Under this alternative, all of the waste sources would be completely removed, transported to a different physical location, and managed under established regulatory programs and accepted waste management practices to ensure continued effectiveness. Removal of these waste sources would eliminate threats of disturbance at the site due to burrowing animals, livestock grazing, and ski area maintenance work. After the removal is completed, the excavated areas would be revegetated; consequently, the site problems associated with the solid media are expected to be permanently corrected.

The multi-layered cap is expected to increase the long-term effectiveness and permanence. Run-on controls and grading would reduce infiltration by directing upgradient flows around the repository, as well as by eliminating ponding and promoting runoff from the cap. The cap and run-on controls would have to be maintained to ensure that they continue to perform as designed; consequently, long-term monitoring and frequent inspection and maintenance of the repository would be required. Through the use of institutional controls, the cap would be protected from disruption of cover integrity by vehicles and livestock grazing, but could still be compromised by deep-rooting vegetation, and burrowing animals. However, the cover could be easily inspected and the required maintenance could be easily determined.

### 8.6.4 Reduction of Toxicity, Mobility, of Volume Through Treatment

The implementation of this alternative would result in eliminating the effects of toxicity, mobility, and volume from the site. Furthermore, contaminant mobility would be reduced through disposal in an engineered repository. Also, the wastes would be permanently transported to a different physical location where they can be managed under established regulatory programs to ensure continued effectiveness. Overall, the effects of toxicity, mobility, and volume of the wastes at the site would be reduced to such an extent that Alternative 5b would provide overall ecological risk reduction of 85%.

### 8.6.5 Short-Term Effectiveness

It is anticipated that the construction phase of this alternative would be accomplished in a relatively short time period (one field season); therefore, impacts associated with construction would be short-term.

Short-term impacts to the surrounding community as a result of construction activities could occur. Short-term air quality impacts to the surrounding environment may occur due to the volumes of wastes requiring excavation and transportation. Efforts to minimize dust generation during excavation and hauling and control of loss of waste materials from the haul trucks during transport would be required to minimize these risks. On-site workers would be adequately protected during the construction phase by utilizing appropriate personal protective equipment and by following proper operating and safety procedures. Control of fugitive dust emissions would be provided by applying water (via water truck) to roads and surfaces receiving heavy vehicle traffic and in excavation areas, etc. Loss of materials from the loads could be minimized by requiring that all haul trucks be filled only to struck capacity and by covering loads as necessary.

Another potential short-term impact to the surrounding community would involve increased vehicle traffic (and associated safety hazards and dust generation) in the vicinity of private property along the access roads. Application of water and/or dust suppressants to the roads in these areas may become necessary if dust generation is significant. The main site access road would likely require improvements to provide access for heavy equipment. In addition to the increased dust and vehicle traffic hazards associated with the construction, the road construction may cause short-term impacts via storm water runoff related to the construction activities. Construction BMPs would be employed to reduce adverse impacts on surface water from the construction activities.

Under this alternative, all of the waste materials located at the Great Divide Sand Tailings Site would be removed. Storm water runoff from general construction activities may cause short-term adverse impacts to water quality in Jennie's Fork. Construction BMPs would be used to treat runoff prior to discharge to the mainstream flow.

### 8.6.6 Implementability

Alternative 5b is technically and administratively feasible and could be implemented in a relatively short period of time (one construction season). The excavation, consolidation, grading, capping, and revegetation steps required are considered conventional construction practices and materials and construction methods are readily available. Also, design methods and requirements are well documented and well understood. However, the construction steps required to implement this alternative should be performed by experienced contractors utilizing appropriately sized equipment. Inappropriate equipment and/or inexperienced contractors and crews would likely prolong the construction phase and may result in increased costs and/or compromised performance.

### 8.6.7 Cost

The total capital cost for Alternative 5b has been estimated at $1,863,983. Table F-7 (Appendix F) presents the cost details associated with implementing this alternative.

## 8.7 ALTERNATIVE 6: CONSOLIDATION IN THE BALD BUTTE DEQ REPOSITORY

### 8.7.1 Overall Protection of Human Health and the Environment

This alternative would stabilize the surfaces of most sources with respect to migration to surface water. The reduction in risk to the environment would be sufficient to achieve the risk reductions dictated by the risk assessment. No reduction in human health risk is required based on the risk assessment. Alternative 6 would sufficiently mitigate the migration of contaminants and degradation of surface water quality.

Protection of the environment would be achieved under this alternative. Reduction of the ecologic exposures via the scenarios identified in the ecologic risk assessment would occur.

A risk reduction achievement matrix (Table 8-11) was developed to summarize whether the alternative affords sufficient protection to human health and the environment for the pathways and COCs identified in the human health risk assessment (Section 5.1) and the ecological risk assessment (Section 5.2). The conclusions presented in the table are based on worst-case modeling results subject to the limitations and assumptions used in the models (see Section 8.1 for discussion).

## TABLE 8-11
## GREAT DIVIDE SAND TAILINGS SITE
## RISK REDUCTION ACHIEVEMENT MATRIX - ALTERNATIVE 6

| Alternative 6 | Copper | Lead | Silver | Overall |
|---|---|---|---|---|
| Human Health Exposure Pathways: | | | | |
| Soil Ingestion | -- | -- | -- | -- |
| Ecologic Exposure Pathways: | | | | |
| Surface Water | Yes | -- | Yes | Yes |
| Sediments | -- | Yes | Yes | Yes |
| Deer Ingestion | -- | Yes | -- | Yes |
| Phytotoxicity | -- | -- | Yes | Yes |

-- = Risk reduction not required for the contaminant for that pathway.

### 8.7.2 Compliance with ARARs

Water quality ARARs are expected to be achieved under this alternative. A water quality ARARs attainment matrix (Table 8-12) was developed to summarize whether the alternative will achieve ARARs for those contaminants and media where they are exceeded. The conclusions presented in the table are based on worst-case modeling results subject to the limitations and assumptions used in the models (see Section 8.1 for discussion).

## TABLE 8-12
## GREAT DIVIDE SAND TAILINGS SITE
## WATER QUALITY ARARS ATTAINMENT FOR ALTERNATIVE 6

| Alternative 6 | Copper | Lead | Silver |
|---|---|---|---|
| Onsite Surface water (µg/L) | 8.4 | 9.3 | 3.4 |
| Onsite Surface Water ARARs | Yes | Yes | Yes |

Surface water ARARs are State HHSs or Acute AWQC, whichever is lower.
µg/L – micrograms per Liter

Onsite surface water would meet water quality ARARs.

### 8.7.3 Long-Term Effectiveness and Permanence

Under this alternative, all of the waste sources would be completely removed, transported to a different physical location, and managed by the DEQ and BLM under established regulatory programs and accepted waste management practices to ensure continued effectiveness. Removal of these waste sources would eliminate threats of disturbance at the site due to burrowing animals, livestock grazing, and ski area maintenance work. After the removal is completed, the excavated areas would be revegetated; consequently, the site problems associated with the solid media are expected to be permanently corrected.

### 8.7.4 Reduction of Toxicity, Mobility, of Volume Through Treatment

The implementation of this alternative would result in eliminating the effects of toxicity, mobility, and volume from the site. Furthermore, contaminant mobility would be reduced through disposal in an engineered repository. Also, the wastes would be permanently transported to a different physical location where they can be managed by the DEQ and BLM under established regulatory programs to ensure continued effectiveness. Overall, the effects of toxicity, mobility, and volume of the wastes would be reduced to such an extent that this alternative would provide an overall ecological risk reduction would be 88%.

### 8.7.5 Short-Term Effectiveness

It is anticipated that the construction phase of this alternative would be accomplished in a relatively short time period (one field season); therefore, impacts associated with construction would be short-term.

Short-term impacts to the surrounding community as a result of construction activities could occur. Short-term air quality impacts to the surrounding environment may occur due to the volumes of wastes requiring excavation and transportation. Efforts to minimize dust generation during excavation and hauling and control of loss of waste materials from the haul trucks during transport would be required to minimize these risks. On-site workers would be adequately protected during the construction phase by utilizing appropriate personal protective equipment and by following proper operating and safety procedures. Control of fugitive dust emissions would be provided by applying water (via water truck) to roads and surfaces receiving heavy vehicle traffic and in excavation areas, etc. Loss of materials from the loads could be minimized by requiring that all haul trucks be filled only to struck capacity and by covering loads as necessary.

Another potential short-term impact to the surrounding community would involve increased vehicle traffic (and associated safety hazards and dust generation) in the vicinity of private property along the access roads. Application of water and/or dust suppressants to the roads in these areas may become necessary if dust generation is significant. The main site access road would likely require improvements to provide access for heavy equipment. In addition to the increased dust and vehicle traffic hazards associated with the construction, the road construction may cause short-term impacts via storm water runoff related to the construction activities.

Construction BMPs would be employed to reduce adverse impacts on surface water from the construction activities.

Under this alternative, all of the waste materials located at the Great Divide Sand Tailings Site would be removed. Storm water runoff from general construction activities may cause short-term adverse impacts to water quality in Jennie's Fork. Construction BMPs would be used to treat runoff prior to discharge to the mainstream flow.

### 8.7.6 Implementability

Alternative 6 is technically and administratively feasible and could be implemented in a relatively short period of time (one construction season). The excavation, consolidation, grading, and revegetation steps required are considered conventional construction practices and materials and construction methods are readily available. Also, design methods and requirements are well documented and well understood. However, the construction steps required to implement this alternative should be performed by experienced contractors utilizing appropriately sized equipment. Close coordination with the DEQ Bald Butte reclamation project will be required in order to successfully implement this alternative. Inappropriate equipment and/or inexperienced contractors and crews would likely prolong the construction phase and may result in increased costs and/or compromised performance.

### 8.7.7 Cost

The total capital cost for Alternative 6 has been estimated at $960,761. Table F-9 (Appendix F) presents the cost details associated with implementing this alternative.

# 9.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section provides a comparison of the solid media reclamation alternatives retained for the Great Divide Sand Tailings Site. The comparison focuses mainly on the following criteria: 1) the relative protectiveness of human health and the environment provided by the alternatives; 2) the long-term effectiveness provided by the alternatives; and 3) the estimated attainment of ARARs for each alternative. Modeling results are used in the comparisons to contrast the two threshold criteria of "overall protection of human health and the environment" and "compliance with ARARs" for each alternative. The primary balancing criteria are also compared although the evaluation of each of these criteria is very similar due to the technical similarities in the alternatives themselves, with the exception of cost. Table 9-1 presents a summary of the alternatives with respect to the first seven NCP evaluation criteria.

The baseline risk assessment concluded that no further reduction in human health risk is required at the site. As a result, all of the alternatives provide sufficient protectiveness of human health.

Alternative 1 would not achieve any risk reduction or provide any protection of the environment. The current risks, impacts and effectiveness would remain the same.

Alternatives 4a and 4b do not achieve sufficient overall risk reduction in regard to the environment. Aquatic life exposure to silver in sediment and plant phytotoxicity due to silver would not be sufficiently reduced. Silver concentrations in surface water would continue to exceed the acute water quality concentrations ARARs under both alternatives, while lead would continue to exceed the human health ARARs under Alternative 4a. Overall, Alternative 4a provides an ecologic risk reduction of 65% and Alternative 4b reduces ecologic risk by 75%.

Alternatives 5a and 5b each achieve significant risk reduction in regard to the environment. Alternative 5a provides a 78% ecologic risk reduction, while Alternative 5b provides an 85% ecologic risk reduction. However, these alternatives do not fully meet the risk reduction goals for silver in regards to stream sediment and plant phytotoxicity, and are at a substantially higher capital cost than Alternative 6, which provides a greater overall ecological risk reduction of 88% while meeting all risk reduction goals. The significant difference in capital costs between Alternatives 5a, 5b and 6 can be attributed to the substantially lower cost of consolidating wastes at a centralized repository site that would be established by DEQ for the Bald Butte reclamation project.

The short-term effectiveness is expected to be similar for each of the action alternatives. The alternatives are all technically similar, and the construction steps required to implement them would be similar as well. All alternatives may have short-term impacts to residents or recreational users due to the need for road access improvements and the need for imported materials. All of the alternatives can be completed in one construction season.

The long-term effectiveness of Alternatives 4a and 4b is similar. Both in-place containment alternatives provide moderate ecologic risk reduction. Surface water quality in Jennie's Fork would be improved; however, ARARs would continue to be exceeded.

TABLE 9-1
GREAT DIVIDE SAND TAILINGS SITE
COMPARATIVE ANALYSIS OF ALTERNATIVES

| Assessment Criteria | Alternative 1:<br>No Action | Alternative 4a<br>In-Place Containment<br>with Cover Soil Cap | Alternative 4b:<br>Consolidation and In-Place Containment<br>with Cover soil Cap | Alternative 5a:<br>Consolidation in Off-site<br>Repository with Cover Soil Cap | Alternative 5b:<br>Consolidation in Off-site<br>Repository with Multi-layered Cap | Alternative 6<br>Consolidation in Bald Butte<br>DEQ Repository |
|---|---|---|---|---|---|---|
| **Overall Protectiveness of Public Health, Safety, and Welfare -** | No reduction in risk. | Fully protective of Human Health - No risk reduction required. | Fully protective of Human Health - No risk reduction required. | Fully protective of Human Health - No risk reduction required. | Fully protective of Human Health - No risk reduction required. | Fully protective of Human Health - No risk reduction required. |
| **Environmental Protectiveness -** | No protection offered. | In-place containment and stabilization of sources is expected to reduce ecological exposure risk by 65% overall. | Consolidation with in-place containment and stabilization of sources is expected to reduce ecological exposure risk by 75% overall. | Off-site containment and stabilization of sources is expected to reduce ecological exposure risk by 78% overall. | Off-site containment and stabilization of sources is expected to reduce ecological exposure risk by 85% overall. | Off-site containment and stabilization of sources is expected to reduce ecological exposure risk by 88% overall. |
| **Compliance with ARARs -**<br>Chemical Specific | None Apply | There are no ARARs that apply to in-place stabilization of contaminated solid media. Surface water quality ARARs are exceeded. (HHS for Pb; Acute WQC for Ag) | There are no ARARs that apply to in-place stabilization of contaminated solid media. Surface water quality ARARs are exceeded. (Acute WQC for Ag) | There are no ARARs that apply to stabilization/containment of contaminated solid media. No water quality ARARs are exceeded. | There are no ARARs that apply to stabilization/containment of contaminated solid media. No water quality ARARs are exceeded | There are no ARARs that apply to stabilization/containment of contaminated solid media No water quality ARARs are exceeded |
| Location Specific | None Apply. | All location-specific ARARs would be met. | All location-specific ARARs would be met. | All location-specific ARARs would be met. | All location-specific ARARs would be met | All location-specific ARARs would be met. |
| Action Specific | None Apply. | All location-specific ARARs would be met. | All location-specific ARARs would be met. | All location-specific ARARs would be met. | All action-specific ARARs would be met. | All action-specific ARARs would be met. |
| **Long-term Effectiveness and Permanence -**<br>Magnitude of Residual Risk | No reduction in COC levels in any environmental media, except by natural degradation/erosion | Overall risk reduction goal not achieved. | Overall risk reduction goal not achieved. | Overall risk reduction goal not achieved. | Overall risk reduction goal achieved. | Overall risk reduction goal achieved. |
| Adequacy and Reliability of Controls | No controls over any on-site contamination, no reliability. | Long term reliability is not achieved. | Long term reliability is not achieved. | Containment controls are adequate for intended purposes. | Containment controls are adequate for intended purposes. | Containment controls are adequate for intended purposes. |
| **Reduction of Toxicity, Mobility, and Volume -**<br>Treatment Process Used and Materials Treated | None | In-place cover/containment and revegetation of tailings will reduce mobility of COCs. Future impacts to surface water (Jennie's Fork) possible due to physical location of tailings | In-place cover/containment and revegetation of tailings will reduce mobility of COCs. Future impacts to surface water (Jennie's Fork) possible due to physical location of tailings. | Removal of all tailings materials to an off-site repository is expected to provide significant reduction in mobility of COCs from wind and water erosion as well as infiltration. | Removal of all tailings materials to an off-site repository is expected to provide significant reduction in mobility of COCs from wind and water erosion as well as infiltration. | Removal of all tailings materials to an off-site repository is expected to provide significant reduction in mobility of COCs from wind and water erosion as well as infiltration. |
| Volume of Contaminated Materials Treated/Haudled | No reduction in COC toxicity, mobility, or volume | No volume actively treated; approximately 42,000 cy capped/revegetated to reduce exposure to environmental receptors. | No volume actively treated; approximately 42,000 cy capped/revegetated to reduce exposure to environmental receptors. | Total volume of waste material expected to be consolidated within the repository to effectively isolate from environmental receptors is approximately 42,000 cy. | Total volume of waste material expected to be consolidated within the repository to effectively isolate from environmental receptors is approximately 42,000 cy. | Total volume of waste material expected to be consolidated within the repository to effectively isolate from environmental receptors is approximately 42.000 cy. |
| Expected Degree of Reduction | Minimal, via natural degradation only (potential for future increases in mobility of contaminants) | Volume of wastes would not be reduced; however, mobility of COCs would be moderately reduced. | Volume of wastes would not be reduced; however, mobility of COCs would be moderately reduced. | Volume or toxicity of COCs would not be reduced; however, significant reduction in mobility is expected. | Volume or toxicity of COCs would not be reduced; however, significant reduction in mobility is expected. | Volume or toxicity of COCs would not be reduced; however, significant reduction in mobility is expected. |
| **Short-term Effectiveness**<br>Protection of Surrounding Area During Reclamation Action | Not Applicable. | Fugitive emissions control may be required during construction | Fugitive emissions control may be required during construction | Fugitive emissions control may be required during construction | Fugitive emissions control may be required during construction | Fugitive emissions control may be required during construction |
| Protection of On-Site Workers During Reclamation Action | Not Applicable | Expected to be sufficient. Safety hazards likely more prevalent than hazards associated with wastes. | Expected to be sufficient. Safety hazards likely more prevalent than hazards associated with wastes. | Expected to be sufficient. Safety hazards likely more prevalent than hazards associated with wastes | Expected to be sufficient Safety hazards likely more prevalent than hazards associated with wastes. | Expected to be sufficient. Safety hazards likely more prevalent than hazards associated with wastes. |
| Environmental Impacts | Same as baseline conditions. | Same as baseline conditions. | Same as baseline conditions. | Same as baseline conditions. | Same as baseline conditions. | Same as baseline conditions. |
| Time Until Reclamation Action Objectives are Achieved | Not Applicable | One field season | One field season. | One field season following identification of an off-site repository/borrow location | One field season following identification of an off-site repository/borrow location. | One field season following construction of the Bald Butte repository/borrow location. |
| **Implementability** | | | | | | |
| Ability to Construct and Operate | No construction or operation involved. | Easily implementable | Easily implementable | Moderately implementable due to increased haul truck traffic | Moderately implementable due to increased haul truck traffic | Moderately implementable due to increased haul truck traffic |
| Ease of Implementing more action if necessary. | Not Applicable. | Easily implementable | Easily implementable | Easily implementable | Easily implementable | Easily implementable |
| Availability of Services and Capacities | Not Applicable. | Available locally and within state | Available locally and within state. | Available locally and within state. | Available locally and within state. | Available locally and within state |
| Availability of Equipment and Materials | Not Applicable. | Available locally and within state | Available locally and within state. | Available locally and within state. | Available locally and within state. | Available locally and within state. |
| **Estimated Capital Costs** | $0.00 | $621,652 | $721,701 | $1,582,205 | $1,863,983 | $960,761 |

Alternatives 5a, 5b and 6 offer greater long-term effectiveness when compared to Alternatives 4a and 4b. All three off-site alternatives are expected to significantly improve the water quality and sediment environment in Jennie's Fork. Future risks and impacts to the site would be eliminated by removing contaminant sources from the site and protecting them from disturbances caused by grazing, vehicles, and damage from ski area maintenance work.

The toxicity and volume of the waste sources would not be reduced by implementing any of the action alternatives; however, under Alternatives 5a, 5b and 6 the wastes would be permanently transported to a different physical location where they can be managed under established regulatory programs to ensure continued effectiveness. The effects of toxicity, mobility, and volume would be eliminated from the site.

Table 9-2 shows the overall cost comparison between the alternatives being considered, the amount of ecologic risk reduction, and the cost per 1% risk reduction for EQ risk. Alternative 6 would achieve the most risk reduction per dollar in comparison to the other alternatives.

### TABLE 9-2
### GREAT DIVIDE SAND TAILINGS SITE
### ALTERNATIVE COST-EFFECTIVENESS COMPARISON SUMMARY

| ALTERNATIVE | ECOLOGIC RISK REDUCTION | TOTAL COST | COST PER 1% REDUCTION IN ECOLOGIC RISK |
|---|---|---|---|
| Alternative 1 | 0% | $0 | $0 |
| Alternative 4a | 65% | $621,652 | $9,564 |
| Alternative 4b | 75% | $721,701 | $9,623 |
| Alternative 5a | 78% | $1,582,205 | $20,285 |
| Alternative 5b | 85% | $1,863,983 | $21,929 |
| Alternative 6 | 88% | $960,761 | $10,918 |

Required Risk Reduction:
Ecological – 83%

## 10.0 PREFERRED ALTERNATIVE

Based on the conclusions of the detailed analysis and comparative analysis of alternatives, Alternative 6: Consolidation in the Bald Butte DEQ Repository is recommended as the preferred alternative for the Great Divide Sand Tailings Site. In summary, this alternative involves excavation and disposal of the Great Divide Sand Tailings in a proposed repository to be constructed by the DEQ. The repository would be constructed to accommodate waste materials from the Bald Butte reclamation project and the Great Divide Sand Tailings Reclamation Project.

Under this alternative approximately 42,000 cy of tailings material would be disposed of in the proposed DEQ repository, including the upper slope, lower slope surficial tailings, and surficial tailings from the parking lot tiers.

Following removal of the tailings, one foot of cover soil would be backfilled in the excavation areas, amended, seeded, and mulched. Construction of three run-on/runoff control ditches would be completed in order to protect the reclaimed surfaces.

Also under this alternative, utilities within the entire tailings area will require relocation and replacement in order to facilitate tailings excavation at depths approaching 10.5 feet. Utilities anticipated to be in conflict include the slope lighting circuit, a tower communications line, a telephone line, water and power lines for the snow making system, and a 2,400v power main feeding the transformer located above the upper slope consolidated tailings area.

This alternative is projected to reduce ecological risk by 88%. The alternative would comply with all action-specific and location-specific ARARs. Alternative 6 is expected to provide sufficient risk reduction over the long term to meet the requirements of the risk assessment. Placement of the tailings materials in the DEQ repository would reduce the erosion and disturbance problems currently found at the site while allowing for long-term monitoring and protection programs at an engineered structure to ensure continued effectiveness.

## 11.0 REFERENCES

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Kevin Taylor March 31, 2006 personal conversation.

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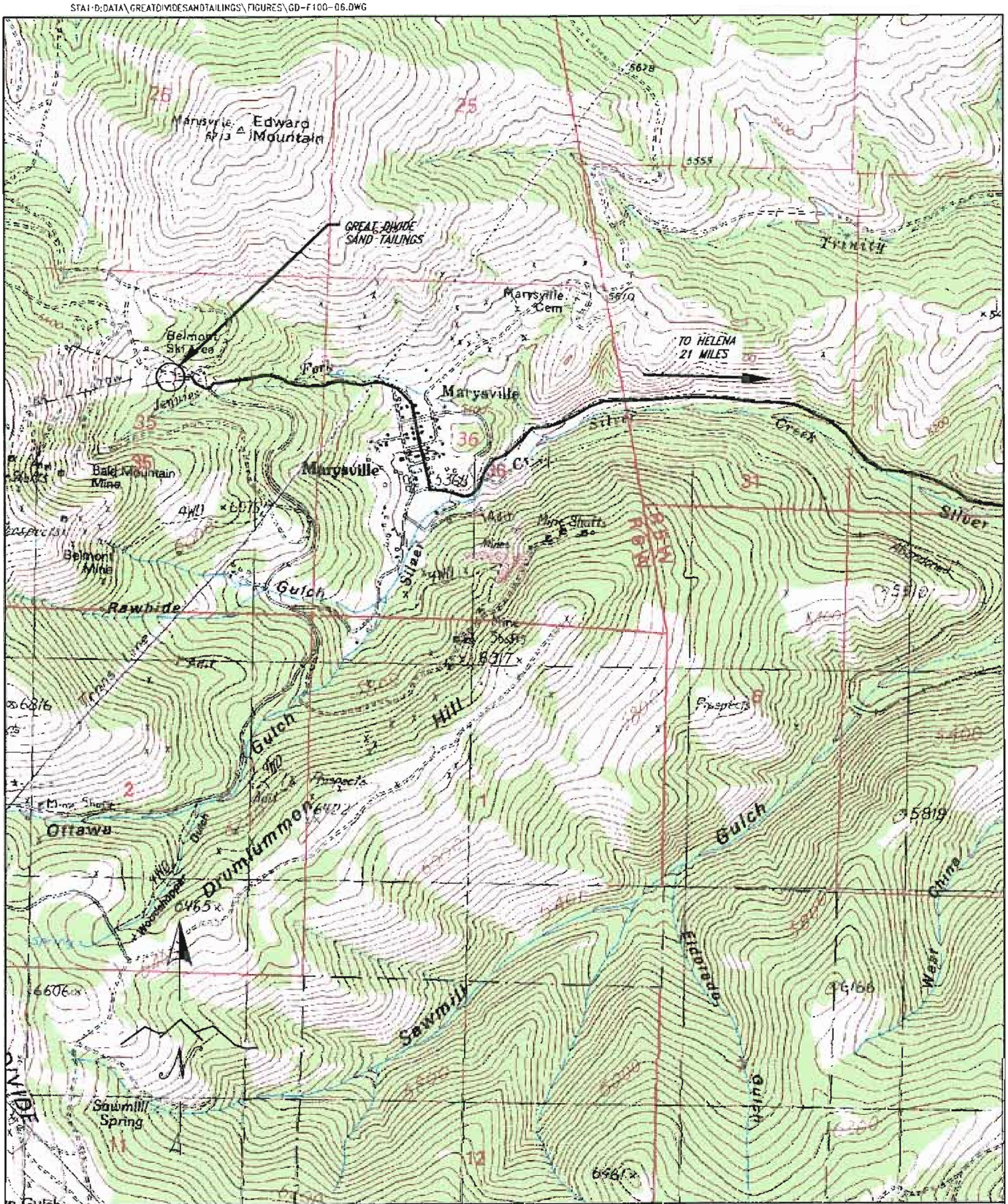
Walker, G.E., 1992. Geology and History of the Marysville Mining District and the Drumlummon Mine, Lewis and Clark County, Montana, Montana Bureau of Mines and Geology Open File Report 254, 27 p.

# FIGURES

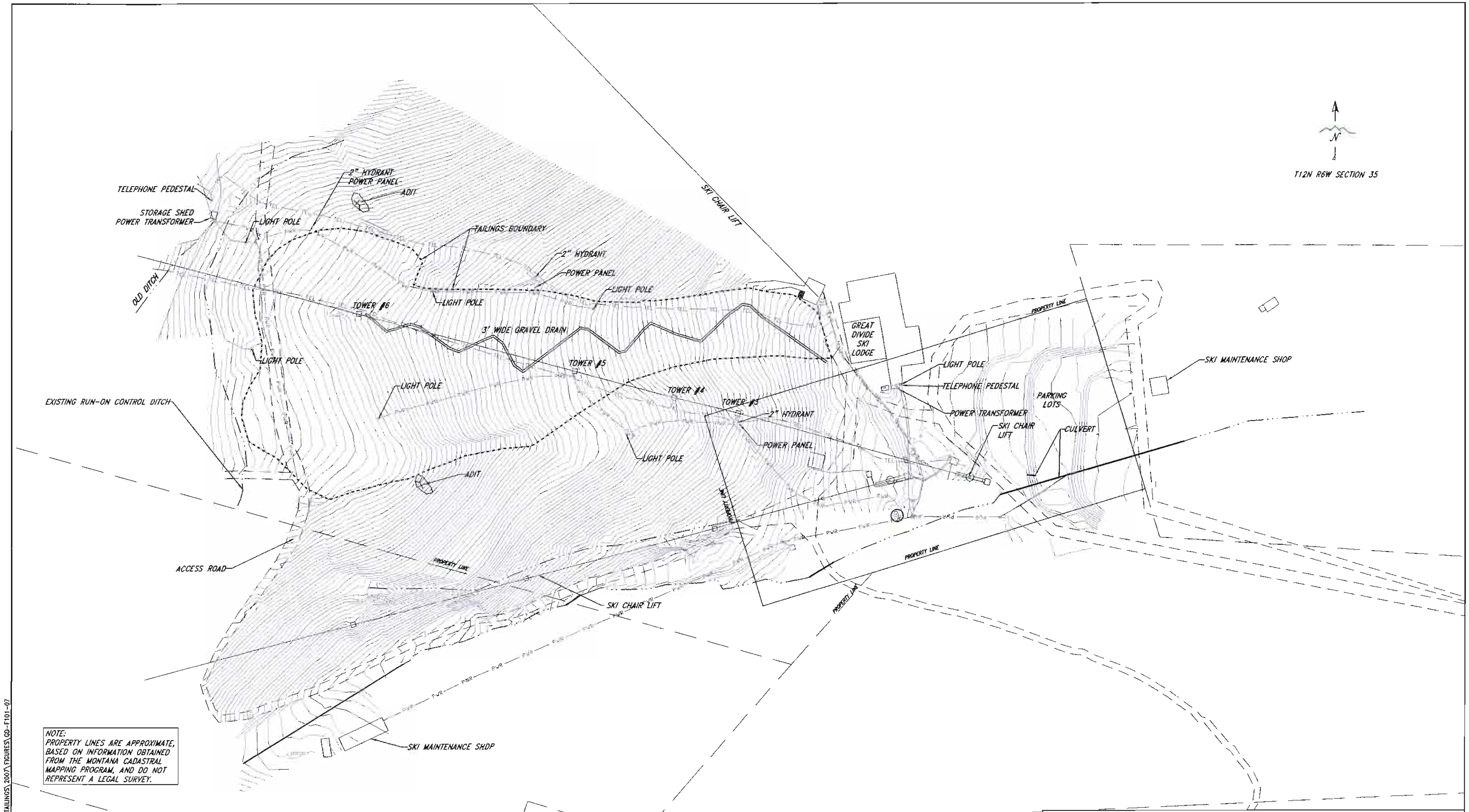
STA1-D:DATA\GREATDIVIDESANDTAILINGS\FIGURES\GD-F100-06.DWG



PIONEER TECHNICAL SERVICES, INC.

## FIGURE 1-1
## GREAT DIVIDE SAND TAILINGS
## GENERAL VICINITY MAP

SCALE: 1"=2000'
DATE: 11/01/07



NOTE:
PROPERTY LINES ARE APPROXIMATE, BASED ON INFORMATION OBTAINED FROM THE MONTANA CADASTRAL MAPPING PROGRAM, AND DO NOT REPRESENT A LEGAL SURVEY.

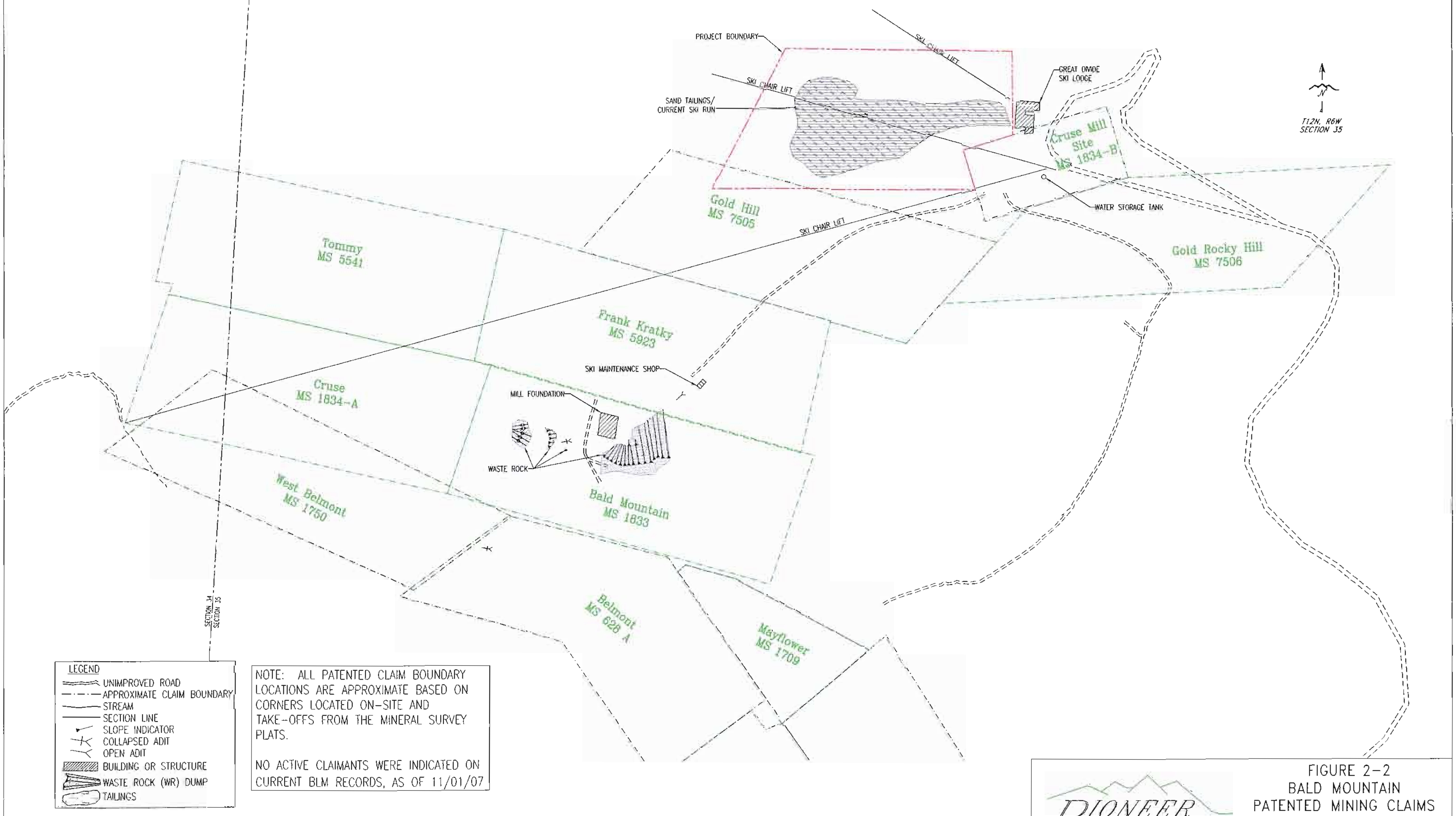
PIONEER TECHNICAL SERVICES, INC.

FIGURE 2-1
GREAT DIVIDE
SAND TAILINGS
SITE MAP

SCALE: 1"=150'
DATE: 11/01/07

STA1\D\DATA\GREATDIVIDESANDTAILINGS\2007\FIGURES\GD-F101-07

STA1:D:DATA\GREATDIVIDESANDTAILINGS\2007\FIGURES\GD-F104-07



NOTE: ALL PATENTED CLAIM BOUNDARY LOCATIONS ARE APPROXIMATE BASED ON CORNERS LOCATED ON-SITE AND TAKE-OFFS FROM THE MINERAL SURVEY PLATS.

NO ACTIVE CLAIMANTS WERE INDICATED ON CURRENT BLM RECORDS, AS OF 11/01/07

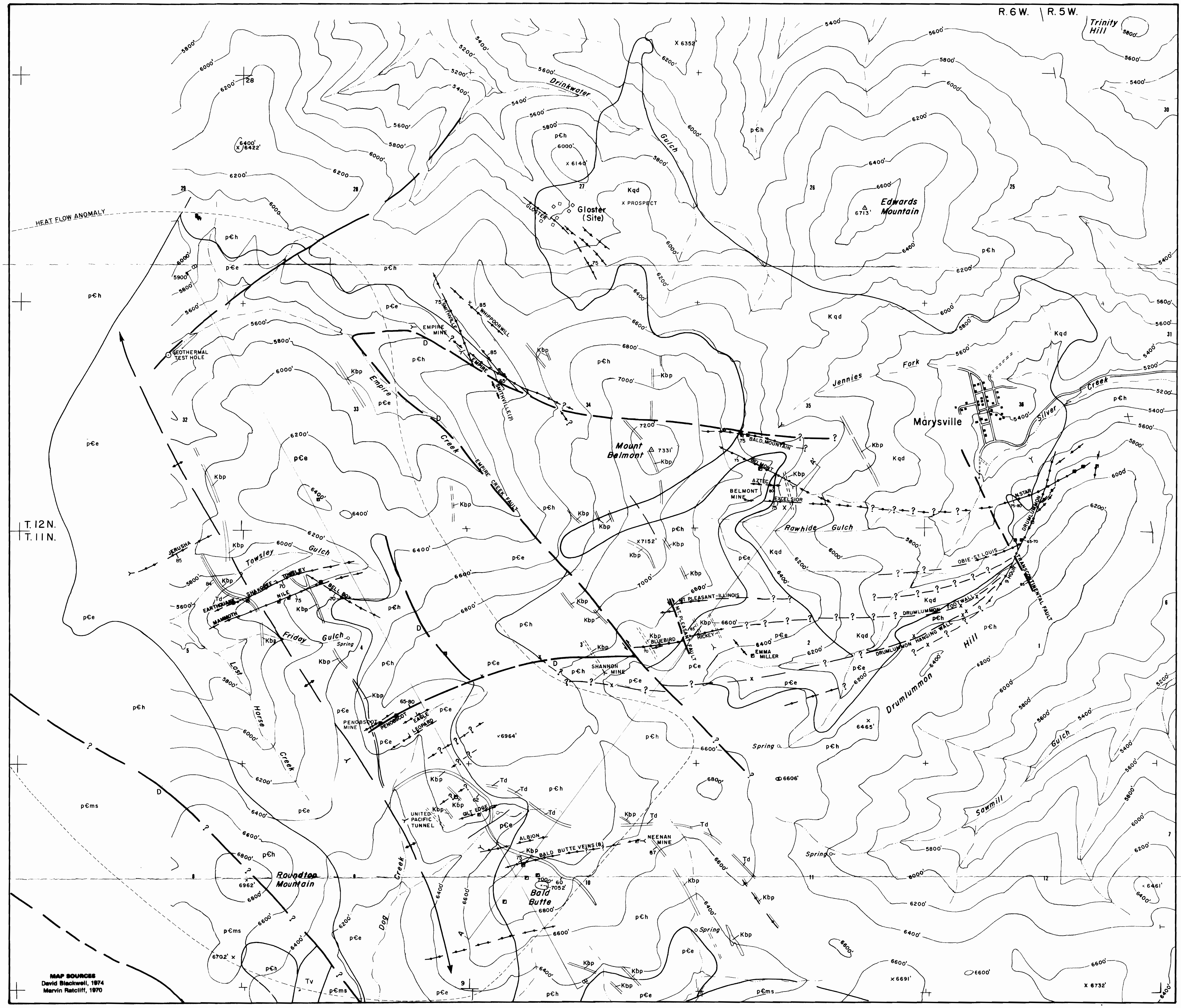
PIONEER
TECHNICAL SERVICES, INC.

FIGURE 2-2
BALD MOUNTAIN
PATENTED MINING CLAIMS

SCALE: 1"=400'
DATE: 11/01/07

MONTANA BUREAU OF MINES AND GEOLOGY
A Department of Montana College of Mineral Science and Technology

Open-file Report No. 284
Marysville Mining District
Giles E. Walker, 1982
Sheet 1 of 2



MAP SOURCES
David Blackwell, 1974
Marvin Ratcliff, 1970

0 100 200 300 400 500 Feet

# GEOLOGIC MAP OF THE MARYSVILLE MINING DISTRICT, MONTANA

by
Giles E. Walker

1982

## EXPLANATION

Contact, dashed where approximate
Vein
Vein, approximate
Fault, dashed where approximate; (D) downthrown side
Shaft
Adit
Section corner
Areas of prospect activity

### Intrusive rocks

Tertiary
- Td Hornblende diorite

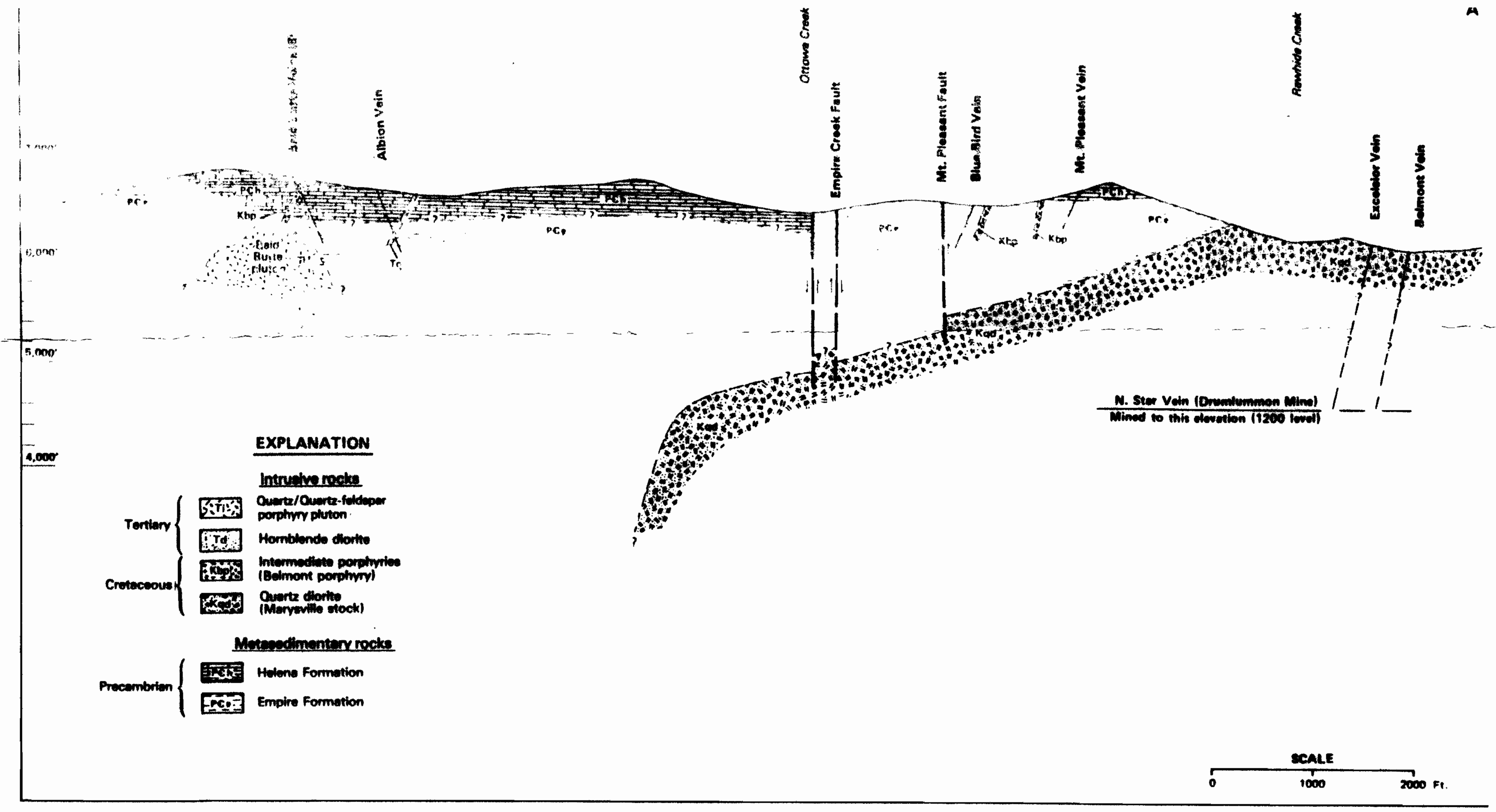
Cretaceous
- Kbp Belmont porphyry
- Kqd Quartz diorite (Marysville stock)

### Extrusive rocks

- Tv Volcanics (rhyolite)

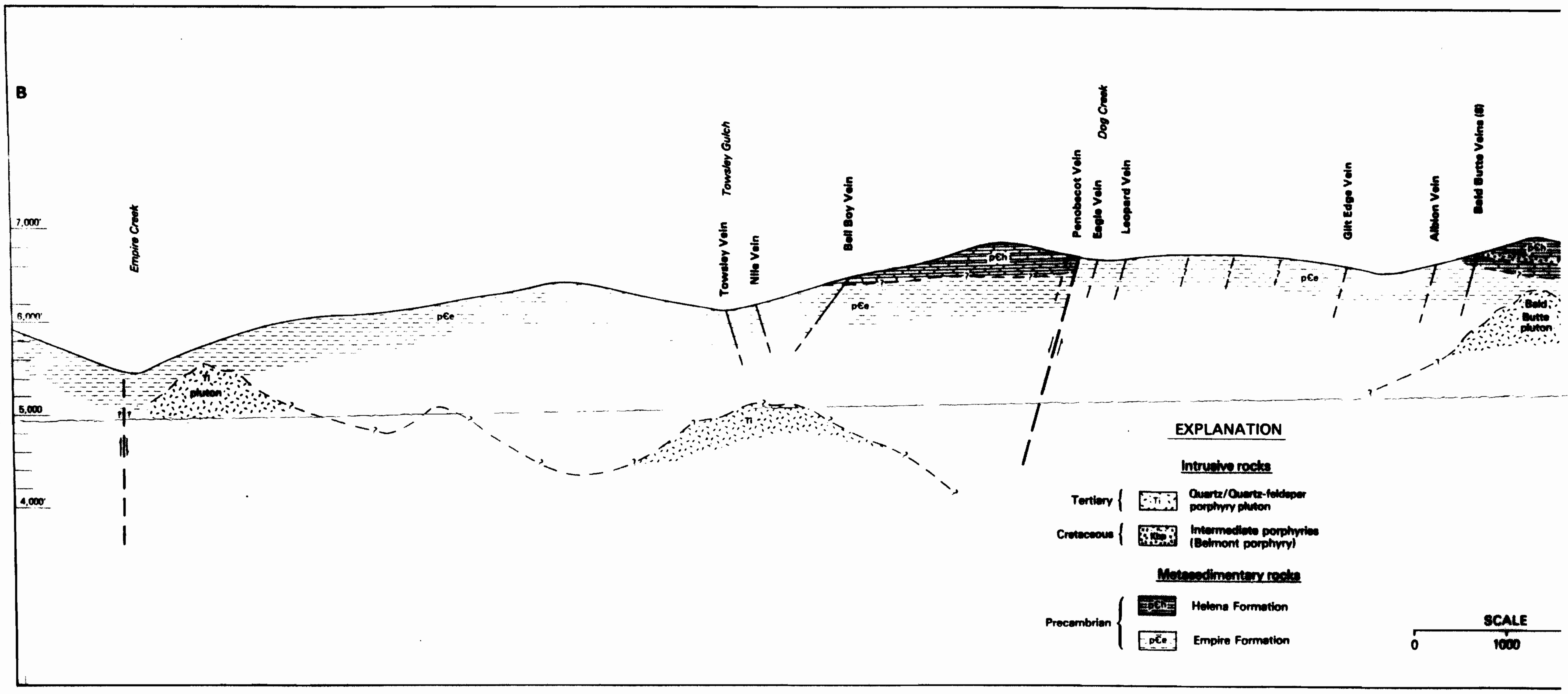
### Metasedimentary rocks

Precambrian
- PЄe Empire Formation
- PЄh Helena Formation
- PЄms Mount Shields Formation



Cross section A-A'

Bald Butte—Marysville stock



Cross section B-B'

Bald Butte—Empire Creek anticline

STA1\D\DATA\GREATDIVIDESANDTAILINGS\2007\FIGURES\GD-F103-07

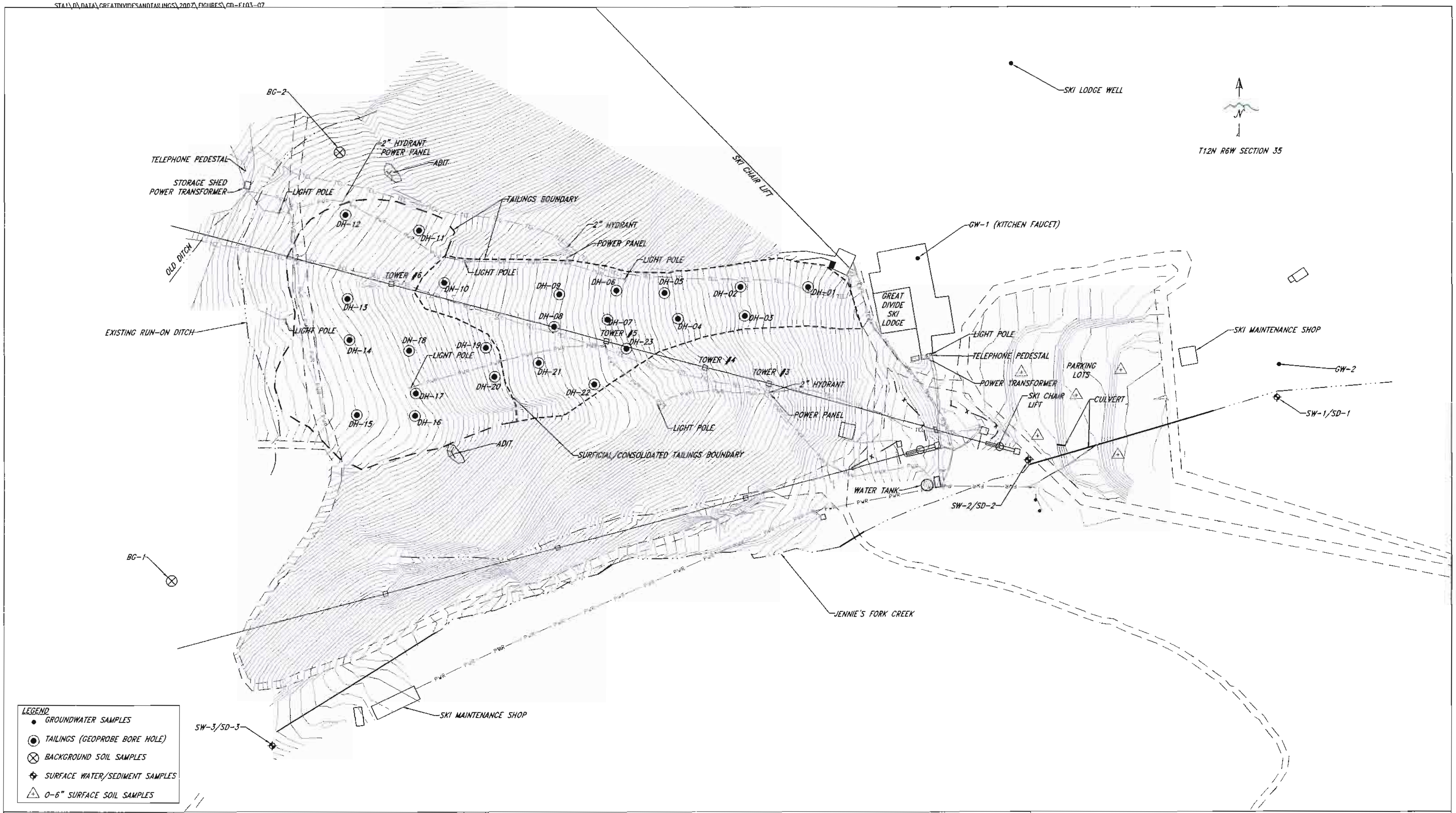


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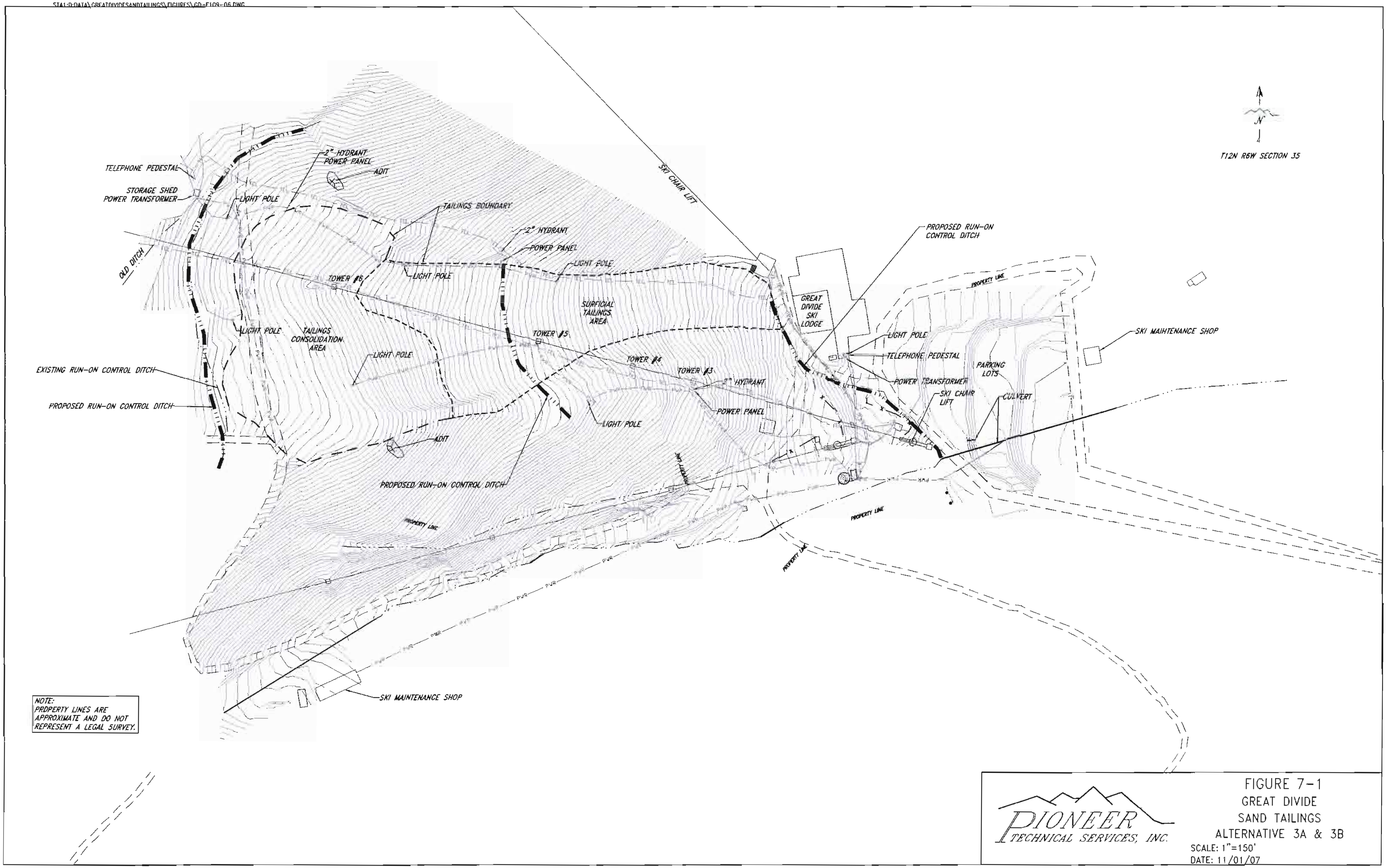
FIGURE 3-1
GREAT DIVIDE
SAND TAILINGS SITE
SAMPLE LOCATIONS

SCALE: 1"=150'
DATE: 11/01/07

STA1:D:DATA\GREATDIVIDESANDTAILINGS\FIGURES\GD-F109-06.DWG



NOTE:
PROPERTY LINES ARE
APPROXIMATE AND DO NOT
REPRESENT A LEGAL SURVEY.

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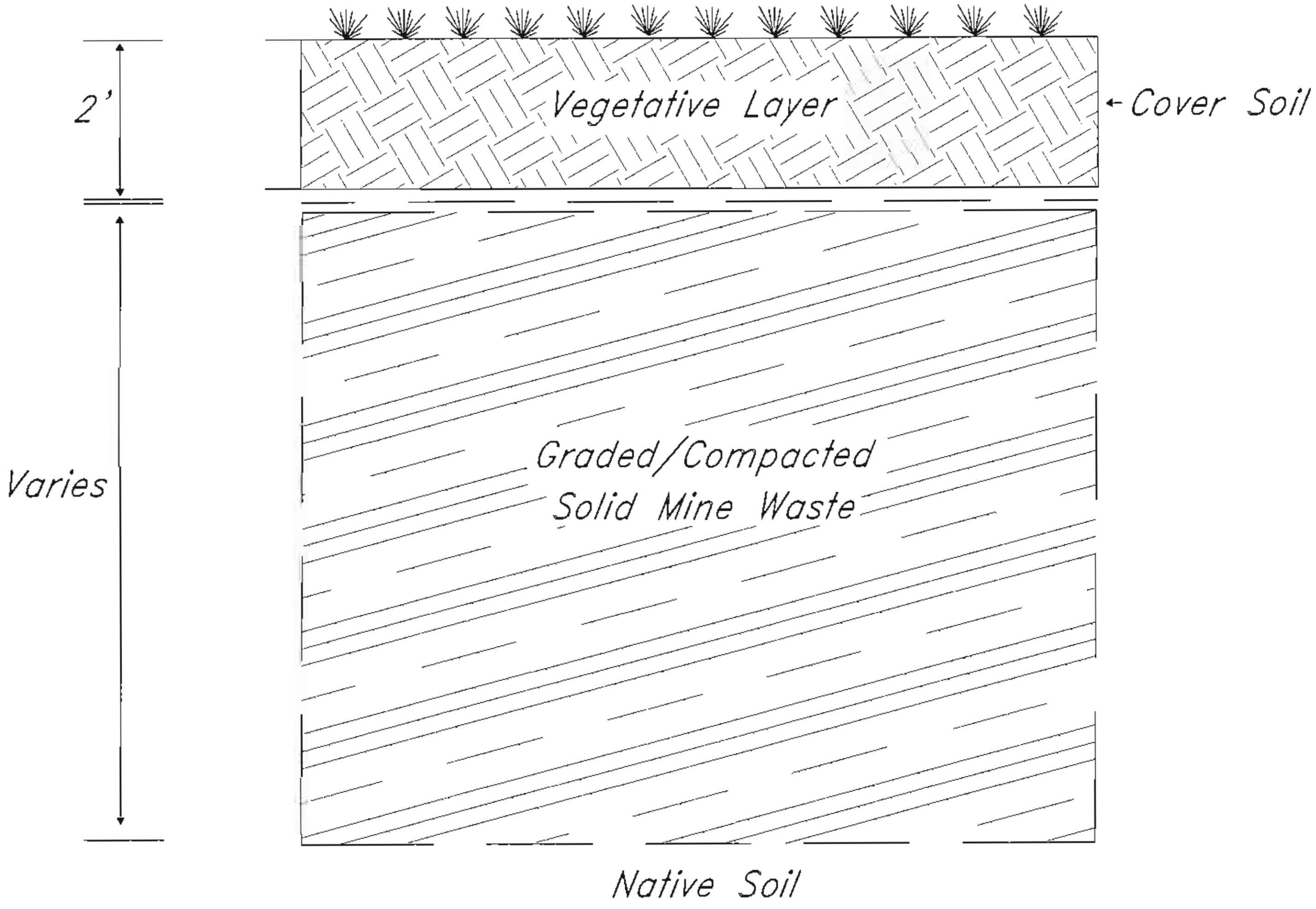
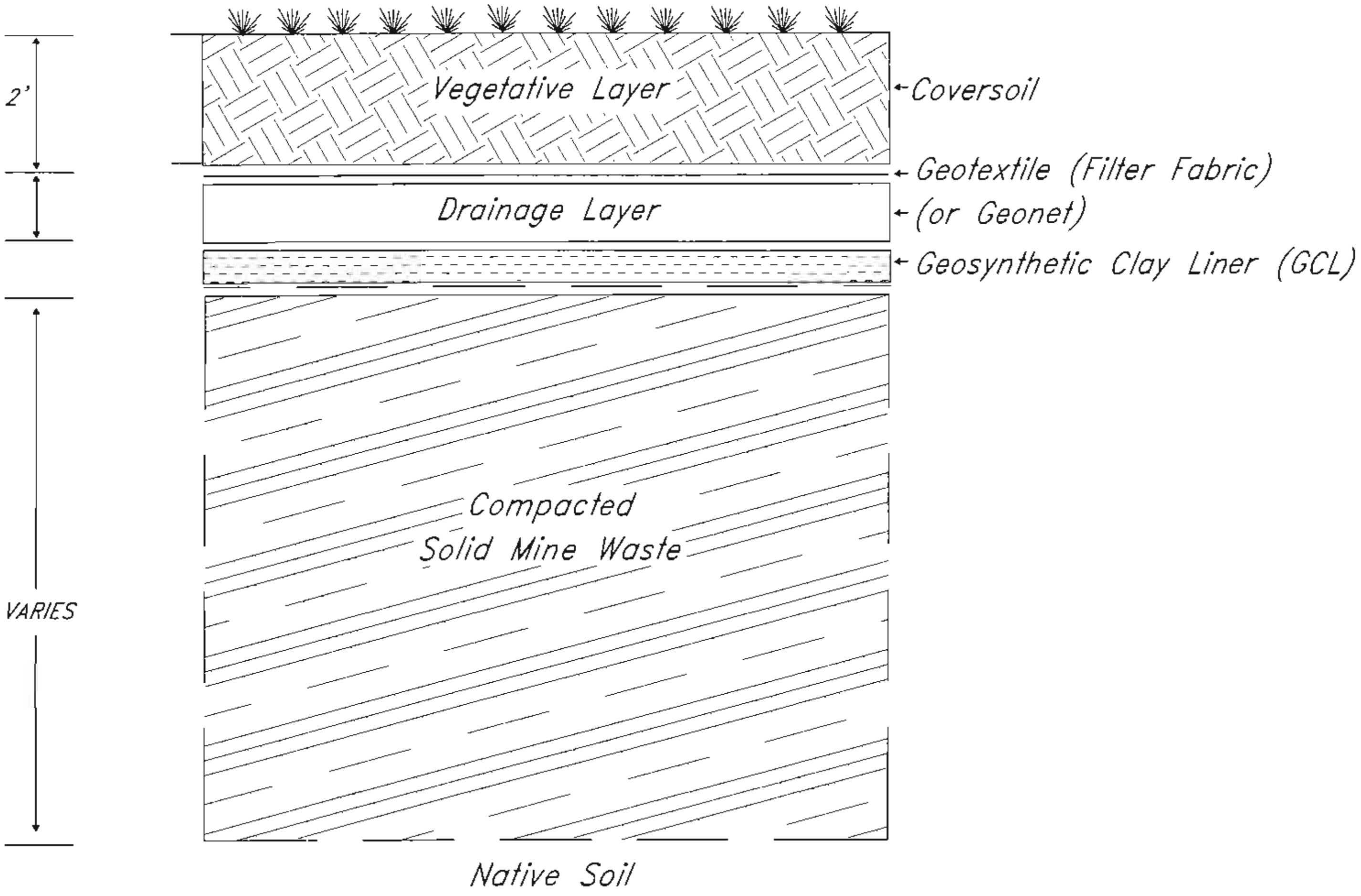
FIGURE 7-1
GREAT DIVIDE
SAND TAILINGS
ALTERNATIVE 3A & 3B
SCALE: 1"=150'
DATE: 11/01/07



PIONEER TECHNICAL SERVICES, INC.

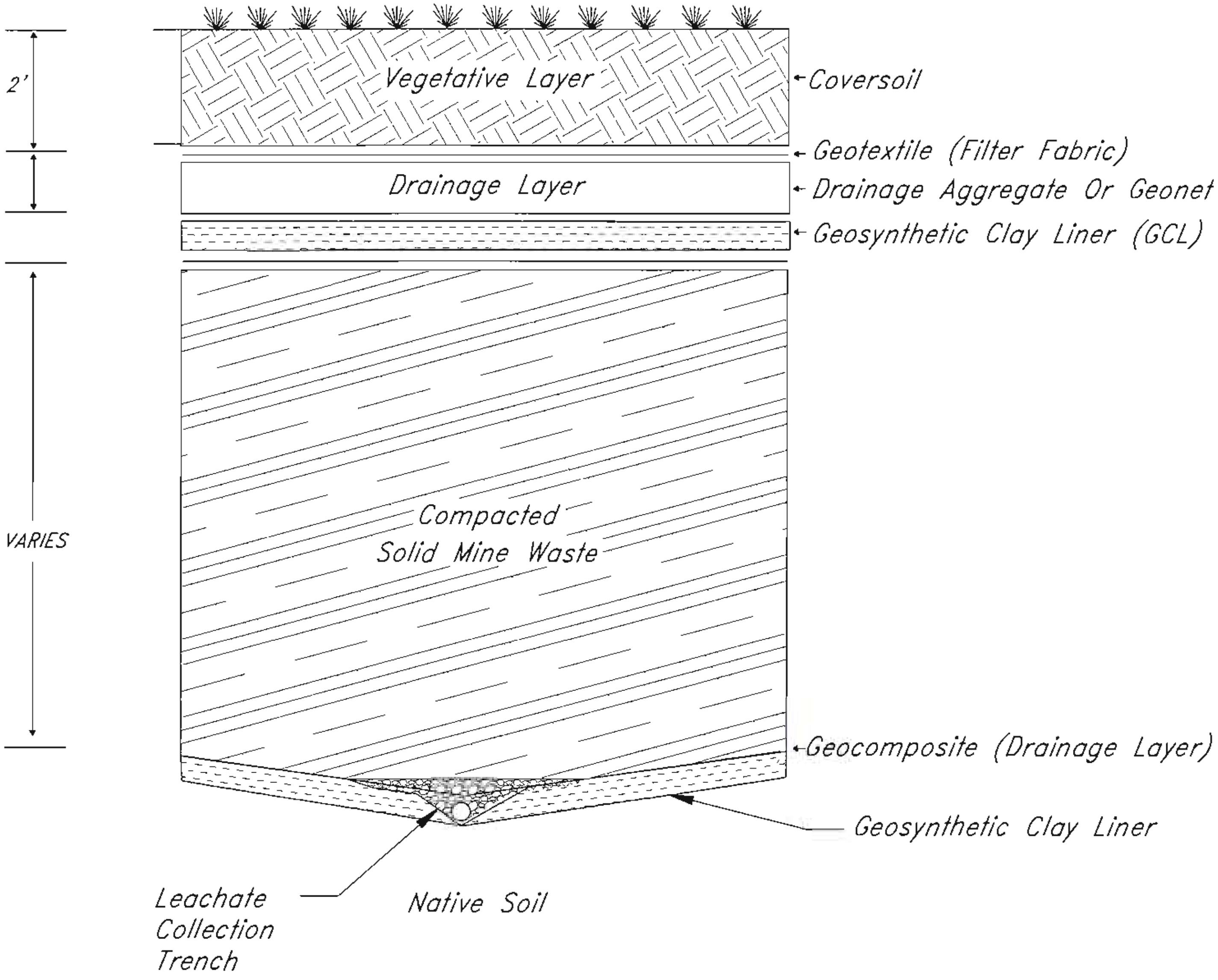
FIGURE 7-2
GREAT DIVIDE SAND TAILINGS
ALTERNATIVE 4a, 4b, & 5a
TYPICAL REPOSITORY SECTION
SCALE: N.T.S.
DATE: 11/01/07



PIONEER TECHNICAL SERVICES, INC.

FIGURE 7-3
GREAT DIVIDE SAND TAILINGS
ALTERNATIVE 5b
TYPICAL REPOSITORY SECTION
SCALE: N.T.S.
DATE: 11/01/07

STA1\D\DATA\GREATDIVIDESANDTAILINGS\FIGURES\GD-F108-06



PIONEER
TECHNICAL SERVICES, INC.

FIGURE 7-4
GREAT DIVIDE SAND TAILINGS
ALTERNATIVE 5c
TYPICAL REPOSITORY SECTION
SCALE: N.T.S.
DATE: 11/01/07

# APPENDIX A

# GREAT DIVIDE SAND TAILINGS SITE SPECIES OF CONCERN

MONTANA
Natural Heritage
Program

SEARCH GO HOME | ANIMALS | PLANTS | ECOLOGY | PUBLICATIONS | REQ

# Species of Concern

The Montana Natural Heritage Program serves as Montana's source of information for Species Concern — plants and animals that are at risk or potentially at risk. Use the search options on t generate current lists of species of concern for the state, counties, watersheds or townships. Yo filter your request by plant or animal groups as well as by Natural Heritage Program global and ranks, and federal agency status.

# Species of Concern Report

*2 Species found with the following criteria:*
*Township = 012 N Range = 006 W*

*Report Date: 5/25/2006 11:03:59 AM*

**▼ Birds**

| Scientific Name | Common Name | Nature Serve | GLOBAL Rank | STATE Rank | USFWS | USFS | BLM |
|---|---|---|---|---|---|---|---|
| Contopus cooperi | Olive-sided Flycatcher | 🦋 | G4 | S3B | | | |

**▼ Mammals**

| Scientific Name | Common Name | Nature Serve | GLOBAL Rank | STATE Rank | USFWS | USFS | BLM |
|---|---|---|---|---|---|---|---|
| Lynx canadensis | Lynx | 🦋 | G5 | S3 | LT | THREATENED | SPECIAL STATUS |

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Please send comments to: mtnhp@mt.gov

**Montana Natural Heritage Program**
PO Box 201800, 1515 East Sixth Avenue,
Helena, MT 59620-1800
Voice: (406) 444-5354 Fax: (406) 444-0581

Data Source: BIOTICS® Database Updated: Nightly

MONTANA
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SEARCH GO HOME | ANIMALS | PLANTS | ECOLOGY | PUBLICATIONS | REQ

# Species of Concern

The Montana Natural Heritage Program serves as Montana's source of information for Species Concern — plants and animals that are at risk or potentially at risk. Use the search options on t generate current lists of species of concern for the state, counties, watersheds or townships. Yo filter your request by plant or animal groups as well as by Natural Heritage Program global and ranks, and federal agency status.

## Species of Concern Report

*4 Species found with the following criteria:*
*Township = 011 N Range = 006 W*

*Report Date: 5/25/2006 11:14:24 AM*

**Birds**

| Scientific Name | Common Name | Nature Serve | GLOBAL Rank | STATE Rank | USFWS | USFS | BLM |
|---|---|---|---|---|---|---|---|
| Contopus cooperi | Olive-sided Flycatcher | 🦋 | G4 | S3B | | | |
| Numenius americanus | Long-billed Curlew | 🦋 | G5 | S2B | | | SENSITIVE |

**Fish**

| Scientific Name | Common Name | Nature Serve | GLOBAL Rank | STATE Rank | USFWS | USFS | BLM |
|---|---|---|---|---|---|---|---|
| Oncorhynchus clarkii lewisi | Westslope Cutthroat Trout | 🦋 | G4T3 | S2 | | SENSITIVE | SENSITIVE |

**Mammals**

| Scientific Name | Common Name | Nature Serve | GLOBAL Rank | STATE Rank | USFWS | USFS | BLM |
|---|---|---|---|---|---|---|---|
| Lynx canadensis | Lynx | 🦋 | G5 | S3 | LT | THREATENED | SPECIAL STATUS |

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# Species of Concern

The Montana Natural Heritage Program serves as Montana's source of information for Species Concern — plants and animals that are at risk or potentially at risk. Use the search options on t generate current lists of species of concern for the state, counties, watersheds or townships. Yo filter your request by plant or animal groups as well as by Natural Heritage Program global and ranks, and federal agency status.

# Species of Concern Report

*6 Species found with the following criteria:*
*Township = 012 N Range = 005 W*

*Report Date: 5/25/2006 11:16:23 AM*

**▼ Birds**

| Scientific Name | Common Name | Nature Serve | GLOBAL Rank | STATE Rank | USFWS | USFS | BLM |
|---|---|---|---|---|---|---|---|
| Dolichonyx oryzivorus | Bobolink | 🦋 | G5 | S2B | | | |
| Melanerpes lewis | Lewis's Woodpecker | 🦋 | G4 | S2B | | | |
| Numenius americanus | Long-billed Curlew | 🦋 | G5 | S2B | | | SENSITIVE |
| Oreoscoptes montanus | Sage Thrasher | 🦋 | G5 | S3B | | | SENSITIVE |
| Spizella breweri | Brewer's Sparrow | 🦋 | G5 | S2B | | | SENSITIVE |

**▼ Mammals**

| Scientific Name | Common Name | Nature Serve | GLOBAL Rank | STATE Rank | USFWS | USFS | BLM |
|---|---|---|---|---|---|---|---|
| Lynx canadensis | Lynx | 🦋 | G5 | S3 | LT | THREATENED | SPECIAL STATUS |

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# Species of Concern

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# Species of Concern Report

*2 Species found with the following criteria:*
*Township = 012 N Range = 007 W*

*Report Date: 5/25/2006 11:17:03 AM*

**▼ Birds**

| Scientific Name | Common Name | Nature Serve | GLOBAL Rank | STATE Rank | USFWS | USFS | BLM |
|---|---|---|---|---|---|---|---|
| Contopus cooperi | Olive-sided Flycatcher | 🦋 | G4 | S3B | | | |

**▼ Mammals**

| Scientific Name | Common Name | Nature Serve | GLOBAL Rank | STATE Rank | USFWS | USFS | BLM |
|---|---|---|---|---|---|---|---|
| Lynx canadensis | Lynx | 🦋 | G5 | S3 | LT | THREATENED | SPECIAL STATUS |

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# APPENDIX B

# GREAT DIVIDE SAND TAILINGS SITE LABORATORY ANALYTICAL REPORTS

# TABLE B-1
# GREAT DIVIDE SAND TAILINGS
# PREVIOUS SOIL DATA

| Sample ID | Sample Date | Sample Description | As mg/kg | Cd mg/kg | Cr mg/kg | Cu mg/kg | Pb mg/kg | Hg mg/kg | Zn mg/kg | CN mg/kg |
|---|---|---|---|---|---|---|---|---|---|---|
| S-1 | Oct-91 | Sample depth 5.5 - 6.0 feet (Chen Northern). | 12.9 | 2 | 7 | 93 | 90 | 0.94 | 120 | 1.4 |
| S-1 | Oct-91 | Sample depth 9.5 - 10.0 feet (Chen Northern). | 16 | 2.3 | 8 | 60 | 125 | 19.9 | 168 | 15.0 |
| S-2 | Oct-91 | Sample depth 5.5 - 6.0 feet. (Chen Northern) | 28.7 | 2 | 8 | 304 | 279 | 0.6 | 446 | 2.6 |
| S-2 | Oct-91 | Sample depth 9.5 - 10.0 feet (Chen Northern). | 13.5 | 1.5 | 8 | 51 | 69 | 0.5 | 120 | 0.06 U |
| 25-167-TP-1 | Aug-93 | Composite Samples (Pioneer) | 28.0 | 1 UJ | 2.9 J | 56.8 | 48.4 | 1.9 | 230 | NA |
| 25-167-TP-2 | Aug-93 | Composite Samples (Pioneer) | 32.2 | 0.7 UJ | 2.6 J | 38.1 | 38 | 0.46 | 208 | <0.27 |
| Background | Aug-93 | From Empire Mill Site (25-175-SS-1) | 38.0 J | 0.5 UJ | 14.1 | 49.7 | 80 | 0.12 | 153 | NA |
| **Total Mercury Analysis Only (Chen Northern, 1992)** | | | | | | | | | | |
| **Sample ID** | **Sample Date** | **Sample Depth (feet)** | | | | | | | | |
| GD-20 | Jun-92 | 0-2 | | | | | | 0.7 | | |
| | | 2-4 | | | | | | 1.4 | | |
| | | 4-6 | | | | | | 1.2 | | |
| | | 6-8 | | | | | | 3.2 | | |
| | | 8-10 | | | | | | 2.3 | | |
| | | 10.5-11 | | | | | | 3.8 | | |
| GD-21 | Jun-92 | 0-2 | | | | | | 0.2 | | |
| | | 2-4 | | | | | | 2.0 | | |
| | | 4-6 | | | | | | 1.7 | | |
| | | 6-8 | | | | | | 0.8 | | |
| | | 8.5-9.5 | | | | | | 4.6 | | |
| GD-22 | Jun-92 | 0-2 | | | | | | 1 | | |
| | | 2-4 | | | | | | 1.9 | | |
| | | 4-5 | | | | | | 2 | | |
| | | 5-6 | | | | | | 0.0 | | |
| GD-23 | Jun-92 | 0-2 | | | | | | 0.2 | | |
| | | 2-2.3 | | | | | | 0.2 | | |
| GD-24 | Jun-92 | 0-2 | | | | | | 1.8 | | |
| | | 2-3.3 | | | | | | 0.3 | | |
| | | 3.3-3.8 | | | | | | 0.6 | | |

Pioneer Technical Services, Inc. 1993
Chen Northern Inc. 1994
U - Not Detected, J - Estimated Quantity
NA - Not sampled
mg/kg - milligrams per kilogram

## TABLE B-2
## GREAT DIVIDE SAND TAILINGS
## TOTAL METALS SURFACE WATER DATA

| Sample ID | Sample Date | Time Sampled | Sample Description | Sb ug/L | As ug/L | Ba ug/L | Cd ug/L | Cr ug/L | Cu ug/L | Fe ug/L | Pb ug/L | Mn ug/L | Hg ug/L | Ni ug/L | Ag ug/L | Zn ug/L | Hardness mg $CaCO_3$/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| UPSTREAM SAMPLES | | | **Samples Collected Upstream of Sources** | | | | | | | | | | | | | | |
| GD-SW03-050206 | May-06 | 14:45 | Collected approximately 600 yards Southwest of tailings from Jenny's fork, approximately 100 yards upgradient of shop area. | < 5 | < 5 | < 100 | < 1 | < 10 | < 10 | < 30 | < 10 | < 10 | < 0.1 | < 10 | < 5 | 30 | |
| HARDNESS | Feb-06 | | Montana Numeric Water Quality Standard (DEQ-7) (February 2006) corrected for hardness (Acute). | NA | NA | NA | 2.63 | NA | 17.0 | NA | 106 | NA | NA | 6.15 | 5.79 | 143 | **123** |
| Sample ID | Sample Date | Time Sampled | Sample Description | | | | | | | | | | | | | | Hardness mg $CaCO_3$/L |
| DOWNSTREAM SAMPLES | | | **Samples Collected Downstream of Sources** | | | | | | | | | | | | | | |
| GD-SW01-050206 | May-06 | 13:45 | Collected approximately 60 yards downgradient (east) of parking lots. | < 5 | < 5 | < 100 | < 1 | < 10 | < 10 | 420 | < 10 | 40 | < 0.1 | < 10 | < 0.005 | 10 | 115 |
| GD-SW02-050206 | May-06 | 15:30 | Collected approximately 10 feet north of Jenny's Fork culvert in Southwest corner of upper parking lot. Main Surface water flow from tailings area (snow melt). | < 5 | 12 | 200 | < 1 | < 10 | 30 | 10,800 | 40 | 780 | 0.6 | < 10 | 8 | 100 | 96 |
| HARDNESS | Feb-06 | | Montana Numeric Water Quality Standard (DEQ-7) (February 2006) corrected for hardness (Acute). | NA | NA | NA | 2.0 | NA | 13.5 | NA | 77.5 | NA | NA | 5.0 | 3.8 | 116 | 96 |
| MONTANA NUMERIC WATER QUALITY STANDARDS (WQB-7) (December 2002) | | | Aquatic Life Standard (Acute)<br>Human Health Standard (Surface Water) | --<br>5.6 | 340<br>10 | --<br>2,000 | -- A<br>5 | --<br>100 | -- A<br>1,300 | – b<br>300 b | -- A<br>15 | 50 C<br>50 C | 1.7<br>0.05 | -- A<br>100 | A<br>100 | – A<br>2,000 | |

NA - Not Available

ug/L - micrograms per Liter

A - Concentration value based on hardness No sample shall exceed these concentrations after corrected for hardness

b - The concentration of iron must not reach values that interfere with the uses specified in the surface and groundwater standards (17 30.601 et seq and 17 30 1001 et seq )

The Secondary Maximum Contaminant Level of 300 micrograms per Liter which is based on aesthetic properties such as taste, odor, and staining may be considered as guidance to determine the levels that will interfere with the specified uses

C- The concentration of manganese must not reach values that interfere with the uses specified in the surface and groundwater standards (17 30 601 et seq and 17 30 1001 et seq )

The Secondary Maximum Contaminant Level of 50 micrograms per Liter which is based on aesthetic properties such as taste, odor, and staining may be considered as guidance to determine the levels that will interfere with the specified uses

## TABLE B-3
## GREAT DIVIDE SAND TAILINGS
## DISSOLVED METALS GROUNDWATER WATER DATA

| Sample ID | Sample Date | Time Sampled | Sample Description | Sb ug/L | As ug/L | Ba ug/L | Cd ug/L | Cr ug/L | Cu ug/L | Fe ug/L | Pb ug/L | Mg ug/L | Mn ug/L | Hg ug/L | Ni ug/L | Ag ug/L | Zn ug/L | Hardness mg $CaCO_3$/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **UPSTREAM SAMPLES** | | | **Samples Collected Upstream of Sources** | | | | | | | | | | | | | | | |
| GD-GW01-080306 | 8/3/06 | 10:45 | Collected from kitchen faucet of ski lodge. | < 5 | < 5 | < 100 | < 1 | < 10 | 20 | < 30 | < 10 | 3000 | < 10 | < 0.1 | < 10 | < 5 | < 10 | 102 |
| **Sample ID** | **Sample Date** | **Time Sampled** | **Sample Description** | | | | | | | | | | | | | | | **Hardness mg $CaCO_3$/L** |
| **DOWNSTREAM SAMPLES** | | | **Samples Collected Downstream of Sources** | | | | | | | | | | | | | | | |
| GD-GW02-080306 | 8/3/06 | 12:50 | Collected approximately 60 yards downgradient (east) of parking lots. | < 5 | < 5 | < 100 | < 1 | < 10 | < 10 | < 30 | < 10 | 5000 | < 10 | < 0.1 | < 10 | < 5 | < 10 | 121 |
| GD-GW02T-080306 | 8/3/06 | 13:05 | QA/QC duplicate sample. Collected approximately 60 yards downgradient (east) of parking lots | < 5 | < 5 | < 100 | < 1 | < 10 | < 10 | < 30 | < 10 | 5000 | < 10 | < 0.1 | < 10 | < 5 | < 10 | 128 |

NA - Not Available
ug/L - micrograms per Liter

# TABLE B-4
# GREAT DIVIDE SAND TAILINGS
# WET CHEMISTRY RESULTS & FIELD MEASUREMENTS

| Sample ID | Sample Date | Sample Time | Sample Description | pH SU | Dissolved Oxygen mg/L | TDS mg/L | Calcium mg/L | Magnesium mg/L | $NO_3/NO_2$ - N mg/L | SC mS/cm | Hardness mg $CaCO_3$/L | Temp °C | Turbidity NTU | Flow Est. ($ft^3$/sec) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **UPSTREAM SAMPLES** | | | **Samples Collected Upstream of Sources** | | | | | | | | | | | |
| GD-SW03-050206 | May-06 | 14:45 | Collected approximately 600 yards Southwest of tailings from Jenny's fork, approximately 100 yards upgradient of shop area. | 7.95 | 7.34 | 165 | 39 | 4 | 0.8 | 220 | 115 | 8.4 | 18 | 0.22 |
| GD-GW01-080306 | 8/3/06 | 10:45 | Collected from kitchen faucet of ski lodge. | 6.24 | 5.47 | 141 | 35 | 3 | 0 44 | 202 | 102 | 11.7 | 0.24 | NA |
| **DOWNSTREAM SAMPLES** | | | **Samples Collected Downstream of Sources** | | | | | | | | | | | |
| GD-SW01-050206 | May-06 | 13:45 | Collected approximately 60 yards downgradient (east) of parking lots. | 7.61 | 6.99 | 165 | 39 | 4 | 0.8 | 219 | 115 | 6.3 | 18 | 0.30 |
| GD-SW02-050206 | May-06 | 15:30 | Collected approximately 10 feet north of Jenny's Fork culvert in Southwest corner of upper parking lot. Main Surface water flow from tailings area (snow melt). | 7.95 | 7.47 | 144 | 32 | 4 | 0.56 | 179.5 | 96 | 8.8 | 200 | 0.11 |
| GD-GW02-080306 | 8/3/06 | 12:50 | Collected approximately 60 yards downgradient (east) of parking lots. | 6.5 | 7.49 | 167 | 40 | 5 | 1.31 | 229 | 121 | 7.5 | 0.5 | NA |
| GD-GW02T-080306 | 8/3/06 | 13:05 | QA/QC duplicate sample. Collected approximately 60 yards downgradient (east) of parking lots. | 6.5 | 7.49 | 168 | 43 | 5 | 1.3 | 229 | 128 | 7.5 | 0.4 | NA |

mg/L - milligrams per Liter
SU - standard units
TDS - Total Dissolved Solids
mS/cm - microSiemens per centimeter
mg/L $CaCO_3$ - milligrams per Liter calcium carbonate
NTU - Nephelometric Turbidity Unit
$ft^3$/sec - cubic feet per second

### TABLE B-5
### GREAT DIVIDE SAND TAILINGS
### STREAM SEDIMENTS SAMPLING DATA

| Sample ID | Sample Date | Sample Time | Sample Description | Sb mg/kg | As mg/kg | Ba mg/kg | Cd mg/kg | Cr mg/kg | Cu mg/kg | Fe mg/kg | Pb mg/kg | Mn mg/kg | Hg mg/kg | Ni mg/kg | Ag mg/kg | Zn mg/kg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **UPSTREAM SAMPLES** | | | **Samples Collected Upstream of Sources** | | | | | | | | | | | | | |
| GD-SD03-050206 | May-06 | 14:45 | Collected approximately 600 yards Southwest of tailings from Jenny's fork, approximately 100 yards upgradient of shop area. | < 5.0 | 13.1 | 35.6 | < 1.0 | < 5.0 | 10.1 | 12,300 D | 9.8 | 325 | < 1 | < 5 | < 5 | 311 |
| **DOWNSTREAM SAMPLES** | | | **Samples Collected Downstream of Sources** | | | | | | | | | | | | | |
| GD-SD01-050206 | May-06 | 13:45 | Collected approximately 60 yards downgradient (east) of parking lots. | < 5.0 | 11 | 41.4 | < 1.0 | < 5 | 50.3 | 9,250 D | 70.2 | 1250 | < 1 | < 5 | 12.9 | 117 |
| GD-SD02-050206 | May-06 | 15:30 | Collected approximately 10 feet north of Jenny's Fork culvert in Southwest corner of upper parking lot. Main Surface water flow from tailings area (snow melt). | < 5.0 | 25 | 48.8 | < 1.0 | 6.6 | 125 | 19,900 D | 169 | 2090 | < 1 | < 5 | 35.2 | 178 |
| **COMPARISON CRITERIA** | | | National Sediment Quality Survey (NSQS) (EPA, 2004) T50 Effect Concentration | -- | **32.6** | -- | -- | -- | **157** | -- | **161** | -- | **0.87** | – | **2.45** | **384** |

mg/kg - milligrams per kilogram
D - Analyte reporting limit increased due to sample matrix interference
NA - Not sampled

## TABLE B-6
## GREAT DIVIDE SAND TAILINGS
## SUPPLEMENTAL SAMPLING SOLID MEDIA DATA

| Sample ID | Sample Date | Sample Time | Sample Description | Sb mg/kg | As mg/kg | Cd mg/kg | Cr mg/kg | Cu mg/kg | Fe mg/kg | Pb mg/kg | Mn mg/kg | Hg mg/kg | Ni mg/kg | Ag mg/kg | Zn mg/kg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Background** | | | | | | | | | | | | | | | |
| GD-BG-1-071106 | 7/11/2006 | 7:30 | 12-point composite collected upgradient (west) of tailings area. | < 5 | 5.2 | < 1 | 8.3 | 11.8 | 19000 | 9.7 | 680 | < 1 | 5.9 | < 5 | 65.4 |
| GD-BG-2-071106 | 7/11/2006 | 8:05 | 15-point composite collected north of tailings area. | < 5 | 16.9 | < 1 | 5.9 | 37.7 | 18000 | 60.4 | 1160 | < 1 | < 5 | < 5 | 135 |
| | | | **Average Background Concentration** | | **11.1** | | 7.1 | **24.8** | **18500** | **35.1** | **920** | **< 1** | **5.5** | **< 5** | **100.2** |
| **Surficial Tailings Area** | | | | | | | | | | | | | | | |
| DH1A-71006 | 07/11/06 | 16:00 | Composite of DH-1 through DH-10; 0 to 6-inches. | < 5 | 17 | < 1 | 12.6 | 40 | 16100 | 38 | 645 | 2.2 | 11.4 | 5.8 | 78.6 |
| DH1B-71006 | 07/11/06 | 16:00 | Composite of DH-1 through DH-10; subsurface tailings. | < 5 | 17.9 | < 1 | 8.7 | 81.7 | 15900 | 109 | 1590 | 1 | 6.2 | 19 | 181 |
| DH1C-71006 | 07/11/06 | 16:00 | Composite of DH-1 through DH-10; underlying native soils (0 to 6 inches). | < 5 | < 5 | < 1 | 6.4 | 6.4 | 17800 | 6.8 | 478 | < 1 | < 5 | < 5 | 58 |
| **Tailings Area** | | | | | | | | | | | | | | | |
| DH2A-71006 | 07/11/06 | 17:00 | Composite of DH-11 through DH-23; 0 to 6-inches. | < 5 | 16.2 | < 1 | 10.7 | 62 | 15100 | 96 | 966 | 1.3 | 8.7 | 7.6 | 135 |
| DH2B-71006 | 07/11/06 | 17:00 | Composite of DH-11 through DH-23; subsurface tailings. | < 5 | 19 | < 1 | 5.6 | 91.2 | 15100 | 142 | 2120 | 1.4 | < 5 | 26.1 | 243 |
| DH2C-71006 | 07/11/06 | 17:00 | Composite of DH-11 through DH-23; underlying native soils (0 to 6 inches). | < 5 | 7.6 | < 1 | 5.9 | 24.1 | 14500 | 22 | 917 | 2.4 | < 5 | 6.7 | 94.3 |
| **Parking Lots** | | | | | | | | | | | | | | | |
| GD-PL-1-071106 | 07/10/06 | 10:10 | 25-point composite of the upper and middle parking lots, 0 to 6-inches. | < 5 | 12.3 | < 1 | 5.1 | 62.8 | 12000 | 78 | 1680 | < 1 | < 5 | 17 | 146 |

mg/kg - milligrams per kilogram

## TABLE B-7
## GREAT DIVIDE SAND TAILINGS
## ACID BASE ACCOUNTING RESULTS

| **SAMPLE I.D.** | **SAMPLE Date** | **Description** | **TOTAL Sulfur %** | **Sulfate Sulfur %** | **Insoluble Sulfide S %** | **Sulfide Sulfur %** | **Organic Sulfur %** | **Neut. Pot. t/1000t** | **SMP Buffer (t/1000t)** | **SMP Lime Requirements (t/1000t)** | **ABA Lime Requirements (t/1000t)** | **Total Lime Requirement (t/1000t)** | **Lime Req. Dollhopf (t/ac.) 1ft.** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DH1B-71006 | 07/11/06 | Composite of DH-1 through DH-10; subsurface tailings. | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 91.00 | 1.00 | 1.00 | 1.17 | **0.0** | **0.0** |
| DH2B-71006 | 07/11/06 | Composite of DH-11 through DH-23; subsurface tailings. | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 46.00 | 1.00 | 1.00 | 1.17 | **0.0** | **0.0** |

## TABLE B-8
## GREAT DIVIDE SAND TAILINGS
## TOXICITY CHARACTERISTIC LEACH PROCEDURE
## METAL RESULTS

| Sample ID | Sample Date | Sample Description | As mg/L | Ba mg/L | Cd mg/L | Cr mg/L | Pb mg/L | Hg mg/L | Se mg/L | Ag mg/L |
|---|---|---|---|---|---|---|---|---|---|---|
| DH1B-71006 | 07/11/06 | Composite of DH-1 through DH-10; subsurface tailings. | < 0.5 | < 10 | < 0.1 | < 0.5 | < 0.5 | < 0.02 | < 0.1 | < 0.5 |
| DH2B-71006 | 07/11/06 | Composite of DH-11 through DH-23; subsurface tailings. | < 0.5 | < 10 | < 0.1 | < 0.5 | < 0.5 | < 0.02 | < 0.1 | < 0.5 |
| GD-PL-1-071106 | 07/10/06 | 25-point composite of the upper and middle parking lots, 0 to 6-inches. | < 0.5 | < 10 | < 0.1 | < 0.5 | < 0.5 | < 0.02 | < 0.1 | < 0.5 |

NA = Not Available or Requested

USGS - U.S. Department of Interior U.S. Geological Survey Open file Report OF-00-239

SAIC -Science Applications International Corporation Preliminary Assessment March 30, 2000

# TABLE B-9
# GREAT DIVIDE SAND TAILINGS
# SUPPLEMENTAL SOIL SAMPLING PHYSICAL PROPERTIES

| Sample ID | Sample Date | Sample Time | Sample Description | Sample Texture | Rapid Hydrometer Percent Coarse, Sand Silt and Clay | | | | Field Capacity (1/3 Bar) | Wilting Point (15 Bar %) | Available Moisture (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Coarse % | Sand % | Silt % | Clay % | | | |
| DH1A-71006 | 07/11/06 | 16:00 | Composite of DH-1 through DH-10; 0 to 6-inches. | Loam | NR | 41 | 37 | 22 | 19.0 | 8.6 | 1.9 |
| DH1C-71006 | 07/11/06 | 16:00 | Composite of DH-1 through DH-10; underlying native soils (0 to 6 inches). | Loamy Sand | NR | 77 | 17 | 6 | 8.9 | 3.6 | 1.5 |
| DH2A-71006 | 07/11/06 | 17:00 | Composite of DH-11 through DH-23; 0 to 6-inches. | Sandy Loam | NR | 53 | 31 | 16 | 15 | 6.4 | 2.1 |
| DH2C-71006 | 07/11/06 | 17:00 | Composite of DH-11 through DH-23; underlying native soils (0 to 6 inches). | Sandy Loam | NR | 65 | 23 | 12 | 14 | 5.7 | 2.1 |

# TABLE B-10
# GREAT DIVIDE SAND TAILINGS
# SUPPLEMENTAL SAMPLING AGRONOMIC PROPERTIES

| Sample ID | Sample Date | Sample Time | Sample Description | Organic Matter (%) | RECOMMENDED FERTILIZER APPLICATION RATE | | | Soil pH | Cation Exchange Capacity (meq / 100g) | Sodium Adsoption Ratio (unitless) | Saturation Percentage (%) | Electrical Conductivity (μmhos/cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Nitrogen (lbs / ac) | Phosphate ($P_2O_5$) (lbs / ac) | Potash ($K_2O$) (lbs / ac) | | | | | |
| DH1A-71006 | 07/11/06 | 16:00 | Composite of DH-1 through DH-10; 0 to 6-inches. | 1 | 2 | 17.8 | 300 | 8 | 20.7 | 0.63 | 48.3 | 0.41 |
| DH1C-71006 | 07/11/06 | 16:00 | Composite of DH-1 through DH-10; underlying native soils (0 to 6 inches). | 0.51 | 3.8 | 92 | 272 | 7.6 | 12.1 | 0.67 | 35.8 | 0.35 |
| DH2A-71006 | 07/11/06 | 17:00 | Composite of DH-11 through DH-23; 0 to 6-inches. | 0.65 | 1.7 | 14.4 | 208 | 8.1 | 16.4 | 0.46 | 48 | 0.3 |
| DH2C-71006 | 07/11/06 | 17:00 | Composite of DH-11 through DH-23; underlying native soils (0 to 6 | 1.6 | 6.8 | 164 | 508 | 7.4 | 21.2 | 0.61 | 43.7 | 0.53 |

lbs/acre - pounds per acre
umhos/cm - micromhos per centimeter
meq/milliequivalence per 100 grams

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# LABORATORY ANALYTICAL REPORT

**Client:** Pioneer Technical Services
**Project:** Great Divide
**Lab ID:** H06050030-001
**Client Sample ID:** GD-SW01-050206

**Report Date:** 05/18/06
**Collection Date:** 05/02/06 13:45
**Date Received:** 05/02/06
**Matrix:** Aqueous

| Analyses | Result | Units | Qual | RL | MCL/ QCL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| PHYSICAL PROPERTIES | | | | | | | |
| Turbidity | 18.0 | NTU | | 0.01 | | E180.1 | 05/03/06 16:19 / sld |
| Solids, Total Dissolved TDS @ 180 C | 165 | mg/L | | 10 | | A2540 C | 05/04/06 08:31 / sld |
| INORGANICS | | | | | | | |
| Hardness as CaCO3 | 115 | mg/L | | 1 | | A2340 B | 05/15/06 08:13 / wjj |
| NUTRIENTS | | | | | | | |
| Nitrogen, Nitrate+Nitrite as N | 0.80 | mg/L | | 0.05 | | E353.2 | 05/04/06 12:20 / sld |
| METALS, DISSOLVED | | | | | | | |
| Calcium | 39 | mg/L | | 1 | | E200.7 | 05/03/06 11:53 / skr |
| Magnesium | 4 | mg/L | | 1 | | E200.7 | 05/03/06 11:53 / skr |
| METALS, TOTAL | | | | | | | |
| Antimony | ND | mg/L | | 0.005 | | E200.8 | 05/07/06 00:41 / jjw |
| Arsenic | ND | mg/L | | 0.005 | | E200.8 | 05/07/06 00:41 / jjw |
| Barium | ND | mg/L | | 0.1 | | E200.8 | 05/07/06 00:41 / jjw |
| Cadmium | ND | mg/L | | 0.001 | | E200.8 | 05/07/06 00:41 / jjw |
| Chromium | ND | mg/L | | 0.01 | | E200.8 | 05/07/06 00:41 / jjw |
| Copper | ND | mg/L | | 0.01 | | E200.8 | 05/07/06 00:41 / jjw |
| Iron | 0.42 | mg/L | | 0.03 | | E200.7 | 05/06/06 12:51 / eli-b |
| Lead | ND | mg/L | | 0.01 | | E200.8 | 05/07/06 00:41 / jjw |
| Manganese | 0.04 | mg/L | | 0.01 | | E200.8 | 05/07/06 00:41 / jjw |
| Mercury | ND | mg/L | | 0.0001 | | E245.1 | 05/11/06 11:45 / KC |
| Nickel | ND | mg/L | | 0.01 | | E200.8 | 05/07/06 00:41 / jjw |
| Silver | ND | mg/L | | 0.005 | | E200.8 | 05/07/06 00:41 / jjw |
| Zinc | 0.01 | mg/L | | 0.01 | | E200.7 | 05/06/06 12:51 / eli-b |

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

## LABORATORY ANALYTICAL REPORT

**Client:** Pioneer Technical Services
**Project:** Great Divide
**Lab ID:** H06050030-002
**Client Sample ID:** GD-SD01-050602

**Report Date:** 05/18/06
**Collection Date:** 05/02/06 13:45
**Date Received:** 05/02/06
**Matrix:** Soil

| Analyses | Result | Units | Qual | RL | MCL/ QCL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| METALS, TOTAL | | | | | | | |
| Antimony | ND | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:08 / eli-b |
| Arsenic | 11.0 | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:08 / eli-b |
| Barium | 41.4 | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:08 / eli-b |
| Cadmium | ND | mg/kg | | 1.0 | | SW6010B | 05/09/06 01:08 / eli-b |
| Chromium | ND | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:08 / eli-b |
| Copper | 50.3 | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:08 / eli-b |
| Iron | 9250 | mg/kg | D | 8.0 | | SW6010B | 05/09/06 01:08 / eli-b |
| Lead | 70.2 | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:08 / eli-b |
| Manganese | 1250 | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:08 / eli-b |
| Mercury | ND | mg/kg | | 1.0 | | SW7471A | 05/12/06 11:30 / KC |
| Nickel | ND | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:08 / eli-b |
| Silver | 12.9 | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:08 / eli-b |
| Zinc | 117 | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:08 / eli-b |

**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.

# LABORATORY ANALYTICAL REPORT

**Client:** Pioneer Technical Services
**Project:** Great Divide
**Lab ID:** H06050030-005
**Client Sample ID:** GD-SW02-050206

**Report Date:** 05/18/06
**Collection Date:** 05/02/06 15:30
**Date Received:** 05/02/06
**Matrix:** Aqueous

| Analyses | Result | Units | Qual | RL | MCL/ QCL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| PHYSICAL PROPERTIES | | | | | | | |
| Turbidity | 200 | NTU | | 0.01 | | E180.1 | 05/03/06 16:21 / sld |
| Solids, Total Dissolved TDS @ 180 C | 144 | mg/L | | 10 | | A2540 C | 05/04/06 08:31 / sld |
| INORGANICS | | | | | | | |
| Hardness as CaCO3 | 96 | mg/L | | 1 | | A2340 B | 05/15/06 08:13 / wjj |
| NUTRIENTS | | | | | | | |
| Nitrogen, Nitrate+Nitrite as N | 0.56 | mg/L | | 0.05 | | E353.2 | 05/04/06 12:24 / sld |
| METALS, DISSOLVED | | | | | | | |
| Calcium | 32 | mg/L | | 1 | | E200.7 | 05/03/06 11:59 / skr |
| Magnesium | 4 | mg/L | | 1 | | E200.7 | 05/03/06 11:59 / skr |
| METALS, TOTAL | | | | | | | |
| Antimony | ND | mg/L | | 0.005 | | E200.8 | 05/07/06 00:55 / jjw |
| Arsenic | 0.012 | mg/L | | 0.005 | | E200.8 | 05/07/06 00:55 / jjw |
| Barium | 0.2 | mg/L | | 0.1 | | E200.8 | 05/07/06 00:55 / jjw |
| Cadmium | ND | mg/L | | 0.001 | | E200.7 | 05/06/06 12:58 / eli-b |
| Chromium | ND | mg/L | | 0.01 | | E200.8 | 05/07/06 00:55 / jjw |
| Copper | 0.03 | mg/L | | 0.01 | | E200.8 | 05/07/06 00:55 / jjw |
| Iron | 10.8 | mg/L | | 0.03 | | E200.7 | 05/06/06 12:58 / eli-b |
| Lead | 0.04 | mg/L | | 0.01 | | E200.8 | 05/07/06 00:55 / jjw |
| Manganese | 0.78 | mg/L | | 0.01 | | E200.8 | 05/07/06 00:55 / jjw |
| Mercury | 0.0006 | mg/L | | 0.0001 | | E245.1 | 05/11/06 11:50 / KC |
| Nickel | ND | mg/L | | 0.01 | | E200.8 | 05/07/06 00:55 / jjw |
| Silver | 0.008 | mg/L | | 0.005 | | E200.8 | 05/07/06 00:55 / jjw |
| Zinc | 0.10 | mg/L | | 0.01 | | E200.7 | 05/06/06 12:58 / eli-b |

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

# LABORATORY ANALYTICAL REPORT

**Client:** Pioneer Technical Services
**Project:** Great Divide
**Lab ID:** H06050030-006
**Client Sample ID:** GD-SD02-050602

**Report Date:** 05/18/06
**Collection Date:** 05/02/06 15:30
**Date Received:** 05/02/06
**Matrix:** Soil

| Analyses | Result | Units | Qual | RL | MCL/ QCL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **METALS, TOTAL** | | | | | | | |
| Antimony | ND | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:23 / eli-b |
| Arsenic | 25.0 | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:23 / eli-b |
| Barium | 48.8 | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:23 / eli-b |
| Cadmium | ND | mg/kg | | 1.0 | | SW6010B | 05/09/06 01:23 / eli-b |
| Chromium | 6.6 | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:23 / eli-b |
| Copper | 125 | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:23 / eli-b |
| Iron | 19900 | mg/kg | D | 8.0 | | SW6010B | 05/09/06 01:23 / eli-b |
| Lead | 169 | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:23 / eli-b |
| Manganese | 2090 | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:23 / eli-b |
| Mercury | ND | mg/kg | | 1.0 | | SW7471A | 05/12/06 11:34 / KC |
| Nickel | ND | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:23 / eli-b |
| Silver | 35.2 | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:23 / eli-b |
| Zinc | 178 | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:23 / eli-b |

**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.

# LABORATORY ANALYTICAL REPORT

**Client:** Pioneer Technical Services
**Project:** Great Divide
**Lab ID:** H06050030-003
**Client Sample ID:** GD-SW03-050206

**Report Date:** 05/18/06
**Collection Date:** 05/02/06 14:45
**Date Received:** 05/02/06
**Matrix:** Aqueous

| Analyses | Result | Units | Qual | RL | MCL/ QCL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| PHYSICAL PROPERTIES | | | | | | | |
| Turbidity | 14.2 | NTU | | 0.01 | | E180.1 | 05/03/06 16:26 / sld |
| Solids, Total Dissolved TDS @ 180 C | 169 | mg/L | | 10 | | A2540 C | 05/04/06 08:31 / sld |
| INORGANICS | | | | | | | |
| Hardness as CaCO3 | 123 | mg/L | | 1 | | A2340 B | 05/15/06 08:13 / wjj |
| NUTRIENTS | | | | | | | |
| Nitrogen, Nitrate+Nitrite as N | 0.63 | mg/L | | 0.05 | | E353.2 | 05/04/06 12:22 / sld |
| METALS, DISSOLVED | | | | | | | |
| Calcium | 43 | mg/L | | 1 | | E200.7 | 05/03/06 11:56 / skr |
| Magnesium | 4 | mg/L | | 1 | | E200.7 | 05/03/06 11:56 / skr |
| METALS, TOTAL | | | | | | | |
| Antimony | ND | mg/L | | 0.005 | | E200.8 | 05/07/06 00:48 / jjw |
| Arsenic | ND | mg/L | | 0.005 | | E200.8 | 05/07/06 00:48 / jjw |
| Barium | ND | mg/L | | 0.1 | | E200.8 | 05/07/06 00:48 / jjw |
| Cadmium | ND | mg/L | | 0.001 | | E200.8 | 05/07/06 00:48 / jjw |
| Chromium | ND | mg/L | | 0.01 | | E200.8 | 05/07/06 00:48 / jjw |
| Copper | ND | mg/L | | 0.01 | | E200.8 | 05/07/06 00:48 / jjw |
| Iron | ND | mg/L | | 0.03 | | E200.7 | 05/06/06 12:55 / eli-b |
| Lead | ND | mg/L | | 0.01 | | E200.8 | 05/07/06 00:48 / jjw |
| Manganese | ND | mg/L | | 0.01 | | E200.8 | 05/07/06 00:48 / jjw |
| Mercury | ND | mg/L | | 0.0001 | | E245.1 | 05/11/06 11:47 / KC |
| Nickel | ND | mg/L | | 0.01 | | E200.8 | 05/07/06 00:48 / jjw |
| Silver | ND | mg/L | | 0.005 | | E200.8 | 05/07/06 00:48 / jjw |
| Zinc | 0.03 | mg/L | | 0.01 | | E200.7 | 05/06/06 12:55 / eli-b |

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

# LABORATORY ANALYTICAL REPORT

**Client:** Pioneer Technical Services
**Project:** Great Divide
**Lab ID:** H06050030-004
**Client Sample ID:** GD-SD03-050602

**Report Date:** 05/18/06
**Collection Date:** 05/02/06 14:45
**Date Received:** 05/02/06
**Matrix:** Soil

| Analyses | Result | Units | Qual | RL | MCL/ QCL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| METALS, TOTAL | | | | | | | |
| Antimony | ND | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:11 / eli-b |
| Arsenic | 13.1 | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:11 / eli-b |
| Barium | 35.6 | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:11 / eli-b |
| Cadmium | ND | mg/kg | | 1.0 | | SW6010B | 05/09/06 01:11 / eli-b |
| Chromium | ND | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:11 / eli-b |
| Copper | 10.1 | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:11 / eli-b |
| Iron | 12300 | mg/kg | D | 8.0 | | SW6010B | 05/09/06 01:11 / eli-b |
| Lead | 9.8 | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:11 / eli-b |
| Manganese | 325 | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:11 / eli-b |
| Mercury | ND | mg/kg | | 1.0 | | SW7471A | 05/12/06 11:32 / KC |
| Nickel | ND | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:11 / eli-b |
| Silver | ND | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:11 / eli-b |
| Zinc | 311 | mg/kg | | 5.0 | | SW6010B | 05/09/06 01:11 / eli-b |

**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.

# QA/QC Summary Report

**Client:** Pioneer Technical Services
**Project:** Great Divide

**Report Date:** 05/18/06
**Work Order:** H06050030

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method:** A2540 C | | | | | | | | | Batch: 060504A-SLDS-TDS-W |
| **Sample ID:** MBLK1_060504A | Method Blank | | | | Run: SOLIDS_060504B | | | | 05/04/06 08:27 |
| Solids, Total Dissolved TDS @ 180 C | ND | mg/L | 1 | | | | | | |
| **Sample ID:** LCS1_060504A | Laboratory Control Sample | | | | Run: SOLIDS_060504B | | | | 05/04/06 08:28 |
| Solids, Total Dissolved TDS @ 180 C | 990 | mg/L | 10 | 99 | 90 | 110 | | | |
| **Sample ID:** H06050019-005ADUP | Sample Duplicate | | | | Run: SOLIDS_060504B | | | | 05/04/06 08:29 |
| Solids, Total Dissolved TDS @ 180 C | 1190 | mg/L | 10 | | | | 0.8 | 20 | |
| **Sample ID:** H06050028-001AMS | Sample Matrix Spike | | | | Run: SOLIDS_060504B | | | | 05/04/06 08:30 |
| Solids, Total Dissolved TDS @ 180 C | 3520 | mg/L | 10 | 97 | 80 | 120 | | | |
| **Sample ID:** H06050028-001AMSD | Sample Matrix Spike Duplicate | | | | Run: SOLIDS_060504B | | | | 05/04/06 08:30 |
| Solids, Total Dissolved TDS @ 180 C | 3520 | mg/L | 10 | 97 | 80 | 120 | | 10 | |
| **Method:** E180.1 | | | | | | | | | Batch: 060503A-TURB-W |
| **Sample ID:** MBLK1_060503A | Method Blank | | | | Run: TURBIDITY_060503A | | | | 05/03/06 16:15 |
| Turbidity | 0.06 | NTU | | | | | | | |
| **Sample ID:** LCS1_060503A | Laboratory Control Sample | | | | Run: TURBIDITY_060503A | | | | 05/03/06 16:15 |
| Turbidity | 10.2 | NTU | 0.010 | 101 | 90 | 110 | | | |
| **Sample ID:** H06050030-003CDUP | Sample Duplicate | | | | Run: TURBIDITY_060503A | | | | 05/03/06 16:26 |
| Turbidity | 14.5 | NTU | 0.010 | | | | 1.8 | 20 | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

**Client:** Pioneer Technical Services
**Project:** Great Divide

**Report Date:** 05/18/06
**Work Order:** H06050030

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method:** E200.7 | | | | | | | | | Batch: B_20971 |
| **Sample ID:** MB-20971 | Method Blank | | | | Run: SUB-B75317 | | | | 05/06/06 12:08 |
| Cadmium | ND | mg/L | 0.001 | | | | | | |
| Iron | ND | mg/L | 0.005 | | | | | | |
| Zinc | 0.001 | mg/L | 0.001 | | | | | | |
| **Sample ID:** LCS1-20971 | Laboratory Control Sample | | | | Run: SUB-B75317 | | | | 05/06/06 12:16 |
| Cadmium | 0.0514 | mg/L | 0.0010 | 103 | 85 | 115 | | | |
| Iron | 0.502 | mg/L | 0.030 | 100 | 85 | 115 | | | |
| Zinc | 0.105 | mg/L | 0.010 | 103 | 85 | 115 | | | |
| **Sample ID:** LCS3 - 20971 | Laboratory Control Sample | | | | Run: SUB-B75317 | | | | 05/06/06 12:19 |
| Cadmium | 0.485 | mg/L | 0.0010 | 97 | 85 | 115 | | | |
| Iron | 5.03 | mg/L | 0.030 | 101 | 85 | 115 | | | |
| Zinc | 1.02 | mg/L | 0.010 | 102 | 85 | 115 | | | |
| **Sample ID:** B06050540-007C MS3 | Sample Matrix Spike | | | | Run: SUB-B75317 | | | | 05/06/06 13:13 |
| Cadmium | 0.4795 | mg/L | 0.0010 | 96 | 70 | 130 | | | |
| Iron | 4.940 | mg/L | 0.030 | 99 | 70 | 130 | | | |
| Zinc | 0.9877 | mg/L | 0.010 | 98 | 70 | 130 | | | |
| **Sample ID:** B06050540-007C MSD3 | Sample Matrix Spike Duplicate | | | | Run: SUB-B75317 | | | | 05/06/06 13:16 |
| Cadmium | 0.4847 | mg/L | 0.0010 | 97 | 70 | 130 | 1.1 | 20 | |
| Iron | 5.060 | mg/L | 0.030 | 101 | 70 | 130 | 2.4 | 20 | |
| Zinc | 1.006 | mg/L | 0.010 | 100 | 70 | 130 | 1.8 | 20 | |
| **Method:** E200.7 | | | | | | | | | Analytical Run: SUB-B75317 |
| **Sample ID:** QCS | Initial Calibration Verification Standard | | | | | | | | 05/06/06 10:31 |
| Cadmium | 0.495 | mg/L | 0.010 | 99 | 95 | 105 | | | |
| Iron | 5.08 | mg/L | 0.030 | 102 | 95 | 105 | | | |
| Zinc | 1.00 | mg/L | 0.010 | 100 | 95 | 105 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

**Client:** Pioneer Technical Services
**Project:** Great Divide

**Report Date:** 05/18/06
**Work Order:** H06050030

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method:** E200.7 | | | | | | | | | Analytical Run: ICP1-HE_060503B |
| **Sample ID:** ICV | Initial Calibration Verification Standard | | | | | | | | 05/03/06 10:30 |
| Calcium | 50.3 | meq/l | 1.0 | 101 | 90 | 110 | | | |
| Magnesium | 51.2 | meq/l | 1.0 | 102 | 90 | 110 | | | |
| **Method:** E200.7 | | | | | | | | | Batch: R27812 |
| **Sample ID:** H06050012-010CDup | Sample Duplicate | | | | Run: ICP1-HE_060503B | | | | 05/03/06 11:17 |
| Calcium | 29.9 | mg/L | 1.0 | | | | 3.4 | 20 | |
| Magnesium | 17.7 | mg/L | 1.0 | | | | 2.0 | 20 | |
| **Sample ID:** H06050012-015CMS | Sample Matrix Spike | | | | Run: ICP1-HE_060503B | | | | 05/03/06 11:35 |
| Calcium | 65.9 | mg/L | 1.0 | 62 | 80 | 120 | | | S |
| Magnesium | 60.4 | mg/L | 1.0 | 80 | 80 | 120 | | | |
| **Sample ID:** H06050012-015CMSD | Sample Matrix Spike Duplicate | | | | Run: ICP1-HE_060503B | | | | 05/03/06 11:38 |
| Calcium | 67.2 | mg/L | 1.0 | 65 | 80 | 120 | 2.0 | 20 | S |
| Magnesium | 61.4 | mg/L | 1.0 | 82 | 80 | 120 | 1.6 | 20 | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

S - Spike recovery outside of advisory limits.

# QA/QC Summary Report

**Client:** Pioneer Technical Services
**Project:** Great Divide

**Report Date:** 05/18/06
**Work Order:** H06050030

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method:** E200.8 | | | | | | | | | Batch: B_20971 |
| **Sample ID:** MB-20971 | Method Blank | | | | Run: SUB-B75314 | | | | 05/06/06 22:47 |
| Antimony | ND | mg/L | 1E-05 | | | | | | |
| Arsenic | ND | mg/L | 4E-05 | | | | | | |
| Barium | 0.0001 | mg/L | 3E-05 | | | | | | |
| Cadmium | 0.0004 | mg/L | 9E-06 | | | | | | |
| Chromium | 0.0008 | mg/L | 4E-05 | | | | | | |
| Copper | 0.0001 | mg/L | 7E-05 | | | | | | |
| Lead | 5E-05 | mg/L | 8E-06 | | | | | | |
| Manganese | 0.0001 | mg/L | 5E-05 | | | | | | |
| Nickel | ND | mg/L | 3E-05 | | | | | | |
| Silver | ND | mg/L | 3E-05 | | | | | | |
| **Sample ID:** LCS1-20971 | Laboratory Control Sample | | | | Run: SUB-B75314 | | | | 05/06/06 22:54 |
| Antimony | 0.104 | mg/L | 0.0050 | 104 | 85 | 115 | | | |
| Arsenic | 0.101 | mg/L | 0.0050 | 101 | 85 | 115 | | | |
| Barium | 0.105 | mg/L | 0.10 | 105 | 85 | 115 | | | |
| Cadmium | 0.0509 | mg/L | 0.0010 | 101 | 85 | 115 | | | |
| Chromium | 0.102 | mg/L | 0.010 | 101 | 85 | 115 | | | |
| Copper | 0.0976 | mg/L | 0.010 | 97 | 85 | 115 | | | |
| Lead | 0.103 | mg/L | 0.010 | 103 | 85 | 115 | | | |
| Manganese | 0.507 | mg/L | 0.010 | 101 | 85 | 115 | | | |
| Nickel | 0.0979 | mg/L | 0.010 | 98 | 85 | 115 | | | |
| Silver | 0.0488 | mg/L | 0.0050 | 98 | 85 | 115 | | | |
| **Sample ID:** B06050517-001B MS1 | Sample Matrix Spike | | | | Run: SUB-B75314 | | | | 05/07/06 00:14 |
| Antimony | 0.1103 | mg/L | 0.0050 | 110 | 70 | 130 | | | |
| Arsenic | 0.1008 | mg/L | 0.0050 | 100 | 70 | 130 | | | |
| Barium | 0.8052 | mg/L | 0.10 | | 70 | 130 | | | A |
| Cadmium | 0.05109 | mg/L | 0.0010 | 101 | 70 | 130 | | | |
| Chromium | 0.1016 | mg/L | 0.010 | 100 | 70 | 130 | | | |
| Copper | 0.09493 | mg/L | 0.010 | 94 | 70 | 130 | | | |
| Lead | 0.1047 | mg/L | 0.010 | 105 | 70 | 130 | | | |
| Manganese | 0.4994 | mg/L | 0.010 | 98 | 70 | 130 | | | |
| Nickel | 0.09830 | mg/L | 0.010 | 96 | 70 | 130 | | | |
| Silver | 0.04838 | mg/L | 0.0050 | 97 | 70 | 130 | | | |
| **Sample ID:** B06050517-001B MSD1 | Sample Matrix Spike Duplicate | | | | Run: SUB-B75314 | | | | 05/07/06 00:21 |
| Antimony | 0.1103 | mg/L | 0.0050 | 110 | 70 | 130 | 0.0 | 20 | |
| Arsenic | 0.1037 | mg/L | 0.0050 | 103 | 70 | 130 | 2.8 | 20 | |
| Barium | 0.8053 | mg/L | 0.10 | | 70 | 130 | 0.0 | 20 | A |
| Cadmium | 0.05044 | mg/L | 0.0010 | 99 | 70 | 130 | 1.3 | 20 | |
| Chromium | 0.1035 | mg/L | 0.010 | 102 | 70 | 130 | 1.9 | 20 | |

**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:** Pioneer Technical Services
**Project:** Great Divide

**Report Date:** 05/18/06
**Work Order:** H06050030

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| Method: E200.8 | | | | | | | | Batch: B_20971 | |
| Sample ID: B06050517-001B MSD1 | Sample Matrix Spike Duplicate | | | | Run: SUB-B75314 | | | 05/07/06 00:21 | |
| Copper | 0.09781 | mg/L | 0.010 | 97 | 70 | 130 | 3.0 | 20 | |
| Lead | 0.1052 | mg/L | 0.010 | 105 | 70 | 130 | 0.5 | 20 | |
| Manganese | 0.5060 | mg/L | 0.010 | 100 | 70 | 130 | 1.3 | 20 | |
| Nickel | 0.09897 | mg/L | 0.010 | 97 | 70 | 130 | 0.7 | 20 | |
| Silver | 0.04983 | mg/L | 0.0050 | 100 | 70 | 130 | 3.0 | 20 | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

**Client:** Pioneer Technical Services
**Project:** Great Divide

**Report Date:** 05/18/06
**Work Order:** H06050030

**Method:** E200.8 Analytical Run: SUB-B75314

**Sample ID:** QCS - **ME050621C,0601** Initial Calibration Verification Standard 05/06/06 17:20

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| Antimony | 0.050 | mg/L | 0.050 | 100 | 90 | 110 | | | |
| Arsenic | 0.049 | mg/L | 0.0050 | 98 | 90 | 110 | | | |
| Barium | 0.050 | mg/L | 0.10 | 100 | 90 | 110 | | | |
| Cadmium | 0.025 | mg/L | 0.0010 | 100 | 90 | 110 | | | |
| Chromium | 0.049 | mg/L | 0.010 | 98 | 90 | 110 | | | |
| Copper | 0.049 | mg/L | 0.010 | 98 | 90 | 110 | | | |
| Lead | 0.049 | mg/L | 0.010 | 98 | 90 | 110 | | | |
| Manganese | 0.24 | mg/L | 0.010 | 98 | 90 | 110 | | | |
| Nickel | 0.049 | mg/L | 0.010 | 98 | 90 | 110 | | | |
| Silver | 0.026 | mg/L | 0.0050 | 104 | 90 | 110 | | | |

**Sample ID:** QCS - **ME050621C,0601** Initial Calibration Verification Standard 05/07/06 03:11

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| Antimony | 0.050 | mg/L | 0.050 | 99 | 90 | 110 | | | |
| Arsenic | 0.050 | mg/L | 0.0050 | 101 | 90 | 110 | | | |
| Barium | 0.050 | mg/L | 0.10 | 99 | 90 | 110 | | | |
| Cadmium | 0.025 | mg/L | 0.0010 | 98 | 90 | 110 | | | |
| Chromium | 0.049 | mg/L | 0.010 | 97 | 90 | 110 | | | |
| Copper | 0.050 | mg/L | 0.010 | 100 | 90 | 110 | | | |
| Lead | 0.049 | mg/L | 0.010 | 99 | 90 | 110 | | | |
| Manganese | 0.25 | mg/L | 0.010 | 99 | 90 | 110 | | | |
| Nickel | 0.049 | mg/L | 0.010 | 99 | 90 | 110 | | | |
| Silver | 0.026 | mg/L | 0.0050 | 103 | 90 | 110 | | | |

**Sample ID:** QCS - **ME050621C,0601** Initial Calibration Verification Standard 05/07/06 12:27

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| Antimony | 0.050 | mg/L | 0.050 | 100 | 90 | 110 | | | |
| Arsenic | 0.049 | mg/L | 0.0050 | 99 | 90 | 110 | | | |
| Barium | 0.050 | mg/L | 0.10 | 99 | 90 | 110 | | | |
| Cadmium | 0.024 | mg/L | 0.0010 | 97 | 90 | 110 | | | |
| Chromium | 0.050 | mg/L | 0.010 | 100 | 90 | 110 | | | |
| Copper | 0.050 | mg/L | 0.010 | 100 | 90 | 110 | | | |
| Lead | 0.050 | mg/L | 0.010 | 99 | 90 | 110 | | | |
| Manganese | 0.25 | mg/L | 0.010 | 99 | 90 | 110 | | | |
| Nickel | 0.050 | mg/L | 0.010 | 100 | 90 | 110 | | | |
| Silver | 0.026 | mg/L | 0.0050 | 105 | 90 | 110 | | | |

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

**Client:** Pioneer Technical Services
**Project:** Great Divide

**Report Date:** 05/18/06
**Work Order:** H06050030

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| Method: E245.1 | | | | | | | | | Batch: B_21023 |
| Sample ID: B06050932-002AMS | Sample Matrix Spike | | | | Run: SUB-B75543 | | | | 05/11/06 12:16 |
| Mercury | 0.0018 | mg/L | 0.00020 | 92 | 70 | 130 | | | |
| Sample ID: B06050932-002AMSD | Sample Matrix Spike Duplicate | | | | Run: SUB-B75543 | | | | 05/11/06 12:18 |
| Mercury | 0.0019 | mg/L | 0.00020 | 94 | 70 | 130 | 2.2 | 10 | |
| Sample ID: MB-21023 | Method Blank | | | | Run: SUB-B75543 | | | | 05/11/06 11:07 |
| Mercury | ND | mg/L | 5E-05 | | | | | | |
| Method: E245.1 | | | | | | | | | Analytical Run: SUB-B75543 |
| Sample ID: QCS | Initial Calibration Verification Standard | | | | | | | | 05/11/06 11:00 |
| Mercury | 0.0019 | mg/L | 0.0010 | 94 | 90 | 110 | | | |
| Method: E353.2 | | | | | | | | | Analytical Run: NUTRIENTS_060504C |
| Sample ID: ICV-1 | Initial Calibration Verification Standard | | | | | | | | 05/04/06 10:48 |
| Nitrogen, Nitrate+Nitrite as N | 1.01 | mg/L | 0.050 | 101 | 90 | 110 | | | |
| Method: E353.2 | | | | | | | | | Batch: A2006-05-04_5_NO3_01 |
| Sample ID: LCS-2 | Laboratory Control Sample | | | | Run: NUTRIENTS_060504C | | | | 05/04/06 10:50 |
| Nitrogen, Nitrate+Nitrite as N | 25.9 | mg/L | 0.30 | 98 | 90 | 110 | | | |
| Sample ID: LFB-3 | Laboratory Fortified Blank | | | | Run: NUTRIENTS_060504C | | | | 05/04/06 10:52 |
| Nitrogen, Nitrate+Nitrite as N | 0.520 | mg/L | 0.050 | 104 | 90 | 110 | | | |
| Sample ID: MBLK-5 | Method Blank | | | | Run: NUTRIENTS_060504C | | | | 05/04/06 10:56 |
| Nitrogen, Nitrate+Nitrite as N | ND | mg/L | 0.01 | | | | | | |
| Sample ID: H06040134-003ADUP | Sample Duplicate | | | | Run: NUTRIENTS_060504C | | | | 05/04/06 11:02 |
| Nitrogen, Nitrate+Nitrite as N | 8.62 | mg/L | 0.059 | | | | 0.5 | 20 | |
| Sample ID: H06050029-001BMS | Sample Matrix Spike | | | | Run: NUTRIENTS_060504C | | | | 05/04/06 12:16 |
| Nitrogen, Nitrate+Nitrite as N | 1.61 | mg/L | 0.050 | 91 | 90 | 110 | | | |
| Sample ID: H06050029-001BMSD | Sample Matrix Spike Duplicate | | | | Run: NUTRIENTS_060504C | | | | 05/04/06 12:18 |
| Nitrogen, Nitrate+Nitrite as N | 1.64 | mg/L | 0.050 | 94 | 90 | 110 | 1.8 | 20 | |

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**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

**Client:** Pioneer Technical Services
**Project:** Great Divide

**Report Date:** 05/18/06
**Work Order:** H06050030

Method: **SW6010B** Batch: B_20984

**Sample ID:** MB-20984 Method Blank Run: SUB-B75383 05/09/06 00:57

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| Antimony | ND | mg/kg | 1 | | | | | | |
| Arsenic | ND | mg/kg | 1 | | | | | | |
| Barium | ND | mg/kg | 0.03 | | | | | | |
| Cadmium | ND | mg/kg | 0.05 | | | | | | |
| Chromium | ND | mg/kg | 2 | | | | | | |
| Copper | ND | mg/kg | 0.2 | | | | | | |
| Iron | ND | mg/kg | 5 | | | | | | |
| Lead | ND | mg/kg | 0.6 | | | | | | |
| Manganese | ND | mg/kg | 0.3 | | | | | | |
| Nickel | ND | mg/kg | 0.9 | | | | | | |
| Silver | ND | mg/kg | 0.2 | | | | | | |
| Zinc | 0.08 | mg/kg | 0.05 | | | | | | |

**Sample ID:** LCS-20984 Laboratory Control Sample Run: SUB-B75383 05/09/06 01:00

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| Antimony | 53.0 | mg/kg | 5.0 | 68 | 2.57 | 180 | | | |
| Arsenic | 67.8 | mg/kg | 5.0 | 84 | 70 | 130 | | | |
| Barium | 136 | mg/kg | 5.0 | 87 | 70 | 130 | | | |
| Cadmium | 186 | mg/kg | 1.0 | 80 | 70 | 130 | | | |
| Chromium | 51.9 | mg/kg | 5.0 | 85 | 70 | 130 | | | |
| Copper | 124 | mg/kg | 5.0 | 95 | 70 | 130 | | | |
| Iron | 13200 | mg/kg | 8.0 | 92 | 70 | 130 | | | |
| Lead | 64.5 | mg/kg | 5.0 | 84 | 70 | 130 | | | |
| Manganese | 265 | mg/kg | 5.0 | 87 | 70 | 130 | | | |
| Nickel | 43.1 | mg/kg | 5.0 | 87 | 70 | 130 | | | |
| Silver | 70.0 | mg/kg | 5.0 | 87 | 70 | 130 | | | |
| Zinc | 97.7 | mg/kg | 5.0 | 84 | 70 | 130 | | | |

**Sample ID:** B06050671-006AMS3 Sample Matrix Spike Run: SUB-B75383 05/09/06 01:55

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| Antimony | 11.5 | mg/kg | 5.0 | 46 | 75 | 125 | | | S |
| Arsenic | 24.0 | mg/kg | 5.0 | 80 | 75 | 125 | | | |
| Barium | 87.4 | mg/kg | 5.0 | 59 | 75 | 125 | | | S |
| Cadmium | 9.54 | mg/kg | 1.0 | 76 | 75 | 125 | | | |
| Chromium | 28.0 | mg/kg | 5.0 | 79 | 75 | 125 | | | |
| Copper | 34.0 | mg/kg | 5.0 | 93 | 75 | 125 | | | |
| Iron | 8660 | mg/kg | 5.0 | | 75 | 125 | | | A |
| Lead | 27.1 | mg/kg | 5.0 | 77 | 75 | 125 | | | |
| Manganese | 326 | mg/kg | 5.0 | 27 | 75 | 125 | | | S |
| Nickel | 28.1 | mg/kg | 5.0 | 80 | 75 | 125 | | | |
| Silver | 10.6 | mg/kg | 5.0 | 85 | 75 | 125 | | | |
| Zinc | 60.7 | mg/kg | 5.0 | 65 | 75 | 125 | | | S |

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**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.

S - Spike recovery outside of advisory limits.

# QA/QC Summary Report

**Client:** Pioneer Technical Services
**Project:** Great Divide

**Report Date:** 05/18/06
**Work Order:** H06050030

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method:** SW6010B | | | | | | | | | Batch: B_20984 |
| **Sample ID:** B06050671-006AMSD3 | Sample Matrix Spike Duplicate | | | | Run: SUB-B75383 | | | | 05/09/06 02:07 |
| Antimony | 11.1 | mg/kg | 5.0 | 44 | 75 | 125 | 3.9 | 20 | S |
| Arsenic | 23.4 | mg/kg | 5.0 | 77 | 75 | 125 | 2.8 | 20 | |
| Barium | 80.1 | mg/kg | 5.0 | 30 | 75 | 125 | 8.7 | 20 | S |
| Cadmium | 9.12 | mg/kg | 1.0 | 73 | 75 | 125 | 4.5 | 20 | S |
| Chromium | 27.2 | mg/kg | 5.0 | 75 | 75 | 125 | 3.0 | 20 | |
| Copper | 31.9 | mg/kg | 5.0 | 85 | 75 | 125 | 6.5 | 20 | |
| Iron | 9310 | mg/kg | 5.0 | | 75 | 125 | 7.2 | 20 | A |
| Lead | 25.9 | mg/kg | 5.0 | 72 | 75 | 125 | 4.5 | 20 | S |
| Manganese | 339 | mg/kg | 5.0 | 38 | 75 | 125 | 3.9 | 20 | S |
| Nickel | 26.9 | mg/kg | 5.0 | 75 | 75 | 125 | 4.4 | 20 | |
| Silver | 9.96 | mg/kg | 5.0 | 80 | 75 | 125 | 6.4 | 20 | |
| Zinc | 57.3 | mg/kg | 5.0 | 51 | 75 | 125 | 5.8 | 20 | S |
| **Method:** SW7471A | | | | | | | | | Batch. B_21053 |
| **Sample ID:** MB-21053 | Method Blank | | | | Run: SUB-B75634 | | | | 05/12/06 11:26 |
| Mercury | ND | mg/kg | 0.01 | | | | | | |
| **Sample ID:** LCS-21053 | Laboratory Control Sample | | | | Run: SUB-B75634 | | | | 05/12/06 11:28 |
| Mercury | 4.0 | mg/kg | 1.0 | 111 | 70 | 130 | | | |
| **Sample ID:** B06050671-010AMSD3 | Sample Matrix Spike Duplicate | | | | Run: SUB-B75634 | | | | 05/12/06 12:37 |
| Mercury | 10 | mg/kg-dry | 1.0 | 88 | 75 | 125 | 16 | 30 | |
| **Method:** SW7471A | | | | | | | | | Analytical Run: SUB-B75634 |
| **Sample ID:** QCS | Initial Calibration Verification Standard | | | | | | | | 05/12/06 11:17 |
| Mercury | 0.0019 | mg/kg | 1.0 | 93 | 85 | 115 | | | |

**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.

S - Spike recovery outside of advisory limits.

ENERGY LABORATORIES

# Chain of Custody and Analytical Request Record

Page ____ of ____

**PLEASE PRINT**, provide as much information as possible. Refer to corresponding notes on reverse side.

Company Name: Pioneer Technical Service, Inc.

Project Name, PWS #, Permit #, Etc.: GREAT Divide

Report Mail Address: P.O. Box 3445 Butte, MT 59701

Contact Name, Phone, Fax, E-mail: MARTY Bennett 406-782-5777 EXT 18 mbennett@Pioneer-Technical.com

Sampler Name if other than Contact:

Invoice Address: SAme

Invoice Contact & Phone #:

Purchase Order #:

ELI Quote #:

Report Required For: POTW/WWTP ☐ DW ☐ Other ________

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

NELAC ☐ A2LA ☐ Level IV ☐

Other ________

EDD/EDT ☐ Format ________

Notify ELI prior to RUSH sample submittal for additional charges and scheduling

Comments:

Shipped by: Hand Del

Cooler ID(s) e

Receipt Temp 7.5 °C

Custody Seal Y [✓ N]

Intact Y [✓ N]

Signature Match Y [✓ N]

| | SAMPLE IDENTIFICATION (Name, Location, Interval, etc.) | Collection Date | Collection Time | MATRIX | TOTAL Metals Sb, As, BA, Cd, CR | Cu, FE, Pb, Mn, Hg | Ni, Ag, ZN | Low Level Hg | Nitrite/Nitrate | TOTAL Dissolved Solids | HARDNESS | Turbidity | Low Level Hg | SEE ATTACHED | Normal Turnaround (TAT) | RUSH Turnaround (TAT) | | LABORATORY USE ONLY Lab ID |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8 GD-SW01-050206 | 5/2/06 | 13:45 | W | X | | | X | X | X | X | X | X | | | | | C06050030-001 |
| 2 | GD-SD-01-050206 | | 13:45 | Soil | X | | | | | | | | | | | | | 002 |
| 3 | GD-SW03-050206 | | 14:45 | W | X | | | X | X | X | X | X | X | | | | | 003 |
| 4 | GD-SD03-050206 | | 14:45 | Soil | X | | | | | | | | | | | | | 004 |
| 5 | GD-SW02-050206 | | 15:30 | W | X | | | X | X | X | X | X | X | | | | | 005 |
| 6 | GD-SD02-050206 | | 15:30 | Soil | X | | | | | | | | | | | | | 006 |
| 7 | | | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | |

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

**Custody Record MUST be Signed**

Relinquished by (print): MARTY BENNETT Date/Time: 5/2/06 16:26 Signature: Marty Bennett

Received by (print): Roxanne Tubbs Date/Time: 5.2.06 16:11 Signature: R. Tubbs

Relinquished by (print): Date/Time: Signature:

Received by (print): Date/Time: Signature:

Sample Disposal: Return to client: ________ Lab Disposal: ________

LABORATORY USE ONLY

Sample Type: ________ # of fractions ________

**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, & links.

**ENERGY LABORATORIES, INC.** • P.O. Box 5688 • 3161 East Lyndale Ave. • Helena, MT 59604
877-472-0711 • 406-442-0711 • 406-442-0712 fax • helena@energylab.com

## Energy Laboratories Inc

## Sample Receipt Checklist

Client Name Pioneer Technical Services

Date and Time Received: 5/2/2006 4:27:00 PM

Work Order Number H06050030

Received by rlt

Login completed by: Roxanne L. Tubbs (Signature) 5/2/2006 4:27:00 P (Date)

Reviewed by JDH / GBB (Initials) 5/5/06 / 5/4/06 (Date)

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 in compliance? | Yes ☑ | No ☐ | 7.5 °C |
| Water - VOA vials have zero headspace? | Yes ☐ | No ☐ | No VOA vials submitted ☑ |
| Water - pH acceptable upon receipt? | Yes ☐ | No ☑ | Not Applicable ☐ |

Adjusted? ____________ Checked by ____________

Contact and Corrective Action Comments:

Sulfuric and nitric acid added to samples in laboratory. Rt/5/3/06

LABORATORIES
877-472-0711 • 406-442-0711 • 406-442-0712 fax • helena@energylab.com

# ** REPORT **

RECEIVED
AUG 18 2006

Pioneer Technical Services
Marty Bennett
PO Box 3445
Butte MT 59702

Great Divide
- Sand Tailings
Groundwater Results

LABORATORIES 877-472-0711 • 406-442-0711 • 406-442-0712 fax • helena@energylab.com

# INVOICE

Invoice Date: *August 15, 2006*

**Invoice No: 260860197**

Purchase Order

Account Number P1016

TERMS: NET 30 Days
Interest charged after 30 days 1.5% per month.
VISA/MasterCard payments accepted

BILL TO: **Pioneer Technical Services**
**Attn: Amanda Booth**
**PO Box 3445**
**Butte, MT 59702**

*Page 1*

Project Name: Great Divide

| Item | Remarks | Matrix | List Price | Mult | Price | Qty | Test Total |
|---|---|---|---|---|---|---|---|
| **WorkOrder:** H06080038 | | | | | | | |
| Metals by ICP/ICPMS, Dissolved | | Aqueous | $165.00 | 1 | $165.00 | 3 | $495.00 |
| Nitrogen, Nitrate + Nitrite | | Aqueous | $15.00 | 1 | $15.00 | 3 | $45.00 |
| Solids, Total Dissolved | | Aqueous | $10.00 | 1 | $10.00 | 3 | $30.00 |
| Turbidity | | Aqueous | $10.00 | 1 | $10.00 | 3 | $30.00 |

| | |
|---|---|
| **Subtotal:** | **$600.00** |
| 25% Discount: | ($150.00) |
| **INVOICE Total:** | **$450.00** |
| Amount Received: | $0.00 |
| **AMOUNT DUE:** | **$450.00** |

Please detach and return this section with your payment. Thank you

REMIT TO: Energy Laboratories Inc
Accounts Receivable
PO Box 30975
Billings, MT 59107-0975

| | |
|---|---|
| Account Number: | P1016 |
| Invoice Number: | 260860197 |
| Invoice Date: | 08/15/06 |
| Purchase Order: | |
| Invoice Total: | $450.00 |
| Amount Received: | $0.00 |
| Amount Due: | $450.00 |

P1016 260860197 000045000 0260906293

LABORATORIES
877-472-0711 • 406-442-0711 • 406-442-0712 fax • helena@energylab.com

# ANALYTICAL SUMMARY REPORT

August 15, 2006

Marty Bennett
Pioneer Technical Services
PO Box 3445
Butte, MT 59702

Workorder No.: H06080038

Project Name: Great Divide

Energy Laboratories Inc received the following 3 samples from Pioneer Technical Services on 8/3/2006 for analysis.

| Sample ID | Client Sample ID | Collect Date | Receive Date | Matrix | Test |
|---|---|---|---|---|---|
| H06080038-001 | GD-GW-01-080306 | 08/03/06 10:45 | 08/03/06 | Aqueous | Metals by ICP/ICPMS, Dissolved<br>Hardness as CaCO3<br>Nitrogen, Nitrate + Nitrite<br>Solids, Total Dissolved<br>Turbidity |
| H06080038-002 | GD-GW-02-080306 | 08/03/06 12:50 | 08/03/06 | Aqueous | Same As Above |
| H06080038-003 | GD-GW-02T-080306 | 08/03/06 13:05 | 08/03/06 | Aqueous | Same As Above |

There were no problems with the analyses and all data for associated QC met EPA or laboratory specifications except where noted in the Case Narrative or Report.

If you have any questions regarding these tests results, please call.

**Report Approved By:**

# LABORATORY ANALYTICAL REPORT

**Client:** Pioneer Technical Services
**Project:** Great Divide
**Lab ID:** H06080038-001
**Client Sample ID:** GD-GW-01-080306

**Report Date:** 08/15/06
**Collection Date:** 08/03/06 10:45
**DateReceived:** 08/03/06
**Matrix:** Aqueous

| Analyses | Result | Units | Qualifiers | RL | MCL/ QCL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| PHYSICAL PROPERTIES | | | | | | | |
| Turbidity | 0.24 | NTU | | 0.01 | | E180.1 | 08/04/06 13:15 / sld |
| Solids, Total Dissolved TDS @ 180 C | 141 | mg/L | | 10 | | A2540 C | 08/09/06 15:15 / sld |
| INORGANICS | | | | | | | |
| Hardness as CaCO3 | 102 | mg/L | | 1 | | A2340 B | 08/11/06 16:01 / eli-b |
| NUTRIENTS | | | | | | | |
| Nitrogen, Nitrate+Nitrite as N | 0.44 | mg/L | | 0.05 | | E353.2 | 08/07/06 11:00 / sld |
| METALS, DISSOLVED | | | | | | | |
| Antimony | ND | mg/L | | 0.005 | | E200.8 | 08/11/06 01:41 / eli-b |
| Arsenic | ND | mg/L | | 0.005 | | E200.8 | 08/11/06 01:41 / eli-b |
| Barium | ND | mg/L | | 0.1 | | E200.7 | 08/09/06 17:32 / eli-b |
| Cadmium | ND | mg/L | | 0.001 | | E200.8 | 08/11/06 01:41 / eli-b |
| Calcium | 35 | mg/L | | 1 | | E200.7 | 08/09/06 17:32 / eli-b |
| Chromium | ND | mg/L | | 0.01 | | E200.8 | 08/11/06 01:41 / eli-b |
| Copper | 0.02 | mg/L | | 0.01 | | E200.8 | 08/11/06 01:41 / eli-b |
| Iron | ND | mg/L | | 0.03 | | E200.7 | 08/09/06 17:32 / eli-b |
| Lead | ND | mg/L | | 0.01 | | E200.8 | 08/11/06 01:41 / eli-b |
| Magnesium | 3 | mg/L | | 1 | | E200.7 | 08/09/06 17:32 / eli-b |
| Manganese | ND | mg/L | | 0.01 | | E200.7 | 08/09/06 17:32 / eli-b |
| Mercury | ND | mg/L | | 0.0001 | | E200.8 | 08/11/06 01:41 / eli-b |
| Nickel | ND | mg/L | | 0.01 | | E200.7 | 08/09/06 17:32 / eli-b |
| Silver | ND | mg/L | | 0.005 | | E200.8 | 08/11/06 01:41 / eli-b |
| Zinc | ND | mg/L | | 0.01 | | E200.7 | 08/09/06 17:32 / eli-b |

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

# LABORATORY ANALYTICAL REPORT

**Client:** Pioneer Technical Services
**Project:** Great Divide
**Lab ID:** H06080038-002
**Client Sample ID:** GD-GW-02-080306

**Report Date:** 08/15/06
**Collection Date:** 08/03/06 12:50
**DateReceived:** 08/03/06
**Matrix:** Aqueous

| Analyses | Result | Units | Qualifiers | RL | MCL/ QCL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| PHYSICAL PROPERTIES | | | | | | | |
| Turbidity | 0.50 | NTU | | 0.01 | | E180.1 | 08/04/06 13:15 / sld |
| Solids, Total Dissolved TDS @ 180 C | 167 | mg/L | | 10 | | A2540 C | 08/09/06 15:15 / sld |
| INORGANICS | | | | | | | |
| Hardness as CaCO3 | 121 | mg/L | | 1 | | A2340 B | 08/11/06 16:01 / eli-b |
| NUTRIENTS | | | | | | | |
| Nitrogen, Nitrate+Nitrite as N | 1.31 | mg/L | | 0.05 | | E353.2 | 08/07/06 11:10 / sld |
| METALS, DISSOLVED | | | | | | | |
| Antimony | ND | mg/L | | 0.005 | | E200.8 | 08/11/06 01:48 / eli-b |
| Arsenic | ND | mg/L | | 0.005 | | E200.8 | 08/11/06 01:48 / eli-b |
| Barium | ND | mg/L | | 0.1 | | E200.7 | 08/09/06 17:37 / eli-b |
| Cadmium | ND | mg/L | | 0.001 | | E200.8 | 08/11/06 01:48 / eli-b |
| Calcium | 40 | mg/L | | 1 | | E200.7 | 08/09/06 17:37 / eli-b |
| Chromium | ND | mg/L | | 0.01 | | E200.8 | 08/11/06 01:48 / eli-b |
| Copper | ND | mg/L | | 0.01 | | E200.8 | 08/11/06 01:48 / eli-b |
| Iron | ND | mg/L | | 0.03 | | E200.7 | 08/09/06 17:37 / eli-b |
| Lead | ND | mg/L | | 0.01 | | E200.8 | 08/11/06 01:48 / eli-b |
| Magnesium | 5 | mg/L | | 1 | | E200.7 | 08/09/06 17:37 / eli-b |
| Manganese | ND | mg/L | | 0.01 | | E200.7 | 08/09/06 17:37 / eli-b |
| Mercury | ND | mg/L | | 0.0001 | | E200.8 | 08/11/06 01:48 / eli-b |
| Nickel | ND | mg/L | | 0.01 | | E200.7 | 08/09/06 17:37 / eli-b |
| Silver | ND | mg/L | | 0.005 | | E200.8 | 08/11/06 01:48 / eli-b |
| Zinc | ND | mg/L | | 0.01 | | E200.7 | 08/09/06 17:37 / eli-b |

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

# LABORATORY ANALYTICAL REPORT

**Client:** Pioneer Technical Services
**Project:** Great Divide
**Lab ID:** H06080038-003
**Client Sample ID:** GD-GW-02T-080306

**Report Date:** 08/15/06
**Collection Date:** 08/03/06 13:05
**DateReceived:** 08/03/06
**Matrix:** Aqueous

| Analyses | Result | Units | Qualifiers | RL | MCL/ QCL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| PHYSICAL PROPERTIES | | | | | | | |
| Turbidity | 0.41 | NTU | | 0.01 | | E180.1 | 08/04/06 13:17 / sld |
| Solids, Total Dissolved TDS @ 180 C | 168 | mg/L | | 10 | | A2540 C | 08/09/06 15:15 / sld |
| INORGANICS | | | | | | | |
| Hardness as CaCO3 | 128 | mg/L | | 1 | | A2340 B | 08/11/06 16:01 / eli-b |
| NUTRIENTS | | | | | | | |
| Nitrogen, Nitrate+Nitrite as N | 1.32 | mg/L | | 0.05 | | E353.2 | 08/07/06 11:12 / sld |
| METALS, DISSOLVED | | | | | | | |
| Antimony | ND | mg/L | | 0.005 | | E200.8 | 08/11/06 02:23 / eli-b |
| Arsenic | ND | mg/L | | 0.005 | | E200.8 | 08/11/06 02:23 / eli-b |
| Barium | ND | mg/L | | 0.1 | | E200.7 | 08/09/06 17:45 / eli-b |
| Cadmium | ND | mg/L | | 0.001 | | E200.8 | 08/11/06 02:23 / eli-b |
| Calcium | 43 | mg/L | | 1 | | E200.7 | 08/09/06 17:45 / eli-b |
| Chromium | ND | mg/L | | 0.01 | | E200.8 | 08/11/06 02:23 / eli-b |
| Copper | ND | mg/L | | 0.01 | | E200.8 | 08/11/06 02:23 / eli-b |
| Iron | ND | mg/L | | 0.03 | | E200.7 | 08/09/06 17:45 / eli-b |
| Lead | ND | mg/L | | 0.01 | | E200.8 | 08/11/06 02:23 / eli-b |
| Magnesium | 5 | mg/L | | 1 | | E200.7 | 08/09/06 17:45 / eli-b |
| Manganese | ND | mg/L | | 0.01 | | E200.7 | 08/09/06 17:45 / eli-b |
| Mercury | ND | mg/L | | 0.0001 | | E200.8 | 08/11/06 02:23 / eli-b |
| Nickel | ND | mg/L | | 0.01 | | E200.7 | 08/09/06 17:45 / eli-b |
| Silver | ND | mg/L | | 0.005 | | E200.8 | 08/11/06 02:23 / eli-b |
| Zinc | ND | mg/L | | 0.01 | | E200.7 | 08/09/06 17:45 / eli-b |

**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:** Pioneer Technical Services
**Project:** Great Divide

**Report Date:** 08/15/06
**Work Order:** H06080038

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method:** A2540 C | | | | | | | | | Batch: 060809A-SLDS-TDS-W |
| Sample ID: MBLK1_060809A | Method Blank | | | | Run: SOLIDS_060809A | | | | 08/09/06 15:14 |
| Solids, Total Dissolved TDS @ 180 C | ND | mg/L | 1 | | | | | | |
| Sample ID: LCS1_060809A | Laboratory Control Sample | | | | Run: SOLIDS_060809A | | | | 08/09/06 15:15 |
| Solids, Total Dissolved TDS @ 180 C | 999 | mg/L | 10 | 100 | 90 | 110 | | | |
| Sample ID: H06080038-003AMS | Sample Matrix Spike | | | | Run: SOLIDS_060809A | | | | 08/09/06 15:15 |
| Solids, Total Dissolved TDS @ 180 C | 2110 | mg/L | 10 | 97 | 80 | 120 | | | |
| Sample ID: H06080038-003AMSD | Sample Matrix Spike Duplicate | | | | Run: SOLIDS_060809A | | | | 08/09/06 15:16 |
| Solids, Total Dissolved TDS @ 180 C | 2120 | mg/L | 10 | 98 | 80 | 120 | 0.3 | 10 | |
| **Method:** E180.1 | | | | | | | | | Batch: 060804A-TURB-W |
| Sample ID: MBLK1_060804A | Method Blank | | | | Run: TURBIDITY_060804A | | | | 08/04/06 13:11 |
| Turbidity | 0.2 | NTU | | | | | | | |
| Sample ID: LCS1_060804A | Laboratory Control Sample | | | | Run: TURBIDITY_060804A | | | | 08/04/06 13:12 |
| Turbidity | 1.02 | NTU | 0.010 | 87 | 90 | 110 | | | |
| Sample ID: H06080038-002ADUP | Sample Duplicate | | | | Run: TURBIDITY_060804A | | | | 08/04/06 13:16 |
| Turbidity | 0.501 | NTU | 0.010 | | | | 0.0 | 20 | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

**Client:** Pioneer Technical Services
**Project:** Great Divide

**Report Date:** 08/15/06
**Work Order:** H06080038

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| Method: E200.7 | | | | | | | | | Analytical Run: SUB-B80278 |
| **Sample ID: QCS** | Initial Calibration Verification Standard | | | | | | | | 08/09/06 15:50 |
| Barium | 1.08 | mg/L | 0.10 | 108 | 90 | 110 | | | |
| Calcium | 49.0 | mg/L | 1.0 | 98 | 90 | 110 | | | |
| Iron | 5.00 | mg/L | 0.030 | 100 | 90 | 110 | | | |
| Magnesium | 49.4 | mg/L | 1.0 | 99 | 90 | 110 | | | |
| Manganese | 5.20 | mg/L | 0.010 | 104 | 90 | 110 | | | |
| Nickel | 1.04 | mg/L | 0.050 | 104 | 90 | 110 | | | |
| Zinc | 1.06 | mg/L | 0.010 | 106 | 90 | 110 | | | |
| **Sample ID: CRI** | CRDL Standard for ICP | | | | | | | | 08/09/06 16:02 |
| Barium | 0.00335 | mg/L | 0.10 | 112 | 50 | 150 | | | |
| Calcium | 0.524 | mg/L | 1.0 | 105 | 50 | 150 | | | |
| Iron | 0.0250 | mg/L | 0.030 | 125 | 50 | 150 | | | |
| Magnesium | 0.534 | mg/L | 1.0 | 107 | 50 | 150 | | | |
| Manganese | 0.00490 | mg/L | 0.010 | 98 | 50 | 150 | | | |
| Nickel | 0.0207 | mg/L | 0.050 | 104 | 50 | 150 | | | |
| Zinc | 0.00964 | mg/L | 0.010 | 96 | 50 | 150 | | | |
| **Sample ID: ICSA** | Interference Check Sample A | | | | | | | | 08/09/06 16:05 |
| Barium | 0.000700 | mg/L | 0.10 | | -0.005 | 0.0005 | | | |
| Iron | 199 | mg/L | 0.20 | 99 | 80 | 120 | | | |
| Magnesium | 545 | mg/L | 1.0 | 109 | 80 | 120 | | | |
| Manganese | -0.00500 | mg/L | 0.010 | | -0.01 | 0.01 | | | |
| Nickel | 0.0443 | mg/L | 0.050 | | -0.05 | 0.05 | | | |
| Zinc | -0.0172 | mg/L | 0.010 | | -0.01 | 0.01 | | | |
| **Sample ID: ICSAB** | Interference Check Sample AB | | | | | | | | 08/09/06 16:09 |
| Calcium | 541 | mg/L | 1.0 | 108 | 80 | 120 | | | |
| Iron | 188 | mg/L | 0.030 | 94 | 80 | 120 | | | |
| Magnesium | 565 | mg/L | 1.0 | 113 | 80 | 120 | | | |
| Manganese | 0.562 | mg/L | 0.010 | 112 | 80 | 120 | | | |
| Nickel | 1.12 | mg/L | 0.050 | 112 | 80 | 120 | | | |
| Zinc | 1.15 | mg/L | 0.010 | 115 | 80 | 120 | | | |
| **Sample ID: CRI** | CRDL Standard for ICP | | | | | | | | 08/10/06 08:48 |
| Barium | 0.00303 | mg/L | 0.10 | 101 | 50 | 150 | | | |
| Calcium | 0.459 | mg/L | 1.0 | 92 | 50 | 150 | | | |
| Iron | 0.0207 | mg/L | 0.030 | 103 | 50 | 150 | | | |
| Magnesium | 0.380 | mg/L | 1.0 | 76 | 50 | 150 | | | |
| Manganese | 0.00519 | mg/L | 0.010 | 104 | 50 | 150 | | | |
| Nickel | 0.0204 | mg/L | 0.050 | 102 | 50 | 150 | | | |
| Zinc | 0.00933 | mg/L | 0.010 | 93 | 50 | 150 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

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# QA/QC Summary Report

**Client:** Pioneer Technical Services
**Project:** Great Divide

**Report Date:** 08/15/06
**Work Order:** H06080038

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method:** E200.7 | | | | | | Analytical Run: SUB-B80278 | | | |
| **Sample ID:** ICSA | Interference Check Sample A | | | | | | | 08/10/06 08:51 | |
| Barium | 8.00E-05 | mg/L | 0.10 | | -0.005 | 0.0005 | | | |
| Calcium | 561 | mg/L | 1.0 | 112 | 80 | 120 | | | |
| Iron | 187 | mg/L | 0.030 | 94 | 80 | 120 | | | |
| Magnesium | 559 | mg/L | 1.0 | 112 | 80 | 120 | | | |
| Manganese | -0.00609 | mg/L | 0.010 | | -0.01 | 0.01 | | | |
| Nickel | 0.0431 | mg/L | 0.050 | | -0.05 | 0.05 | | | |
| Zinc | -0.0153 | mg/L | 0.010 | | -0.01 | 0.01 | | | |
| **Sample ID:** ICSAB | Interference Check Sample AB | | | | | | | 08/10/06 08:55 | |
| Barium | 0.588 | mg/L | 0.10 | 118 | 80 | 120 | | | |
| Calcium | 555 | mg/L | 1.0 | 111 | 80 | 120 | | | |
| Iron | 186 | mg/L | 0.030 | 93 | 80 | 120 | | | |
| Magnesium | 555 | mg/L | 1.0 | 111 | 80 | 120 | | | |
| Manganese | 0.560 | mg/L | 0.010 | 112 | 80 | 120 | | | |
| Nickel | 1.08 | mg/L | 0.050 | 108 | 80 | 120 | | | |
| Zinc | 1.14 | mg/L | 0.010 | 114 | 80 | 120 | | | |
| **Method:** E200.7 | | | | | | | | Batch: B_R80278 | |
| **Sample ID:** B06080633-003AMS2 | Sample Matrix Spike | | | | Run: SUB-B80278 | | | 08/09/06 18:23 | |
| Barium | 2.377 | mg/L | 0.10 | 117 | 70 | 130 | | | |
| Calcium | 146.4 | mg/L | 1.0 | 109 | 70 | 130 | | | |
| Iron | 11.38 | mg/L | 0.030 | 114 | 70 | 130 | | | |
| Magnesium | 116.7 | mg/L | 1.0 | 110 | 70 | 130 | | | |
| Manganese | 11.78 | mg/L | 0.010 | 118 | 70 | 130 | | | |
| Nickel | 2.389 | mg/L | 0.010 | 119 | 70 | 130 | | | |
| Zinc | 2.431 | mg/L | 0.010 | 121 | 70 | 130 | | | |
| **Sample ID:** MB-TJADIS060809A | Method Blank | | | | Run: SUB-B80278 | | | 08/09/06 16:20 | |
| Barium | ND | mg/L | 0.0004 | | | | | | |
| Calcium | ND | mg/L | 0.1 | | | | | | |
| Iron | ND | mg/L | 0.003 | | | | | | |
| Magnesium | ND | mg/L | 0.05 | | | | | | |
| Manganese | ND | mg/L | 0.001 | | | | | | |
| Nickel | ND | mg/L | 0.003 | | | | | | |
| Zinc | ND | mg/L | 0.002 | | | | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

**Client:** Pioneer Technical Services
**Project:** Great Divide

**Report Date:** 08/15/06
**Work Order:** H06080038

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method:** E200.8 | | | | | | | | | Analytical Run: SUB-B80360 |
| **Sample ID:** QCS - ME060417BA, ME | Initial Calibration Verification Standard | | | | | | | | 08/10/06 10:35 |
| Antimony | 0.050 | mg/L | 0.050 | 100 | 90 | 110 | | | |
| Arsenic | 0.050 | mg/L | 0.0050 | 99 | 90 | 110 | | | |
| Cadmium | 0.025 | mg/L | 0.0010 | 99 | 90 | 110 | | | |
| Chromium | 0.050 | mg/L | 0.010 | 99 | 90 | 110 | | | |
| Copper | 0.049 | mg/L | 0.010 | 98 | 90 | 110 | | | |
| Lead | 0.050 | mg/L | 0.010 | 100 | 90 | 110 | | | |
| Mercury | 0.0020 | mg/L | 0.0010 | 101 | 90 | 110 | | | |
| Silver | 0.025 | mg/L | 0.0050 | 98 | 90 | 110 | | | |
| **Sample ID:** QCS - ME060417BA, ME | Initial Calibration Verification Standard | | | | | | | | 08/10/06 22:34 |
| Antimony | 0.050 | mg/L | 0.050 | 100 | 90 | 110 | | | |
| Arsenic | 0.050 | mg/L | 0.0050 | 99 | 90 | 110 | | | |
| Cadmium | 0.025 | mg/L | 0.0010 | 99 | 90 | 110 | | | |
| Chromium | 0.050 | mg/L | 0.010 | 100 | 90 | 110 | | | |
| Copper | 0.049 | mg/L | 0.010 | 98 | 90 | 110 | | | |
| Lead | 0.050 | mg/L | 0.010 | 100 | 90 | 110 | | | |
| Mercury | 0.0020 | mg/L | 0.0010 | 102 | 90 | 110 | | | |
| Silver | 0.025 | mg/L | 0.0050 | 100 | 90 | 110 | | | |
| **Method:** E200.8 | | | | | | | | | Batch: B_R80360 |
| **Sample ID:** B06080545-005BMS | Sample Matrix Spike | | | | Run: SUB-B80360 | | | | 08/10/06 18:10 |
| Antimony | 0.05697 | mg/L | 0.0050 | 113 | 70 | 130 | | | |
| Arsenic | 0.05954 | mg/L | 0.0050 | 111 | 70 | 130 | | | |
| Cadmium | 0.05210 | mg/L | 0.0010 | 104 | 70 | 130 | | | |
| Chromium | 0.05452 | mg/L | 0.010 | 107 | 70 | 130 | | | |
| Copper | 0.04866 | mg/L | 0.010 | 97 | 70 | 130 | | | |
| Lead | 0.05429 | mg/L | 0.010 | 109 | 70 | 130 | | | |
| Mercury | 0.001006 | mg/L | 0.0010 | 93 | 70 | 130 | | | |
| Silver | 0.01706 | mg/L | 0.0050 | 85 | 70 | 130 | | | |
| **Sample ID:** B06080545-005BMSD | Sample Matrix Spike Duplicate | | | | Run: SUB-B80360 | | | | 08/10/06 18:17 |
| Antimony | 0.05833 | mg/L | 0.0050 | 116 | 70 | 130 | 2.4 | 20 | |
| Arsenic | 0.06098 | mg/L | 0.0050 | 114 | 70 | 130 | 2.4 | 20 | |
| Cadmium | 0.05296 | mg/L | 0.0010 | 106 | 70 | 130 | 1.6 | 20 | |
| Chromium | 0.05570 | mg/L | 0.010 | 109 | 70 | 130 | 2.1 | 20 | |
| Copper | 0.04957 | mg/L | 0.010 | 99 | 70 | 130 | 1.9 | 20 | |
| Lead | 0.05455 | mg/L | 0.010 | 109 | 70 | 130 | 0.5 | 20 | |
| Mercury | 0.0009620 | mg/L | 0.0010 | 88 | 70 | 130 | 0.0 | 20 | |
| Silver | 0.01938 | mg/L | 0.0050 | 97 | 70 | 130 | 13 | 20 | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

**Client:** Pioneer Technical Services
**Project:** Great Divide

**Report Date:** 08/15/06
**Work Order:** H06080038

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method:** E200.8 | | | | | | | | | Batch: B_R80360 |
| **Sample ID:** LRB | Method Blank | | | | Run: SUB-B80360 | | | | 08/10/06 11:48 |
| Antimony | ND | mg/L | 4E-05 | | | | | | |
| Arsenic | ND | mg/L | 9E-05 | | | | | | |
| Cadmium | ND | mg/L | 0.0001 | | | | | | |
| Chromium | ND | mg/L | 8E-05 | | | | | | |
| Copper | ND | mg/L | 0.0002 | | | | | | |
| Lead | ND | mg/L | 1E-05 | | | | | | |
| Mercury | ND | mg/L | 2E-05 | | | | | | |
| Silver | ND | mg/L | 7E-05 | | | | | | |
| **Sample ID:** LFB | Laboratory Fortified Blank | | | | Run: SUB-B80360 | | | | 08/10/06 11:55 |
| Antimony | 0.053 | mg/L | 0.050 | 106 | 85 | 115 | | | |
| Arsenic | 0.052 | mg/L | 0.0050 | 104 | 85 | 115 | | | |
| Cadmium | 0.052 | mg/L | 0.0010 | 103 | 85 | 115 | | | |
| Chromium | 0.049 | mg/L | 0.010 | 97 | 85 | 115 | | | |
| Copper | 0.050 | mg/L | 0.010 | 100 | 85 | 115 | | | |
| Lead | 0.051 | mg/L | 0.010 | 102 | 85 | 115 | | | |
| Mercury | 0.0010 | mg/L | 0.0010 | 100 | 85 | 115 | | | |
| Silver | 0.020 | mg/L | 0.0050 | 99 | 85 | 115 | | | |
| **Method:** E353.2 | | | | | | | | | Analytical Run: NUTRIENTS_060807A |
| **Sample ID:** ICV-1 | Initial Calibration Verification Standard | | | | | | | | 08/07/06 10:20 |
| Nitrogen, Nitrate+Nitrite as N | 1.01 | mg/L | 0.050 | 101 | 90 | 110 | | | |
| **Method:** E353.2 | | | | | | | | | Batch: A2006-08-07_5_NO3_01 |
| **Sample ID:** LCS-2 | Laboratory Control Sample | | | | Run: NUTRIENTS_060807A | | | | 08/07/06 10:22 |
| Nitrogen, Nitrate+Nitrite as N | 26.4 | mg/L | 0.30 | 100 | 90 | 110 | | | |
| **Sample ID:** LFB-3 | Laboratory Fortified Blank | | | | Run: NUTRIENTS_060807A | | | | 08/07/06 10:24 |
| Nitrogen, Nitrate+Nitrite as N | 0.520 | mg/L | 0.050 | 104 | 90 | 110 | | | |
| **Sample ID:** MBLK-5 | Method Blank | | | | Run: NUTRIENTS_060807A | | | | 08/07/06 10:28 |
| Nitrogen, Nitrate+Nitrite as N | ND | mg/L | 0.01 | | | | | | |
| **Sample ID:** H06070303-006ADUP | Sample Duplicate | | | | Run: NUTRIENTS_060807A | | | | 08/07/06 10:38 |
| Nitrogen, Nitrate+Nitrite as N | ND | mg/L | 0.050 | | | | 0.0 | 20 | |
| **Sample ID:** H06080038-001CMS | Sample Matrix Spike | | | | Run: NUTRIENTS_060807A | | | | 08/07/06 11:02 |
| Nitrogen, Nitrate+Nitrite as N | 1.36 | mg/L | 0.050 | 92 | 90 | 110 | | | |
| **Sample ID:** H06080038-001CMSD | Sample Matrix Spike Duplicate | | | | Run: NUTRIENTS_060807A | | | | 08/07/06 11:08 |
| Nitrogen, Nitrate+Nitrite as N | 1.36 | mg/L | 0.050 | 92 | 90 | 110 | 0.0 | 20 | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

**ENERGY LABORATORIES**

# Chain of Custody and Analytical Request Record

Page 1 of 1

**PLEASE PRINT**, provide as much information as possible. Refer to corresponding notes on reverse side.

Company Name: Pioneer Technical Services

Project Name, PWS #, Permit #, Etc.: Great Divide

Report Mail Address: 63½ W Broadway
Butte, MT 59701

Contact Name, Phone, Fax, E-mail: Marty Bennett
406-782-5177

Sampler Name if other than Contact: Julie Flammang

Invoice Address: Same as above

Invoice Contact & Phone #: ~~Same~~ Amanda Booth
406-782-5177

Purchase Order #:

ELI Quote #:

Report Required For: POTW/WWTP ☐ DW ☐ Other ______

Special Report Formats - ELI must be notified prior to sample submittal for the following:
NELAC ☐ A2LA ☐ Level IV ☐
Other ______
EDD/EDT ☐ Format ______

Notify ELI prior to RUSH sample submittal for additional charges and scheduling

Comments: Need Low Detection Limit for Hg

Shipped by: hand del.
Cooler ID(s):
Receipt Temp 9 - on Ice °C
Custody Seal Y [✓ N]
Intact Y [✓ N]
Signature Match Y [✓ N]

## ANALYSIS REQUESTED

| SAMPLE IDENTIFICATION (Name, Location, Interval, etc.) | Collection Date | Collection Time | Number of Containers | Sample Type: A W S V B O (Air Water Soils/Solids Vegetation Bioassay Other) MATRIX | Hardness Turbidity TDS | NO2/NO3 | Dm Sb, As, Ba, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Ag, Zn | | | | | | | SEE ATTACHED | Normal Turnaround (TAT) | RUSH Turnaround (TAT) | LABORATORY USE ONLY Lab ID |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 GD-GW-01-080306 | 8/3/06 | 1045 | 4 | W | ✓ | ✓ | ✓ | | | | | | | | | | B06080038-001 |
| 2 GD-GW-02-080306 | ↓ | 1250 | 4 | W | ✓ | ✓ | ✓ | | | | | | | | | | 003 |
| 3 GD-GW-02I-080306 | | 1305 | 4 | W | ✓ | ✓ | ✓ | | | | | | | | | | 003 |
| 4 | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | |

**Custody Record MUST be Signed**

| Relinquished by (print): | Date/Time: | Signature: | Received by (print): | Date/Time: | Signature: |
|---|---|---|---|---|---|
| Julie Flammang | 8/3/06 | Julie Flammang | Wanda Johnson | 8/3/06 14:02 | W |
| Relinquished by (print): | Date/Time: | Signature: | Received by (print): | Date/Time: | Signature: |
| | | | | | |

Sample Disposal: Return to client: ______ Lab Disposal: ______

LABORATORY USE ONLY
Sample Type: ______ # of fractions ______

**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, & links.

# Energy Laboratories Inc

## Sample Receipt Checklist

Client Name Pioneer Technical Services

Date and Time Received: 8/3/2006 2:02:00 PM

Work Order Number H06080038

Received by wjj

Login completed by: Roxanne L. Tubbs 8/3/2006 2:02:00 P
Signature Date

Reviewed by JNH 8/7/06
dBB 8/4/06
Initials Date

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 in compliance? | Yes ☑ | No ☐ | 9 °C From Field |
| Water - VOA vials have zero headspace? | Yes ☐ | No ☐ | No VOA vials submitted ☑ |
| Water - pH acceptable upon receipt? | Yes ☑ | No ☐ | Not Applicable ☐ |

Adjusted? ______________ Checked by ______________

Contact and Corrective Action Comments:

None

**ENERGY LABORATORIES, INC.** • P.O. Box 5688 • 3161 East Lyndale Ave. • Helena, MT 59604
877-472-0711 • 406-442-0711 • 406-442-0712 fax • helena@energylab.com

**Date:** 16-Aug-06

**CLIENT:** Pioneer Technical Services
**Project:** Great Divide
**Sample Delivery Group:** H06070108

# CASE NARRATIVE

Client contacted Energy Laboratories requesting N,P,K in lbs/Ac using depth specified on chain of custody for two samples at 6" and where not specified use 12". Requested Total Sulfur, Total Pyritic & Total Organic sulfur be reported.

**ENERGY LABORATORIES**

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# LABORATORY ANALYTICAL REPORT

**Client:** Pioneer Technical Services
**Project:** Great Divide
**Lab ID:** H06070108-001
**Client Sample ID:** DH1A-071006

**Report Date:** 08/14/06
**Collection Date:** 07/11/06 16:00
**DateReceived:** 07/12/06
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MCL/ QCL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **SATURATED PASTE** | | | | | | | |
| pH, sat. paste | 8.0 | s.u. | | 0.1 | | ASAM10-3.2 | 07/19/06 12:09 / jjm |
| Conductivity, sat. paste | 0.41 | mmhos/cm | | 0.01 | | ASAM10-3 | 07/19/06 12:09 / jjm |
| Saturation | 48.3 | % | | 0.1 | | USDA27a | 07/19/06 12:09 / jjm |
| Sodium Adsorption Ratio (SAR) | 0.63 | unitless | | 0.01 | | Calculation | 07/19/06 12:09 / jjm |
| **SATURATED PASTE** | | | | | | | |
| Calcium, sat. paste | 2.46 | meq/l | | 0.05 | | SW6010B | 07/21/06 12:51 / rp |
| Magnesium, sat. paste | 1.20 | meq/l | | 0.08 | | SW6010B | 07/21/06 12:51 / rp |
| Sodium, sat. paste | 0.85 | meq/l | | 0.04 | | SW6010B | 07/21/06 12:51 / rp |
| **PHYSICAL CHARACTERISTICS** | | | | | | | |
| Moisture (As Received) | 5.6 | % | | 0.1 | | USDA26 | 07/17/06 00:00 / jjm |
| Sand | 41 | % | | 1 | | ASA15-5 | 07/19/06 12:09 / jjm |
| Silt | 37 | % | | 1 | | ASA15-5 | 07/19/06 12:09 / jjm |
| Clay | 22 | % | | 1 | | ASA15-5 | 07/19/06 12:09 / jjm |
| Texture | L | unitless | | | | ASA15-5 | 07/19/06 12:09 / jjm |
| **CHEMICAL CHARACTERISTICS** | | | | | | | |
| Potassium, NH4OAc Extractable | 150 | mg/kg | | 1 | | ASA13-3 | 07/26/06 00:00 / rp |
| Organic Matter | 1.00 | % | | 0.02 | | ASA29-3 | 07/17/06 12:57 / jjm |
| Cation Exchange Capacity | 20.7 | meq/100g | | 0.09 | | SW6010B | 07/25/06 15:25 / skr |
| Phosphorus | 8.9 | mg/kg | | 0.1 | | ASA24-5 | 07/27/06 12:07 / rp |
| Nitrate as N, KCL Extract | ND | mg/kg | | 1 | | ASA38-3 | 07/19/06 11:37 / sld |
| Calculated K in lbs/Ac using a depth of 6 inches. K=300 lbs/Ac | | | | | | | |
| Calculated P in lbs/Ac using a depth of 6 inches. P=17.8 lbs/Ac | | | | | | | |
| Calculated NO3 in lbs/Ac using a depth of 6 inches. NO3=1.92 lbs/Ac | | | | | | | |
| **METALS, TOTAL** | | | | | | | |
| Antimony | ND | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:27 / eli-b |
| Arsenic | 17.0 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:27 / eli-b |
| Cadmium | ND | mg/kg | | 1.0 | | SW6010B | 07/19/06 22:27 / eli-b |
| Chromium | 12.6 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:27 / eli-b |
| Copper | 40.0 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:27 / eli-b |
| Iron | 16100 | mg/kg | D | 8.0 | | SW6010B | 07/19/06 22:27 / eli-b |
| Lead | 37.9 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:27 / eli-b |
| Manganese | 645 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:27 / eli-b |
| Mercury | 2.2 | mg/kg | | 1.0 | | SW7471A | 07/31/06 11:40 / eli-b |
| Nickel | 11.4 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:27 / eli-b |
| Silver | 5.8 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:27 / eli-b |
| Zinc | 78.6 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:27 / eli-b |

**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.

# LABORATORY ANALYTICAL REPORT

**Client:** Pioneer Technical Services
**Project:** Great Divide
**Lab ID:** H06070108-001
**Client Sample ID:** DH1A-071006

**Report Date:** 08/14/06
**Collection Date:** 07/11/06 16:00
**DateReceived:** 07/12/06
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MCL/ QCL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **WATER HOLDING CAPACITY** | | | | | | | |
| 1/3 Bar Moisture | 19 | Wt % | | 0.10 | | SSSA pt4 | 08/07/06 00:00 / eli-t |
| 15 Bar Moisture | 8.6 | Wt % | | 0.10 | | SSSA pt4 | 08/08/06 00:00 / eli-t |

# LABORATORY ANALYTICAL REPORT

**Client:** Pioneer Technical Services
**Project:** Great Divide
**Lab ID:** H06070108-002
**Client Sample ID:** DH1B-071006

**Report Date:** 08/14/06
**Collection Date:** 07/11/06 16:00
**DateReceived:** 07/12/06
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MCL/ QCL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **CHEMICAL CHARACTERISTICS** | | | | | | | |
| Sulfur, Total | ND | % | | 0.01 | | E3.2.3 | 08/01/06 12:00 / ejp |
| Sulfur, Pyritic | ND | % | | 0.01 | | E3.2.3 | 08/01/06 12:00 / ejp |
| Sulfur, Organic | ND | % | | 0.01 | | E3.2.3 | 08/01/06 12:00 / ejp |
| Lime Requirement, SMP buffer | <1.1 | Tons/1000T | | 1 | | ASA12-3 | 07/18/06 00:00 / jjm |
| Neutralization Potential | 91 | t/kt | | | | Sobek Modifie | 07/17/06 00:00 / jjm |
| Neutralization Potential | 96 | t/kt | | | | Sobek Modifie | 08/02/06 00:00 / jjm |
| Acid Potential | ND | t/kt | D | 0.01 | | Sobek Modifie | 08/01/06 00:00 / ejp |
| Acid/Base Potential | 91 | t/kt | | | | Sobek Modifie | 08/01/06 00:00 / ejp |
| **METALS, TOTAL** | | | | | | | |
| Antimony | ND | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:31 / eli-b |
| Arsenic | 17.9 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:31 / eli-b |
| Cadmium | ND | mg/kg | | 1.0 | | SW6010B | 07/19/06 22:31 / eli-b |
| Chromium | 8.7 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:31 / eli-b |
| Copper | 81.7 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:31 / eli-b |
| Iron | 15900 | mg/kg | D | 8.0 | | SW6010B | 07/19/06 22:31 / eli-b |
| Lead | 109 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:31 / eli-b |
| Manganese | 1590 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:31 / eli-b |
| Mercury | 1.0 | mg/kg | | 1.0 | | SW7471A | 07/31/06 11:43 / eli-b |
| Nickel | 6.2 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:31 / eli-b |
| Silver | 19.0 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:31 / eli-b |
| Zinc | 181 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:31 / eli-b |
| **METALS, TCLP EXTRACTABLE** | | | | | | | |
| Arsenic | ND | mg/L | | 0.5 | 5 | SW6010B | 07/19/06 20:55 / eli-b |
| Barium | ND | mg/L | | 10 | 100 | SW6010B | 07/19/06 20:55 / eli-b |
| Cadmium | ND | mg/L | | 0.1 | 1 | SW6010B | 07/19/06 20:55 / eli-b |
| Chromium | ND | mg/L | | 0.5 | 5 | SW6010B | 07/19/06 20:55 / eli-b |
| Lead | ND | mg/L | | 0.5 | 5 | SW6010B | 07/19/06 20:55 / eli-b |
| Mercury | ND | mg/L | | 0.02 | 0.2 | SW7470A | 07/21/06 11:34 / eli-b |
| Selenium | ND | mg/L | | 0.1 | 1 | SW6010B | 07/19/06 20:55 / eli-b |
| Silver | ND | mg/L | | 0.5 | 5 | SW6010B | 07/19/06 20:55 / eli-b |

**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.

## LABORATORY ANALYTICAL REPORT

**Client:** Pioneer Technical Services
**Project:** Great Divide
**Lab ID:** H06070108-003
**Client Sample ID:** DH1C-071006

**Report Date:** 08/14/06
**Collection Date:** 07/11/06 16:00
**DateReceived:** 07/12/06
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MCL/ QCL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **SATURATED PASTE** | | | | | | | |
| pH, sat. paste | 7.6 | s.u. | | 0.1 | | ASAM10-3.2 | 07/19/06 12:09 / jjm |
| Conductivity, sat. paste | 0.35 | mmhos/cm | | 0.01 | | ASAM10-3 | 07/19/06 12:09 / jjm |
| Saturation | 35.8 | % | | 0.1 | | USDA27a | 07/19/06 12:09 / jjm |
| Sodium Adsorption Ratio (SAR) | 0.67 | unitless | | 0.01 | | Calculation | 07/19/06 12:09 / jjm |
| **SATURATED PASTE** | | | | | | | |
| Calcium, sat. paste | 2.38 | meq/l | | 0.05 | | SW6010B | 07/21/06 12:54 / rp |
| Magnesium, sat. paste | 0.27 | meq/l | | 0.08 | | SW6010B | 07/21/06 12:54 / rp |
| Sodium, sat. paste | 0.77 | meq/l | | 0.04 | | SW6010B | 07/21/06 12:54 / rp |
| **PHYSICAL CHARACTERISTICS** | | | | | | | |
| Moisture (As Received) | 8.9 | % | | 0.1 | | USDA26 | 07/17/06 00:00 / jjm |
| Sand | 77 | % | | 1 | | ASA15-5 | 07/19/06 12:09 / jjm |
| Silt | 17 | % | | 1 | | ASA15-5 | 07/19/06 12:09 / jjm |
| Clay | 6 | % | | 1 | | ASA15-5 | 07/19/06 12:09 / jjm |
| Texture | LS | unitless | | | | ASA15-5 | 07/19/06 12:09 / jjm |
| **CHEMICAL CHARACTERISTICS** | | | | | | | |
| Potassium, NH4OAc Extractable | 68 | mg/kg | | 1 | | ASA13-3 | 07/26/06 00:00 / rp |
| Organic Matter | 0.51 | % | | 0.02 | | ASA29-3 | 07/17/06 12:57 / jjm |
| Cation Exchange Capacity | 12.1 | meq/100g | | 0.09 | | SW6010B | 07/25/06 15:28 / skr |
| Phosphorus | 23 | mg/kg | | 0.1 | | ASA24-5 | 07/27/06 12:10 / rp |
| Nitrate as N, KCL Extract | ND | mg/kg | | 1 | | ASA38-3 | 07/19/06 11:39 / sld |
| Calculated K in lbs/Ac using a depth of 12 inches. K=272 lbs/Ac | | | | | | | |
| Calculated P In lbs/Ac using a depth of 12 inches. P=92 lbs/Ac | | | | | | | |
| Calculated NO3 in lbs/Ac using a depth of 12 inches. NO3=3.76 lbs/Ac | | | | | | | |
| **METALS, TOTAL** | | | | | | | |
| Antimony | ND | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:34 / eli-b |
| Arsenic | ND | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:34 / eli-b |
| Cadmium | ND | mg/kg | | 1.0 | | SW6010B | 07/19/06 22:34 / eli-b |
| Chromium | 6.4 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:34 / eli-b |
| Copper | 6.4 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:34 / eli-b |
| Iron | 17800 | mg/kg | D | 8.0 | | SW6010B | 07/19/06 22:34 / eli-b |
| Lead | 6.8 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:34 / eli-b |
| Manganese | 478 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:34 / eli-b |
| Mercury | ND | mg/kg | | 1.0 | | SW7471A | 07/31/06 12:13 / eli-b |
| Nickel | ND | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:34 / eli-b |
| Silver | ND | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:34 / eli-b |
| Zinc | 58.0 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:34 / eli-b |

**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.

## LABORATORY ANALYTICAL REPORT

| | | | |
|---|---|---|---|
| **Client:** | Pioneer Technical Services | **Report Date:** | 08/14/06 |
| **Project:** | Great Divide | **Collection Date:** | 07/11/06 16:00 |
| **Lab ID:** | H06070108-003 | **DateReceived:** | 07/12/06 |
| **Client Sample ID:** | DH1C-071006 | **Matrix:** | Soil |

| Analyses | Result | Units | Qualifiers | RL | MCL/ QCL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **WATER HOLDING CAPACITY** | | | | | | | |
| 1/3 Bar Moisture | 8.9 | Wt % | | 0.10 | | SSSA pt4 | 08/07/06 00:00 / eli-t |
| 15 Bar Moisture | 3.6 | Wt % | | 0.10 | | SSSA pt4 | 08/08/06 00:00 / eli-t |

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

## LABORATORY ANALYTICAL REPORT

**Client:** Pioneer Technical Services
**Project:** Great Divide
**Lab ID:** H06070108-004
**Client Sample ID:** DH2A-071106

**Report Date:** 08/14/06
**Collection Date:** 07/11/06 17:00
**DateReceived:** 07/12/06
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MCL/ QCL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **SATURATED PASTE** | | | | | | | |
| pH, sat. paste | 8.1 | s.u. | | 0.1 | | ASAM10-3.2 | 07/19/06 12:09 / jjm |
| Conductivity, sat. paste | 0.30 | mmhos/cm | | 0.01 | | ASAM10-3 | 07/19/06 12:09 / jjm |
| Saturation | 48.0 | % | | 0.1 | | USDA27a | 07/19/06 12:09 / jjm |
| Sodium Adsorption Ratio (SAR) | 0.46 | unitless | | 0.01 | | Calculation | 07/19/06 12:09 / jjm |
| **SATURATED PASTE** | | | | | | | |
| Calcium, sat. paste | 1.88 | meq/l | | 0.05 | | SW6010B | 07/21/06 12:57 / rp |
| Magnesium, sat. paste | 0.93 | meq/l | | 0.08 | | SW6010B | 07/21/06 12:57 / rp |
| Sodium, sat. paste | 0.55 | meq/l | | 0.04 | | SW6010B | 07/21/06 12:57 / rp |
| **PHYSICAL CHARACTERISTICS** | | | | | | | |
| Moisture (As Received) | 4.1 | % | | 0.1 | | USDA26 | 07/17/06 00:00 / jjm |
| Sand | 53 | % | | 1 | | ASA15-5 | 07/19/06 12:09 / jjm |
| Silt | 31 | % | | 1 | | ASA15-5 | 07/19/06 12:09 / jjm |
| Clay | 16 | % | | 1 | | ASA15-5 | 07/19/06 12:09 / jjm |
| Texture | SL | unitless | | | | ASA15-5 | 07/19/06 12:09 / jjm |
| **CHEMICAL CHARACTERISTICS** | | | | | | | |
| Potassium, NH4OAc Extractable | 104 | mg/kg | | 1 | | ASA13-3 | 07/26/06 00:00 / rp |
| Organic Matter | 0.65 | % | | 0.02 | | ASA29-3 | 07/17/06 12:57 / jjm |
| Cation Exchange Capacity | 16.4 | meq/100g | | 0.09 | | SW6010B | 07/25/06 15:31 / skr |
| Phosphorus | 7.2 | mg/kg | | 0.1 | | ASA24-5 | 07/27/06 12:13 / rp |
| Nitrate as N, KCL Extract | ND | mg/kg | | 1 | | ASA38-3 | 07/19/06 11:41 / sld |
| Calculated K in lbs/Ac using a depth of 6 inches. K=208 lbs/Ac | | | | | | | |
| Calculated P in lbs/Ac using a depth of 6 inches. P=14.4 lbs/Ac | | | | | | | |
| Calculated NO3 in lbs/Ac using a depth of 6 inches. NO3=1.64 lbs/Ac | | | | | | | |
| **METALS, TOTAL** | | | | | | | |
| Antimony | ND | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:38 / eli-b |
| Arsenic | 16.2 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:38 / eli-b |
| Cadmium | ND | mg/kg | | 1.0 | | SW6010B | 07/19/06 22:38 / eli-b |
| Chromium | 10.7 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:38 / eli-b |
| Copper | 62.0 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:38 / eli-b |
| Iron | 15100 | mg/kg | D | 8.0 | | SW6010B | 07/19/06 22:38 / eli-b |
| Lead | 96.2 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:38 / eli-b |
| Manganese | 966 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:38 / eli-b |
| Mercury | 1.3 | mg/kg | | 1.0 | | SW7471A | 07/31/06 11:47 / eli-b |
| Nickel | 8.7 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:38 / eli-b |
| Silver | 7.6 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:38 / eli-b |
| Zinc | 135 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:38 / eli-b |

**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.

## LABORATORY ANALYTICAL REPORT

**Client:** Pioneer Technical Services
**Project:** Great Divide
**Lab ID:** H06070108-004
**Client Sample ID:** DH2A-071106

**Report Date:** 08/14/06
**Collection Date:** 07/11/06 17:00
**DateReceived:** 07/12/06
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MCL/ QCL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| WATER HOLDING CAPACITY | | | | | | | |
| 1/3 Bar Moisture | 15 | Wt % | | 0.10 | | SSSA pt4 | 08/07/06 00:00 / eli-t |
| 15 Bar Moisture | 6.4 | Wt % | | 0.10 | | SSSA pt4 | 08/08/06 00:00 / eli-t |

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

**ENERGY LABORATORIES, INC.** • P.O. Box 5688 • 3161 East Lyndale Ave. • Helena, MT 59604
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# LABORATORY ANALYTICAL REPORT

**Client:** Pioneer Technical Services
**Project:** Great Divide
**Lab ID:** H06070108-005
**Client Sample ID:** DH2B-071106

**Report Date:** 08/14/06
**Collection Date:** 07/11/06 17:00
**DateReceived:** 07/12/06
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MCL/ QCL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **CHEMICAL CHARACTERISTICS** | | | | | | | |
| Sulfur, Total | ND | % | | 0.01 | | E3.2.3 | 08/01/06 12:00 / ejp |
| Sulfur, Pyritic | ND | % | | 0.01 | | E3.2.3 | 08/01/06 12:00 / ejp |
| Sulfur, Organic | ND | % | | 0.01 | | E3.2.3 | 08/01/06 12:00 / ejp |
| Lime Requirement, SMP buffer | <1.1 | Tons/1000T | | 1 | | ASA12-3 | 07/18/06 00:00 / jjm |
| Neutralization Potential | 46 | t/kt | | | | Sobek Modifie | 07/17/06 00:00 / jjm |
| Neutralization Potential | 33 | t/kt | | | | Sobek Modifie | 08/02/06 00:00 / jjm |
| Acid Potential | 0.02 | t/kt | D | 0.01 | | Sobek Modifie | 08/01/06 00:00 / ejp |
| Acid/Base Potential | 46 | t/kt | | | | Sobek Modifie | 08/01/06 00:00 / ejp |
| **METALS, TOTAL** | | | | | | | |
| Antimony | ND | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:41 / eli-b |
| Arsenic | 19.4 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:41 / eli-b |
| Cadmium | ND | mg/kg | | 1.0 | | SW6010B | 07/19/06 22:41 / eli-b |
| Chromium | 5.6 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:41 / eli-b |
| Copper | 91.2 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:41 / eli-b |
| Iron | 15100 | mg/kg | D | 8.0 | | SW6010B | 07/19/06 22:41 / eli-b |
| Lead | 142 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:41 / eli-b |
| Manganese | 2120 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:41 / eli-b |
| Mercury | 1.4 | mg/kg | | 1.0 | | SW7471A | 07/31/06 11:49 / eli-b |
| Nickel | ND | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:41 / eli-b |
| Silver | 26.1 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:41 / eli-b |
| Zinc | 243 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:41 / eli-b |
| **METALS, TCLP EXTRACTABLE** | | | | | | | |
| Arsenic | ND | mg/L | | 0.5 | 5 | SW6010B | 07/19/06 21:24 / eli-b |
| Barium | ND | mg/L | | 10 | 100 | SW6010B | 07/19/06 21:24 / eli-b |
| Cadmium | ND | mg/L | | 0.1 | 1 | SW6010B | 07/19/06 21:24 / eli-b |
| Chromium | ND | mg/L | | 0.5 | 5 | SW6010B | 07/19/06 21:24 / eli-b |
| Lead | ND | mg/L | | 0.5 | 5 | SW6010B | 07/19/06 21:24 / eli-b |
| Mercury | ND | mg/L | | 0.02 | 0.2 | SW7470A | 07/21/06 11:37 / eli-b |
| Selenium | ND | mg/L | | 0.1 | 1 | SW6010B | 07/19/06 21:24 / eli-b |
| Silver | ND | mg/L | | 0.5 | 5 | SW6010B | 07/19/06 21:24 / eli-b |

**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:** Pioneer Technical Services
**Project:** Great Divide
**Lab ID:** H06070108-006
**Client Sample ID:** DH2C-071106

**Report Date:** 08/14/06
**Collection Date:** 07/11/06 17:00
**DateReceived:** 07/12/06
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MCL/ QCL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **SATURATED PASTE** | | | | | | | |
| pH, sat. paste | 7.4 | s.u. | | 0.1 | | ASAM10-3.2 | 07/19/06 12:09 / jjm |
| Conductivity, sat. paste | 0.53 | mmhos/cm | | 0.01 | | ASAM10-3 | 07/19/06 12:09 / jjm |
| Saturation | 43.7 | % | | 0.1 | | USDA27a | 07/19/06 12:09 / jjm |
| Sodium Adsorption Ratio (SAR) | 0.61 | unitless | | 0.01 | | Calculation | 07/19/06 12:09 / jjm |
| **SATURATED PASTE** | | | | | | | |
| Calcium, sat. paste | 3.74 | meq/l | | 0.05 | | SW6010B | 07/21/06 12:59 / rp |
| Magnesium, sat. paste | 0.65 | meq/l | | 0.08 | | SW6010B | 07/21/06 12:59 / rp |
| Sodium, sat. paste | 0.90 | meq/l | | 0.04 | | SW6010B | 07/21/06 12:59 / rp |
| **PHYSICAL CHARACTERISTICS** | | | | | | | |
| Moisture (As Received) | 14.3 | % | | 0.1 | | USDA26 | 07/17/06 00:00 / jjm |
| Sand | 65 | % | | 1 | | ASA15-5 | 07/19/06 12:09 / jjm |
| Silt | 23 | % | | 1 | | ASA15-5 | 07/19/06 12:09 / jjm |
| Clay | 12 | % | | 1 | | ASA15-5 | 07/19/06 12:09 / jjm |
| Texture | SL | unitless | | | | ASA15-5 | 07/19/06 12:09 / jjm |
| **CHEMICAL CHARACTERISTICS** | | | | | | | |
| Potassium, NH4OAc Extractable | 127 | mg/kg | | 1 | | ASA13-3 | 07/26/06 00:00 / rp |
| Organic Matter | 1.57 | % | | 0.02 | | ASA29-3 | 07/17/06 12:57 / jjm |
| Cation Exchange Capacity | 21.2 | meq/100g | | 0.09 | | SW6010B | 07/25/06 15:40 / skr |
| Phosphorus | 41 | mg/kg | | 0.1 | | ASA24-5 | 07/27/06 12:16 / rp |
| Nitrate as N, KCL Extract | 2 | mg/kg | | 1 | | ASA38-3 | 07/19/06 11:43 / sld |
| Calculated K in lbs/Ac using a depth of 12 inches. K=508 lbs/Ac | | | | | | | |
| Calculated P in lbs/Ac using a depth of 12 inches. P=164 lbs/Ac | | | | | | | |
| Calculated NO3 in lbs/Ac using a depth of 12 inches. NO3=6.72 lbs/Ac | | | | | | | |
| **METALS, TOTAL** | | | | | | | |
| Antimony | ND | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:53 / eli-b |
| Arsenic | 7.6 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:53 / eli-b |
| Cadmium | ND | mg/kg | | 1.0 | | SW6010B | 07/19/06 22:53 / eli-b |
| Chromium | 5.9 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:53 / eli-b |
| Copper | 24.1 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:53 / eli-b |
| Iron | 14500 | mg/kg | D | 8.0 | | SW6010B | 07/19/06 22:53 / eli-b |
| Lead | 22.4 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:53 / eli-b |
| Manganese | 917 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:53 / eli-b |
| Mercury | 2.4 | mg/kg | | 1.0 | | SW7471A | 07/31/06 12:23 / eli-b |
| Nickel | ND | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:53 / eli-b |
| Silver | 6.7 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:53 / eli-b |
| Zinc | 94.3 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:53 / eli-b |

**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.

## LABORATORY ANALYTICAL REPORT

| | | | |
|---|---|---|---|
| **Client:** | Pioneer Technical Services | **Report Date:** | 08/14/06 |
| **Project:** | Great Divide | **Collection Date:** | 07/11/06 17:00 |
| **Lab ID:** | H06070108-006 | **DateReceived:** | 07/12/06 |
| **Client Sample ID:** | DH2C-071106 | **Matrix:** | Soil |

| Analyses | Result | Units | Qualifiers | RL | MCL/ QCL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **WATER HOLDING CAPACITY** | | | | | | | |
| 1/3 Bar Moisture | 14 | Wt % | | 0.10 | | SSSA pt4 | 08/07/06 00:00 / eli-t |
| 15 Bar Moisture | 5.7 | Wt % | | 0.10 | | SSSA pt4 | 08/08/06 00:00 / eli-t |

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

# LABORATORY ANALYTICAL REPORT

**Client:** Pioneer Technical Services
**Project:** Great Divide
**Lab ID:** H06070108-007
**Client Sample ID:** GD-BG-1-071106

**Report Date:** 08/14/06
**Collection Date:** 07/11/06 07:30
**DateReceived:** 07/12/06
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MCL/ QCL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **METALS, TOTAL** | | | | | | | |
| Antimony | ND | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:57 / eli-b |
| Arsenic | 5.2 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:57 / eli-b |
| Cadmium | ND | mg/kg | | 1.0 | | SW6010B | 07/19/06 22:57 / eli-b |
| Chromium | 8.3 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:57 / eli-b |
| Copper | 11.8 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:57 / eli-b |
| Iron | 19000 | mg/kg | D | 8.0 | | SW6010B | 07/19/06 22:57 / eli-b |
| Lead | 9.7 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:57 / eli-b |
| Manganese | 680 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:57 / eli-b |
| Mercury | ND | mg/kg | | 1.0 | | SW7471A | 07/31/06 12:17 / eli-b |
| Nickel | 5.9 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:57 / eli-b |
| Silver | ND | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:57 / eli-b |
| Zinc | 65.4 | mg/kg | | 5.0 | | SW6010B | 07/19/06 22:57 / eli-b |

**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.

## LABORATORY ANALYTICAL REPORT

**Client:** Pioneer Technical Services
**Project:** Great Divide
**Lab ID:** H06070108-008
**Client Sample ID:** GD-BG-2-071106

**Report Date:** 08/14/06
**Collection Date:** 07/11/06 08:05
**DateReceived:** 07/12/06
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MCL/ QCL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| METALS, TOTAL | | | | | | | |
| Antimony | ND | mg/kg | | 5.0 | | SW6010B | 07/19/06 23:00 / eli-b |
| Arsenic | 16.9 | mg/kg | | 5.0 | | SW6010B | 07/19/06 23:00 / eli-b |
| Cadmium | ND | mg/kg | | 1.0 | | SW6010B | 07/19/06 23:00 / eli-b |
| Chromium | 5.9 | mg/kg | | 5.0 | | SW6010B | 07/19/06 23:00 / eli-b |
| Copper | 37.7 | mg/kg | | 5.0 | | SW6010B | 07/19/06 23:00 / eli-b |
| Iron | 18000 | mg/kg | D | 8.0 | | SW6010B | 07/19/06 23:00 / eli-b |
| Lead | 60.4 | mg/kg | | 5.0 | | SW6010B | 07/19/06 23:00 / eli-b |
| Manganese | 1160 | mg/kg | | 5.0 | | SW6010B | 07/19/06 23:00 / eli-b |
| Mercury | ND | mg/kg | | 1.0 | | SW7471A | 07/31/06 12:00 / eli-b |
| Nickel | ND | mg/kg | | 5.0 | | SW6010B | 07/19/06 23:00 / eli-b |
| Silver | ND | mg/kg | | 5.0 | | SW6010B | 07/19/06 23:00 / eli-b |
| Zinc | 135 | mg/kg | | 5.0 | | SW6010B | 07/19/06 23:00 / eli-b |

**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.

## LABORATORY ANALYTICAL REPORT

**Client:** Pioneer Technical Services
**Project:** Great Divide
**Lab ID:** H06070108-009
**Client Sample ID:** GD-PL-1-071106

**Report Date:** 08/14/06
**Collection Date:** 07/10/06 10:10
**DateReceived:** 07/12/06
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MCL/ QCL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **METALS, TOTAL** | | | | | | | |
| Antimony | ND | mg/kg | | 5.0 | | SW6010B | 07/19/06 23:04 / eli-b |
| Arsenic | 12.3 | mg/kg | | 5.0 | | SW6010B | 07/19/06 23:04 / eli-b |
| Cadmium | ND | mg/kg | | 1.0 | | SW6010B | 07/19/06 23:04 / eli-b |
| Chromium | 5.1 | mg/kg | | 5.0 | | SW6010B | 07/19/06 23:04 / eli-b |
| Copper | 62.8 | mg/kg | | 5.0 | | SW6010B | 07/19/06 23:04 / eli-b |
| Iron | 12000 | mg/kg | D | 8.0 | | SW6010B | 07/19/06 23:04 / eli-b |
| Lead | 77.8 | mg/kg | | 5.0 | | SW6010B | 07/19/06 23:04 / eli-b |
| Manganese | 1680 | mg/kg | | 5.0 | | SW6010B | 07/19/06 23:04 / eli-b |
| Mercury | ND | mg/kg | | 1.0 | | SW7471A | 07/31/06 12:02 / eli-b |
| Nickel | ND | mg/kg | | 5.0 | | SW6010B | 07/19/06 23:04 / eli-b |
| Silver | 16.9 | mg/kg | | 5.0 | | SW6010B | 07/19/06 23:04 / eli-b |
| Zinc | 146 | mg/kg | | 5.0 | | SW6010B | 07/19/06 23:04 / eli-b |
| **METALS, TCLP EXTRACTABLE** | | | | | | | |
| Arsenic | ND | mg/L | | 0.5 | 5 | SW6010B | 07/19/06 21:28 / eli-b |
| Barium | ND | mg/L | | 10 | 100 | SW6010B | 07/19/06 21:28 / eli-b |
| Cadmium | ND | mg/L | | 0.1 | 1 | SW6010B | 07/19/06 21:28 / eli-b |
| Chromium | ND | mg/L | | 0.5 | 5 | SW6010B | 07/19/06 21:28 / eli-b |
| Lead | ND | mg/L | | 0.5 | 5 | SW6010B | 07/19/06 21:28 / eli-b |
| Mercury | ND | mg/L | | 0.02 | 0.2 | SW7470A | 07/21/06 11:51 / eli-b |
| Selenium | ND | mg/L | | 0.1 | 1 | SW6010B | 07/19/06 21:28 / eli-b |
| Silver | ND | mg/L | | 0.5 | 5 | SW6010B | 07/19/06 21:28 / eli-b |

**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.

# QA/QC Summary Report

**Client:** Pioneer Technical Services
**Project:** Great Divide

**Report Date:** 08/14/06
**Work Order:** H06070108

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method:** ASA24-5 | | | | | | | | | Analytical Run: ICP1-HE_060727B |
| **Sample ID:** ICV | Initial Calibration Verification Standard | | | | | | | | 07/27/06 12:01 |
| Phosphorus | 0.49 | meq/l | 0.10 | 99 | 90 | 110 | | | |
| **Method:** ASA38-3 | | | | | | | | | Analytical Run: NUTRIENTS_060719A |
| **Sample ID:** ICV-1 | Initial Calibration Verification Standard | | | | | | | | 07/19/06 09:41 |
| Nitrate as N, KCL Extract | 1.0 | mg/kg | 1.0 | 102 | 90 | 110 | | | |
| **Method:** ASA38-3 | | | | | | | | | Batch: 2278 |
| **Sample ID:** LCS-2 | Laboratory Control Sample | | | | Run: NUTRIENTS_060719A | | | | 07/19/06 09:43 |
| Nitrate as N, KCL Extract | 26 | mg/kg | 2.5 | 100 | 80 | 120 | | | |
| **Sample ID:** LFB-3 | Laboratory Fortified Blank | | | | Run: NUTRIENTS_060719A | | | | 07/19/06 09:45 |
| Nitrate as N, KCL Extract | 0.52 | mg/kg | 1.0 | 104 | 70 | 130 | | | |
| **Sample ID:** MBLK-5 | Method Blank | | | | Run: NUTRIENTS_060719A | | | | 07/19/06 09:49 |
| Nitrate as N, KCL Extract | ND | mg/kg | 0.1 | | | | | | |
| **Method:** ASAM10-3 | | | | | | | | | Batch: 2282 |
| **Sample ID:** LCS | Laboratory Control Sample | | | | Run: MISC SOILS_060801D | | | | 07/19/06 12:09 |
| Conductivity, sat. paste | 5.32 | mmhos/cm | 0.010 | 107 | 70 | 130 | | | |
| **Method:** ASAM10-3.2 | | | | | | | | | Batch: 2282 |
| **Sample ID:** LCS | Laboratory Control Sample | | | | Run: MISC SOILS_060801D | | | | 07/19/06 12:09 |
| pH, sat. paste | 7.53 | s.u. | 0.10 | 101 | 80 | 120 | | | |
| **Method:** Sobek Modified | | | | | | | | | Batch: 2267 |
| **Sample ID:** MBLK0607170000 | Method Blank | | | | Run: MISC SOILS_060717G | | | | 07/17/06 00:00 |
| Neutralization Potential | 0.3 | t/kt | -5000 | | | | | | |
| **Sample ID:** CONTROL | Laboratory Control Sample | | | | Run: MISC SOILS_060717G | | | | 07/17/06 00:00 |
| Neutralization Potential | 61 | t/kt | | 98 | 70 | 130 | | | |
| **Method:** SSSA pt4 | | | | | | | | | Batch: T_R14950 |
| **Sample ID:** H06070108-006A | Sample Duplicate | | | | Run: SUB-T14950 | | | | 08/08/06 00:00 |
| 15 Bar Moisture | 5.9 | Wt % | 0.10 | | | | 3.5 | 10 | |
| **Method:** SSSA pt4 | | | | | | | | | Batch: T_R14957 |
| **Sample ID:** H06070108-006A | Sample Duplicate | | | | Run: SUB-T14957 | | | | 08/07/06 00:00 |
| 1/3 Bar Moisture | 14 | Wt % | 0.10 | | | | 3.9 | 10 | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

**Client:** Pioneer Technical Services
**Project:** Great Divide

**Report Date:** 08/14/06
**Work Order:** H06070108

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method:** SW6010B | | | | | | | | | Batch: 2292 |
| **Sample ID:** H06070108-004AMS | Sample Matrix Spike | | | | Run: ICP1-HE_060725C | | | | 07/25/06 15:34 |
| Sodium | 280 | mg/kg | 1.0 | 91 | 70 | 130 | | | |
| Cation Exchange Capacity | 24.4 | meq/100g | 0.087 | 91 | 70 | 130 | | | |
| **Sample ID:** H06070108-004AMSD | Sample Matrix Spike Duplicate | | | | Run: ICP1-HE_060725C | | | | 07/25/06 15:37 |
| Sodium | 281 | mg/kg | 1.0 | 92 | 70 | 130 | 0.2 | 30 | |
| Cation Exchange Capacity | 24.4 | meq/100g | 0.087 | 92 | 70 | 130 | 0.2 | 30 | |
| **Method:** SW6010B | | | | | | | | | Batch: B_22181 |
| **Sample ID:** MB-22181 | Method Blank | | | | Run: SUB-B79201 | | | | 07/19/06 19:58 |
| Arsenic | 0.01 | mg/L | 0.01 | | | | | | |
| Barium | 0.001 | mg/L | 0.0003 | | | | | | |
| Cadmium | 0.0007 | mg/L | 0.0004 | | | | | | |
| Chromium | ND | mg/L | 0.003 | | | | | | |
| Lead | ND | mg/L | 0.01 | | | | | | |
| Selenium | ND | mg/L | 0.02 | | | | | | |
| Silver | ND | mg/L | 0.0007 | | | | | | |
| **Sample ID:** B06070653-001AMS3 | Sample Matrix Spike | | | | Run: SUB-B79201 | | | | 07/19/06 20:05 |
| Arsenic | 0.520 | mg/L | 0.50 | 104 | 75 | 125 | | | |
| Barium | 0.546 | mg/L | 10 | 103 | 75 | 125 | | | |
| Cadmium | 0.243 | mg/L | 0.10 | 97 | 75 | 125 | | | |
| Chromium | 0.497 | mg/L | 0.50 | 99 | 75 | 125 | | | |
| Lead | 0.505 | mg/L | 0.50 | 101 | 75 | 125 | | | |
| Selenium | 0.509 | mg/L | 0.10 | 98 | 75 | 125 | | | |
| Silver | 0.228 | mg/L | 0.50 | 91 | 75 | 125 | | | |
| **Sample ID:** B06070653-001AMSD3 | Sample Matrix Spike Duplicate | | | | Run: SUB-B79201 | | | | 07/19/06 20:09 |
| Arsenic | 0.541 | mg/L | 0.50 | 108 | 75 | 125 | 4.0 | 20 | |
| Barium | 0.556 | mg/L | 10 | 105 | 75 | 125 | 0.0 | 20 | |
| Cadmium | 0.244 | mg/L | 0.10 | 97 | 75 | 125 | 0.4 | 20 | |
| Chromium | 0.509 | mg/L | 0.50 | 102 | 75 | 125 | 2.4 | 20 | |
| Lead | 0.504 | mg/L | 0.50 | 101 | 75 | 125 | 0.2 | 20 | |
| Selenium | 0.511 | mg/L | 0.10 | 99 | 75 | 125 | 0.4 | 20 | |
| Silver | 0.229 | mg/L | 0.50 | 92 | 75 | 125 | 0.0 | 20 | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

**Client:** Pioneer Technical Services
**Project:** Great Divide

**Report Date:** 08/14/06
**Work Order:** H06070108

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method:** SW6010B | | | | | | | | | Batch: B_22193 |
| **Sample ID:** MB-22193 | Method Blank | | | | Run: SUB-B79201 | | | | 07/19/06 21:32 |
| Antimony | ND | mg/kg | 0.5 | | | | | | |
| Arsenic | ND | mg/kg | 0.4 | | | | | | |
| Cadmium | ND | mg/kg | 0.02 | | | | | | |
| Chromium | ND | mg/kg | 0.07 | | | | | | |
| Copper | ND | mg/kg | 0.2 | | | | | | |
| Iron | 1.0 | mg/kg | 0.9 | | | | | | |
| Lead | ND | mg/kg | 0.4 | | | | | | |
| Manganese | 0.06 | mg/kg | 0.01 | | | | | | |
| Nickel | ND | mg/kg | 0.1 | | | | | | |
| Silver | ND | mg/kg | 0.09 | | | | | | |
| Zinc | 0.3 | mg/kg | 0.1 | | | | | | |
| **Sample ID:** B06071120-010AMS3 | Sample Matrix Spike | | | | Run: SUB-B79201 | | | | 07/19/06 21:57 |
| Antimony | 16.5 | mg/kg-dry | 5.0 | 43 | 75 | 125 | | | S |
| Arsenic | 33.7 | mg/kg-dry | 5.0 | 83 | 75 | 125 | | | |
| Cadmium | 15.0 | mg/kg-dry | 1.0 | 78 | 75 | 125 | | | |
| Chromium | 41.2 | mg/kg-dry | 5.0 | 86 | 75 | 125 | | | |
| Copper | 47.9 | mg/kg-dry | 5.0 | 95 | 75 | 125 | | | |
| Iron | 12500 | mg/kg-dry | 6.1 | | 75 | 125 | | | A |
| Lead | 40.0 | mg/kg-dry | 5.0 | 80 | 75 | 125 | | | |
| Manganese | 391 | mg/kg-dry | 5.0 | 66 | 75 | 125 | | | S |
| Nickel | 39.8 | mg/kg-dry | 5.0 | 81 | 75 | 125 | | | |
| Silver | 14.2 | mg/kg-dry | 5.0 | 74 | 75 | 125 | | | S |
| Zinc | 70.6 | mg/kg-dry | 5.0 | 83 | 75 | 125 | | | |
| **Sample ID:** B06071120-010AMSD3 | Sample Matrix Spike Duplicate | | | | Run: SUB-B79201 | | | | 07/19/06 22:09 |
| Antimony | 16.4 | mg/kg-dry | 5.0 | 43 | 75 | 125 | 0.7 | 20 | S |
| Arsenic | 33.3 | mg/kg-dry | 5.0 | 82 | 75 | 125 | 1.1 | 20 | |
| Cadmium | 14.9 | mg/kg-dry | 1.0 | 78 | 75 | 125 | 0.3 | 20 | |
| Chromium | 41.0 | mg/kg-dry | 5.0 | 86 | 75 | 125 | 0.4 | 20 | |
| Copper | 48.3 | mg/kg-dry | 5.0 | 96 | 75 | 125 | 0.8 | 20 | |
| Iron | 12500 | mg/kg-dry | 6.1 | | 75 | 125 | 0.1 | 20 | A |
| Lead | 40.4 | mg/kg-dry | 5.0 | 81 | 75 | 125 | 1.0 | 20 | |
| Manganese | 406 | mg/kg-dry | 5.0 | 74 | 75 | 125 | 3.8 | 20 | S |
| Nickel | 39.6 | mg/kg-dry | 5.0 | 81 | 75 | 125 | 0.3 | 20 | |
| Silver | 14.1 | mg/kg-dry | 5.0 | 74 | 75 | 125 | 0.7 | 20 | S |
| Zinc | 69.8 | mg/kg-dry | 5.0 | 82 | 75 | 125 | 1.0 | 20 | |

**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.

S - Spike recovery outside of advisory limits.

# QA/QC Summary Report

**Client:** Pioneer Technical Services
**Project:** Great Divide

**Report Date:** 08/14/06
**Work Order:** H06070108

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method:** SW6010B | | | | | | | | | Analytical Run: SUB-B79201 |
| **Sample ID:** ICSA | Interference Check Sample A | | | | | | | | 07/19/06 12:24 |
| Antimony | 0.0160 | mg/L | 0.0100 | | -0.05 | 0.05 | | | |
| Arsenic | -0.0115 | mg/L | 0.10 | | -0.1 | 0.1 | | | |
| Barium | 0.000410 | mg/L | 0.10 | | -0.005 | 0.0005 | | | |
| Cadmium | -0.00453 | mg/L | 0.010 | | -0.001 | 0.001 | | | |
| Chromium | -0.00269 | mg/L | 0.050 | | -0.01 | 0.01 | | | |
| Copper | 0.00503 | mg/L | 0.010 | | -0.01 | 0.01 | | | |
| Iron | 193 | mg/L | 0.091 | 97 | 80 | 120 | | | |
| Lead | -0.00851 | mg/L | 0.050 | | -0.01 | 0.01 | | | |
| Manganese | 0.00422 | mg/L | 0.010 | | -0.01 | 0.01 | | | |
| Nickel | 0.00119 | mg/L | 0.050 | | -0.05 | 0.05 | | | |
| Selenium | -0.0514 | mg/L | 0.10 | | -0.1 | 0.1 | | | |
| Silver | 0.00151 | mg/L | 0.010 | | -0.005 | 0.005 | | | |
| Zinc | 0.00562 | mg/L | 0.010 | | -0.01 | 0.01 | | | |
| **Sample ID:** ICSAB | Interference Check Sample AB | | | | | | | | 07/19/06 12:27 |
| Antimony | 1.06 | mg/L | 0.0100 | 106 | 80 | 120 | | | |
| Arsenic | 1.02 | mg/L | 0.10 | 102 | 80 | 120 | | | |
| Barium | 0.514 | mg/L | 0.10 | 103 | 80 | 120 | | | |
| Cadmium | 0.933 | mg/L | 0.010 | 93 | 80 | 120 | | | |
| Chromium | 0.481 | mg/L | 0.050 | 96 | 80 | 120 | | | |
| Copper | 0.539 | mg/L | 0.010 | 108 | 80 | 120 | | | |
| Iron | 196 | mg/L | 0.091 | 98 | 80 | 120 | | | |
| Lead | 0.975 | mg/L | 0.050 | 98 | 80 | 120 | | | |
| Manganese | 0.492 | mg/L | 0.010 | 98 | 80 | 120 | | | |
| Nickel | 0.935 | mg/L | 0.050 | 94 | 80 | 120 | | | |
| Selenium | 0.963 | mg/L | 0.10 | 96 | 80 | 120 | | | |
| Silver | 1.05 | mg/L | 0.010 | 104 | 80 | 120 | | | |
| Zinc | 1.02 | mg/L | 0.010 | 102 | 80 | 120 | | | |
| **Method:** SW6010B | | | | | | | | | Analytical Run: ICP1-HE_060721B |
| **Sample ID:** ICV | Initial Calibration Verification Standard | | | | | | | | 07/21/06 10:38 |
| Calcium | 52.3 | mg/L | 1.0 | 105 | 90 | 110 | | | |
| Magnesium | 50.8 | mg/L | 1.0 | 102 | 90 | 110 | | | |
| Sodium | 49.2 | mg/L | 1.0 | 98 | 90 | 110 | | | |
| Calcium, sat. paste | 2.61 | meq/L | 0.050 | 104 | 90 | 110 | | | |
| Magnesium, sat. paste | 4.18 | meq/L | 0.082 | 102 | 90 | 110 | | | |
| Sodium, sat. paste | 2.14 | meq/L | 0.044 | 99 | 90 | 110 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

# QA/QC Summary Report

**Client:** Pioneer Technical Services
**Project:** Great Divide

**Report Date:** 08/14/06
**Work Order:** H06070108

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method:** SW6010B | | | | | | | | | Analytical Run: ICP1-HE_060725C |
| **Sample ID:** ICV | Initial Calibration Verification Standard | | | | | | | | 07/25/06 14:35 |
| Sodium | 50.5 | mg/kg | 1.0 | 101 | 90 | 110 | | | |
| Cation Exchange Capacity | 4.39 | meq/100g | 0.087 | 101 | 90 | 110 | | | |
| **Method:** SW6010B | | | | | | | | | Analytical Run: ICP1-HE_060725B |
| **Sample ID:** ICV | Initial Calibration Verification Standard | | | | | | | | 07/25/06 10:10 |
| Sodium | 45.8 | mg/kg | 1.0 | 92 | 90 | 110 | | | |
| Sodium, Extractable | 1.99 | meq/100g | 0.044 | 92 | 90 | 110 | | | |
| **Method:** SW7470A | | | | | | | | | Batch: B_22180 |
| **Sample ID:** MB-22180 | Method Blank | | | | Run: SUB-B79288 | | | | 07/21/06 10:56 |
| Mercury | ND | mg/L | 0.001 | | | | | | |
| **Sample ID:** B06071137-001AMS | Sample Matrix Spike | | | | Run: SUB-B79288 | | | | 07/21/06 11:06 |
| Mercury | 0.020 | mg/L | 0.020 | 99 | 75 | 125 | | | |
| **Sample ID:** B06071137-001AMSD | Sample Matrix Spike Duplicate | | | | Run: SUB-B79288 | | | | 07/21/06 11:08 |
| Mercury | 0.020 | mg/L | 0.020 | 100 | 75 | 125 | 1.0 | 20 | |
| **Sample ID:** H06070108-005A | Sample Matrix Spike | | | | Run: SUB-B79288 | | | | 07/21/06 11:39 |
| Mercury | 0.021 | mg/L | 0.020 | 100 | 75 | 125 | | | |
| **Sample ID:** H06070108-005A | Sample Matrix Spike Duplicate | | | | Run: SUB-B79288 | | | | 07/21/06 11:44 |
| Mercury | 0.022 | mg/L | 0.020 | 103 | 75 | 125 | 2.8 | 20 | |
| **Method:** SW7471A | | | | | | | | | Batch: B_22273 |
| **Sample ID:** MB-22273 | Method Blank | | | | Run: SUB-B79740 | | | | 07/31/06 11:06 |
| Mercury | ND | mg/kg | 0.01 | | | | | | |
| **Sample ID:** B06070775-001AMS3 | Sample Matrix Spike | | | | Run: SUB-B79740 | | | | 07/31/06 11:15 |
| Mercury | 27 | mg/kg | 1.0 | 98 | 75 | 125 | | | |
| **Sample ID:** B06070775-001AMSD3 | Sample Matrix Spike Duplicate | | | | Run: SUB-B79740 | | | | 07/31/06 11:17 |
| Mercury | 26 | mg/kg | 1.0 | 95 | 75 | 125 | 1.1 | 30 | |
| **Method:** SW7471A | | | | | | | | | Analytical Run: SUB-B79740 |
| **Sample ID:** QCS | Initial Calibration Verification Standard | | | | | | | | 07/31/06 10:29 |
| Mercury | 0.0020 | mg/kg | 1.0 | 99 | 85 | 115 | | | |

**Qualifiers:**

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

ENERGY LABORATORIES

# Chain of Custody and Analytical Request Record

Page 1 of 1

**PLEASE PRINT**, provide as much information as possible. Refer to corresponding notes on reverse side.

Company Name: PIONEER TECHNICAL SERVICES, Inc

Project Name, PWS #, Permit #, Etc.: GREAT DIVIDE

Report Mail Address: P.O. BOX ~~4345~~ 3445
BUTTE, MT 59702

Contact Name, Phone, Fax, E-mail: MARTY BENNETT (406) 782-5177
mbennett@Pioneer-TECHNICAL.com

Sampler Name if other than Contact: JON MAXWELL

Invoice Address: SAME AS ABOVE

Invoice Contact & Phone #: SAME AS ABOVE

Purchase Order #:

ELI Quote #:

Report Required For: POTW/WWTP ☐ DW ☐ Other ______

Special Report Formats - ELI must be notified prior to sample submittal for the following:
NELAC ☐ A2LA ☐ Level IV ☐
Other ______
EDD/EDT ☐ Format ______

Notify ELI prior to RUSH sample submittal for additional charges and scheduling

Comments: SEE ATTACHED SHEET FOR SPECIFIC TESTS
send pdf / excell file. (W)

Receipt Temp ____ °C
Cooler ID(s)
Custody Seal Y [✓ N]
Intact Y [✓ N]
Signature Match Y [✓ N]

| | SAMPLE IDENTIFICATION (Name, Location, Interval, etc.) | Collection Date | Collection Time | Number of Containers Sample Type: A W S V B O Air Water Soils/Solids Vegetation Bioassay Other MATRIX | TOTAL METALS | ABA/SMP | TCLP | AGRONOMIC PARAMETERS | PHYSICAL PARAMETERS | | | | | SEE ATTACHED | Normal Turnaround (TAT) | RUSH Turnaround (TAT) | Comments | Lab ID |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ✓ 1 | DH1A-071006 | 7/11/06 | 16:00 | soil | X | | | X | X | | | | | X | X | | 0-6" | H06070108-001 |
| ✓ 2 | DH1B-071006 | 7-11-06 | 16:00 | soil | X | X | X | | | | | | | | | | TAILINGS | 002 |
| ✓ 3 | DH1C-071006 | 7-11-06 | 16:00 | soil | X | | | X | X | | | | | | | | NATIVE | 003 |
| ✓ 4 | DH2A-071106 | 7-11-06 | 17:00 | soil | X | | | X | X | | | | | | | | 0-6" | 004 |
| ✓ 5 | DH2B-071106 | 7-11-06 | 17:00 | soil | X | X | X | | | | | | | | | | TAILINGS | 005 |
| ✓ 6 | DH2C-071106 | 7-11-06 | 17:00 | soil | X | | | X | X | | | | | | | | NATIVE | 006 |
| ✓ 7 | GD-BG-1-071106 | 7-11-06 | 7:30 | soil | X | | | | | | | | | | | | BACKGROUND | 007 |
| ✓ 8 | GD-BG-2-071106 | 7-11-06 | 8:05 | soil | X | | | | | | | | | | | | BACKGROUND | 008 |
| ✓ 9 | GD-PL-1-071106 | 7-10-06 | 10:10 | soil | X | | X | | | | | | | | | | PARKING LOT | 009 |
| 10 | | | | | | | | | | | | | | | | | | |

LABORATORY USE ONLY

**Custody Record MUST be Signed**

Relinquished by: Jon J. Maxwell Date/Time: 7/12/06 13:17 Shipped by: hand del.
Received by: W Date/Time: 7-12-06 13
Relinquished by: Date/Time: Shipped by:
Received by: Date/Time:

Sample Disposal: Return to client: ______ Lab Disposal: ______

LABORATORY USE ONLY
Sample Type: ______ # of fractions ______

**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, & links.

# Energy Laboratories Inc

## Sample Receipt Checklist

Client Name Pioneer Technical Services

Date and Time Received: 7/12/2006 1:12:00 PM

Work Order Number H06070108

Received by wjj

Login completed by: Wanda Johnson (Signature) 7/12/2006 1:12:00 (Date)

Reviewed by JM (Initials) 7/14/6 (Date)

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 in compliance? | Yes ☑ | No ☐ | NA °C |
| Water - VOA vials have zero headspace? | Yes ☐ | No ☐ | No VOA vials submitted ☑ |
| Water - pH acceptable upon receipt? | Yes ☐ | No ☐ | Not Applicable ☑ |

Adjusted? ______ Checked by ______

Contact and Corrective Action Comments:

None

ENERGY LABORATORIES

**ENERGY LABORATORIES, INC.**

• 1107 SOUTH BROADWAY • P.O. BOX 30916 • BILLINGS, MT 59107 • PHONE (406) 252-6325 •

*Serving the Midland Empire Since 1952*

# Soil Analysis Interpretation Guide

## SOIL REACTION

pH 6.0 to 6.5 - slightly acid soil
pH 6.6 to 7.2 - neutral soil
pH 7.3 to 7.7 - slightly alkaline soil
pH 7.8 to 8.4 - moderately alkaline soil
pH Above 8.5 - strongly alkaline; high in total salts

## % ORGANIC MATTER

0-1.9 - very low
2.0-3.5 - low
3.6-4.9 - medium
Above 5.0 - high

Approximately 25 pounds of nitrogen per acre, is released per 1% organic matter depending upon altitude, soil moisture, and soil temperatures.

## GENERAL RATINGS FOR PLANT NUTRIENTS (0-6" DEPTH)

| Rating | $NO_3$/N Lbs/Ac | Olsen Phos., ppm-P | Potassium ppm-K | Sulfate ppm | Zinc ppm | Iron ppm | Copper ppm | Manganese ppm | Boron ppm |
|---|---|---|---|---|---|---|---|---|---|
| VL | 0-35 | 0-4 | 0-75 | 0-15 | - | - | - | - | - |
| L | 35-60 | 4-8 | 75-125 | 15-30 | 0-1 | 0-5 | 0-1 | 0-3 | 0-0.5 |
| M | 60-90 | 8-11 | 125-250 | 30-45 | 1-4 | 5-10 | 1-4 | 3-7 | 0.5-1 |
| H | >90 | 11-16 | 250-500 | 45-70 | 4-10 | 10-20 | 4-15 | 7-15 | 1-2 |
| VH | - | 16+ | 500+ | 70+ | 10.0+ | 20.0+ | 15+ | 15+ | 2.0+ |

$$\text{pounds/Ac} = \text{ppm X } \frac{\text{Sample depth (inches)}}{3}$$

$1.2 \times K \text{ (lbs/Ac)} = K_2O \text{ (lbs/Ac)}$     $2.3 \times P \text{ (lbs/Ac)} = P_2O_5 \text{ (lbs/Ac)}$

## SALT HAZARD

| Conductivity (mmhos/cm) | Rating |
|---|---|
| 0-2.0 | OK |
| 2.0-4.0 | Slightly Salty |
| 4.0-8.0 | Moderately Salty |
| 8.0-16.0 | Strongly Salty |
| 16.0+ | Very Strongly Salty |

Field beans and clovers are salt sensitive. Barley, sugar beets, wheat grasses, Canadian wildrye, etc. are salt tolerant.

## SODIUM HAZARDS

| Meq/100 gms soil | Rating |
|---|---|
| 0-2.0 | OK |
| 2.0-4.0 | Slightly Sodic |
| 4.0+ | Strongly Sodic |

## AVERAGE AVAILABLE WATER HOLDING CAPACITIES

| Soil Texture | Inches of Water per Foot of Soil |
|---|---|
| Sands and fine sands | 0.75 |
| Very fine sands, loamy sands | 1.00 |
| Sandy loam | 1.50 |
| Loams | 1.90 |
| Silt loam, silt | 2.20 |
| Clay loams, silty clay loams, and sandy clay loams | 2.10 |
| Sandy clays, silty clay and clays | 2.00 |

## FOLIAR SAMPLING FOR NITRATE NITROGEN TESTING

| Crop | Stage of Growth | Plant Part Needed |
|---|---|---|
| Small Grains | 3-4 leaves | Underground stems. |
| | Joint through heading | 1st 2 inches of stem above ground. |
| Corn | Tasseling | Leaves |
| Sugar Beets | July 1, July 15, Aug. 1, Aug. 30 | Petioles from youngest fully mature leaf |
| Potatoes | 34-45 days after planting. | Leaf and petiole (3rd from top). |
| | Early tuber sets (50-60 days) | Recently mature petiole (4th or 5th from top) |
| | 64-74 days | Same |
| | 78-88 days | Same |
| | 92-102 days | Same |

## TIMING FOR SOIL SAMPLING

1. Winter Wheat — Sample July 15 through August 15.
2. Spring Crops — Sample in fall before freeze-up.

NOTE: Allow two weeks for lab to do the analysis. Don't sample the week before planting. Soil sampling procedure sheets are available from the lab.

# Water Analysis Guide

## IRRIGATION WATER CLASSIFICATION

### SALT HAZARD

| Conductivity (umhos) | Rating |
|---|---|
| 10-250 | Low Salinity |
| 250-750 | Moderate Salinity |
| 750-2250 | High Salinity |
| 2250+ | Very High Salinity |

### SODIUM HAZARD (SAR)

| SAR | Rating |
|---|---|
| 0-10 | Low Sodium |
| 10-18 | Medium Sodium |
| 18-26 | High Sodium |
| 26+ | Very High Sodium |

## FITNESS OF WATER FOR LIVESTOCK USE

| Total Dissolved Solids (ppm) | Rating | Total Dissolved Solids (ppm) | Rating |
|---|---|---|---|
| 0-2500 | Good | 3,500-4,500 | Poor |
| 2,500-3,500 | Fair | over 4,500 | Unfit |

## PLANT NUTRIENT UPTAKE (pounds per acre)

| Crop | Yield | Nitrogen | $P_2O_5$ | $K_2O$ | S |
|---|---|---|---|---|---|
| Alfalfa | 6 ton | 340 | 60 | 300 | 30 |
| Corn Grain | 200 bu. | 266 | 114 | 266 | 33 |
| Wheat (ordinary) | 80 bu. | 134 | 54 | 162 | 20 |
| Oats | 100 bu. | 115 | 40 | 145 | 19 |
| Feed Barley | 100 bu. | 150 | 55 | 150 | 20 |
| Grain Sorghum | 110 bu. | 188 | 68 | 150 | 29 |
| Sugar Beets | 20 ton | 170 | 28 | 365 | 30 |
| Potatoes | 500 cwt. | 269 | 90 | 546 | 22 |
| Sunflowers | 1500 lbs. | 75 | 30 | 55 | 7 |

NOTE: These are actual uptake of nutrients by plants. Larger amounts of each nutrient is needed in the soil to assure proper plant growth.

Does your soil have proper balance of nutrients? Only a good quality soil test will tell you!

Courtesy of Potash and Phosphate Institute

## USEFUL CONVERSIONS

### Weight

28.4 grams = 1 ounce
454 grams = 1 pound
1 Kilogram = 2.205 pounds
907 Kilgrams = 1 ton
1 Metric Ton = 2,205 pounds

### Volume

29.6 milliliters = 1 fluid ounce
0.95 liter = 1 quart
3.8 liters = 1 gallon

### Length

2.54 cm = 1 inch
1 meter = 39.37 inches
1.6 Kilometer = 1 mile
320 Rods = 1 mile

### Area

43,560 sq. foot = 1 Acre
1 Hectare = 2.47 Acres

### Miscellaneous

1 Kg/Hectare = 0.9 pounds/Acre
1 gallon water = 8.3 pounds
1 cfs water = 450 gpm
1 acre X 6 inches deep = 2,000,000 pounds soil

$$\text{pounds/Acre} = \text{ppm X } \frac{\text{sample depth (inches)}}{3}$$

# APPENDIX C

# GREAT DIVIDE SAND TAILINGS SITE
BOREHOLE LOGS

201 E Broadway STE C
Helena, MT 59602
Phone: 406-457-8252
Fax: 406-442-1158

# LOG OF BORING

PIONEER TECHNICAL SERVICES, INC.

| | | | |
|---|---|---|---|
| Project Name: Great Divide Geoprobe Drilling | | Project Number: 3913 | |
| Borehole Location: Lower slope | | Borehole Number: DH-01 | Sheet 1 of 1 |
| Drilling Equipment: Geoprobe | Hammer Type: Automatic | Driller: MSE | Logger: J. Maxwell |
| Drilling Fluid: N/A | Borehole Diameter (in): 3 | Date Started: 7-10-06 | Date Finished: 7-10-06 |
| Elevation and Datum: Ground: Casing: | | Notes: BACKFILLED HOLE WITH BENTONITE. | |

| DEPTH (feet) | DRILL OPERATION | DRILL PRESSURE (psi) | DRILL RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT LL | PLASTIC LIMIT PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 100 | | | | | | | SURFICIAL TAILINGS.<br>SAMPLE COMPOSITED INTO DH1A-071006. | 0.5 | |
| 2 | | | | | | | | | | | | | | CAP MATERIAL W/ FEW TAILINGS. | 2.8 | SAMPLE TUBE 1 OF 1. |
| | | | | | | | | | | | | | | TAILINGS.<br>SAMPLE COMPOSITED INTO DH1B-071006. | 3.1 | |
| | | | | | | | | | | | | | | NATIVE SOILS.<br>SAMPLE COMPOSITED INTO DH1C-071006. | 3.9 | |

Operation Types: Auger; Casing Advancer; Core Barrel; Drive Casing

Sampler Types: Split Spoon; Shelby; Bulk Sample; Grab Sample; Penetrometer; Vane Shear; Special Samplers; Testpit

## WATER LEVEL OBSERVATIONS

While Drilling ___ ft Upon Completion of Drilling ___ ft
Time After Drilling
Depth To Water (feet)
Remarks:

201 E Broadway STE C
Helena, MT 59602
Phone: 406-457-8252
Fax: 406-442-1158

# LOG OF BORING

PIONEER
TECHNICAL SERVICES, INC.

| | | | |
|---|---|---|---|
| Project Name: Great Divide Geoprobe Drilling | | Project Number: 3913 | |
| Borehole Location: Lower slope | | Borehole Number: DH-02 | Sheet 1 of 1 |
| Drilling Equipment: Geoprobe | Hammer: Type: Automatic | Driller: MSE | Logger: J. Maxwell |
| Drilling Fluid: N/A | Borehole Diameter (in): 3 | Date Started: 7-10-06 | Date Finished: 7-10-06 |
| Elevation and Datum: Ground: | Casing: | Notes: BACKFILLED HOLE WITH BENTONITE. | |

| DEPTH (feet) | DRILL OPERATION | DRILL PRESSURE (psi) | DRILL RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT LL | PLASTIC LIMIT PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 83 | | | | | | | SURFICIAL TAILINGS. SAMPLE COMPOSITED INTO DH1A-071006. | 0.9 | |
| | | | | | | | | | | | | | | CAP MATERIAL W/ FEW TAILINGS. | 1.8 | |
| 2 | | | | | | | | | | | | | | TAILINGS. SAMPLE COMPOSITED INTO DH1B-071006. | 2.7 | SAMPLE TUBE 1 OF 1. |
| | | | | | | | | | | | | | | NATIVE SOILS. SAMPLE COMPOSITED INTO DH1C-071006. | 3.9 | |

Operation Types:
- Auger
- Casing Advancer
- Core Barrel
- Drive Casing

Sampler Types:
- Split Spoon
- Shelby
- Bulk Sample
- Grab Sample
- Penetrometer
- Vane Shear
- Special Samplers
- Testpit

## WATER LEVEL OBSERVATIONS

While Drilling ▽ ____ ft Upon Completion of Drilling ▼ ____ ft
Time After Drilling ____ ____ ____ ____
Depth To Water (feet) ____ ____ ____ ____
Remarks:

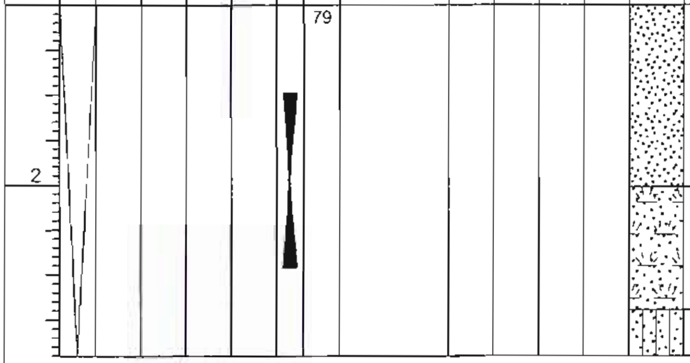
201 E Broadway STE C
Helena, MT 59602
Phone: 406-457-8252
Fax: 406-442-1158

# LOG OF BORING

PIONEER TECHNICAL SERVICES, INC.

| | |
|---|---|
| Project Name: | Great Divide Geoprobe Drilling |
| Project Number: | 3913 |
| Borehole Location: | Lower slope |
| Borehole Number: | DH-03 |
| Sheet | 1 of 1 |
| Drilling Equipment: | Geoprobe |
| Hammer Type: | Automatic |
| Driller: | MSE |
| Logger: | J. Maxwell |
| Drilling Fluid: | N/A |
| Borehole Diameter (in): | 3 |
| Date Started: | 7-10-06 |
| Date Finished: | 7-10-06 |
| Elevation and Datum: | Ground: Casing: |

Notes: BACKFILLED HOLE WITH BENTONITE.



| DEPTH (feet) | DRILL OPERATION | DRILL PRESSURE (psi) | DRILL RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT LL | PLASTIC LIMIT PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 79 | | | | | | | SANDY CAP MATERIAL W/ SURFICIAL TAILINGS.<br>SAMPLE COMPOSITED INTO DH1A-071006 AND DH1B-071006. | | |
| 2 | | | | | | | | | | | | | | CAP MATERIAL. | 2.0 | SAMPLE TUBE 1 OF 1. |
| | | | | | | | | | | | | | | NATIVE SOILS.<br>SAMPLE COMPOSITED INTO DH1C-071006. | 3.4 | |
| | | | | | | | | | | | | | | | 3.9 | |

Operation Types:
- Auger
- Casing Advancer
- Core Barrel
- Drive Casing

Sampler Types:
- Split Spoon
- Shelby
- Bulk Sample
- Grab Sample
- Penetrometer
- Vane Shear
- Special Samplers
- Testpit

WATER LEVEL OBSERVATIONS

While Drilling ▽ ____ ft Upon Completion of Drilling ▼ ____ ft
Time After Drilling ____ ____ ____ ____
Depth To Water (feet) ____ ____ ____ ____
Remarks:

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Helena, MT 59602
Phone: 406-457-8252
Fax: 406-442-1158

# LOG OF BORING

PIONEER TECHNICAL SERVICES, INC.

Project Name: Great Divide Geoprobe Drilling
Project Number: 3913
Borehole Location: Lower slope
Borehole Number: DH-04
Sheet 1 of 1
Drilling Equipment: Geoprobe
Hammer Type: Automatic
Driller: MSE
Logger: J. Maxwell
Drilling Fluid: N/A
Borehole Diameter (in): 3
Date Started: 7-10-06
Date Finished: 7-10-06
Elevation and Datum: Ground: Casing:

Notes: DROVE FIRST TUBE APPROX. 2' AND HIT REFUSAL. NO SAMPLE COLLECTED. SUBSEQUENT TUBE WAS SUCCESSFULLY DRIVEN FULL DEPTH. BACKFILLED HOLE WITH BENTONITE.

| DEPTH (feet) | DRILL OPERATION | DRILL PRESSURE (psi) | DRILL RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT LL | PLASTIC LIMIT PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 91 | | | | | | | SURFICIAL TAILINGS.<br>SAMPLE COMPOSITED INTO DH1A-071006 AND DH1B-071006. | 1.5 | |
| 2 | | | | | | | | | | | | | | CAP MATERIAL MIXED W/ TAILINGS. | 2.9 | SAMPLE TUBE 1 OF 1. |
| | | | | | | | | | | | | | | NATIVE SOILS.<br>SAMPLE COMPOSITED INTO DH1C-071006. | 3.9 | |

Operation Types: Auger, Casing Advancer, Core Barrel, Drive Casing

Sampler Types: Split Spoon, Shelby, Bulk Sample, Grab Sample, Penetrometer, Vane Shear, Special Samplers, Testpit

## WATER LEVEL OBSERVATIONS

While Drilling ▽ ____ ft Upon Completion of Drilling ▼ ____ ft
Time After Drilling ____ ____ ____ ____
Depth To Water (feet) ____ ____ ____ ____
Remarks:

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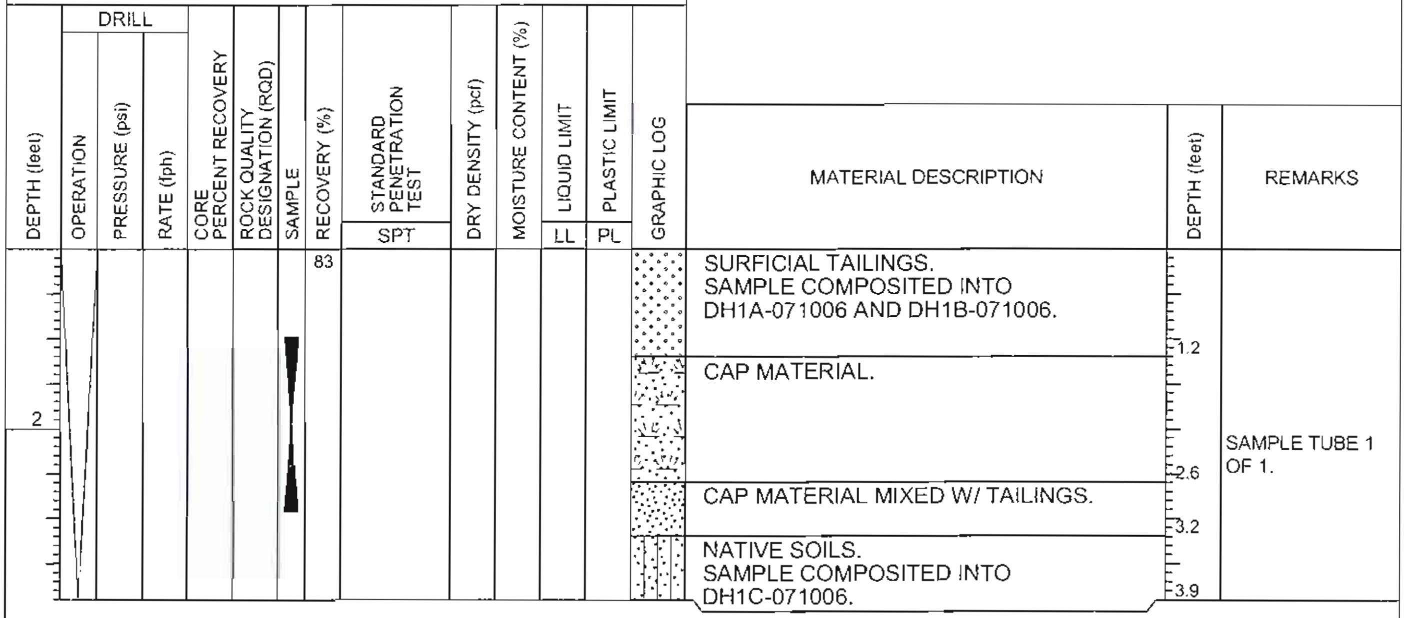
Helena, MT 59602
Phone: 406-457-8252
Fax: 406-442-1158

# LOG OF BORING

PIONEER TECHNICAL SERVICES, INC.

| | | | |
|---|---|---|---|
| Project Name: Great Divide Geoprobe Drilling | | | Project Number: 3913 |
| Borehole Location: Lower slope | | Borehole Number: DH-05 | Sheet 1 of 1 |
| Drilling Equipment: Geoprobe | Hammer Type: Automatic | Driller: MSE | Logger: J. Maxwell |
| Drilling Fluid: N/A | Borehole Diameter (in): 3 | Date Started: 7-10-06 | Date Finished: 7-10-06 |
| Elevation and Datum: Ground: | Casing: | Notes: BACKFILLED HOLE WITH BENTONITE. | |



| DEPTH (feet) | DRILL: OPERATION | DRILL: PRESSURE (psi) | DRILL: RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT LL | PLASTIC LIMIT PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 83 | | | | | | | SURFICIAL TAILINGS.<br>SAMPLE COMPOSITED INTO DH1A-071006 AND DH1B-071006. | 1.2 | |
| 2 | | | | | | | | | | | | | | CAP MATERIAL. | 2.6 | SAMPLE TUBE 1 OF 1. |
| | | | | | | | | | | | | | | CAP MATERIAL MIXED W/ TAILINGS. | 3.2 | |
| | | | | | | | | | | | | | | NATIVE SOILS.<br>SAMPLE COMPOSITED INTO DH1C-071006. | 3.9 | |

Operation Types:
- ▮ Auger
- ▨ Casing Advancer
- ▮ Core Barrel
- ▽ Drive Casing

Sampler Types:
- ☒ Split Spoon
- ■ Shelby
- ▨ Bulk Sample
- ☐ Grab Sample
- ☐ Penetrometer
- ☐ Vane Shear
- ⧗ Special Samplers
- ☰ Testpit

## WATER LEVEL OBSERVATIONS

While Drilling ▽ ______ ft    Upon Completion of Drilling ▼ ______ ft
Time After Drilling ______ ______ ______ ______
Depth To Water (feet) ______ ______ ______ ______
Remarks:

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Helena, MT 59602
Phone: 406-457-8252
Fax: 406-442-1158

# LOG OF BORING

PIONEER TECHNICAL SERVICES, INC.

Project Name: Great Divide Geoprobe Drilling
Project Number: 3913
Borehole Location: Lower slope
Borehole Number: DH-06
Sheet 1 of 1
Drilling Equipment: Geoprobe
Hammer: Type: Automatic
Driller: MSE
Logger: J. Maxwell
Drilling Fluid: N/A
Borehole Diameter (in): 3
Date Started: 7-10-06
Date Finished: 7-10-06
Elevation and Datum: Ground: Casing:
Notes: BACKFILLED HOLE WITH BENTONITE.

| DEPTH (feet) | DRILL<br>OPERATION | DRILL<br>PRESSURE (psi) | DRILL<br>RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST<br>SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT<br>LL | PLASTIC LIMIT<br>PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 83 | | | | | | | SURFICIAL TAILINGS.<br>SAMPLE COMPOSITED INTO DH1A-071006 AND DH1B-071006. | 1.3 | |
| 2 | | | | | | | | | | | | | | CAP MATERIAL. | 2.2 | |
| | | | | | | | | | | | | | | NATIVE MATERIAL W/ FEW TAILINGS. (LIGHTLY FIZZES W/ 10% HCl).<br>SAMPLE COMPOSITED INTO DH1C-071006. | 3.9 | SAMPLE TUBE 1 OF 1. |

Operation Types:
- Auger
- Casing Advancer
- Core Barrel
- Drive Casing

Sampler Types:
- Split Spoon
- Shelby
- Bulk Sample
- Grab Sample
- Penetrometer
- Vane Shear
- Special Samplers
- Testpit

## WATER LEVEL OBSERVATIONS

While Drilling ▽ ____ ft Upon Completion of Drilling ▼ ____ ft
Time After Drilling ____ ____ ____ ____
Depth To Water (feet) ____ ____ ____ ____ ▼
Remarks:

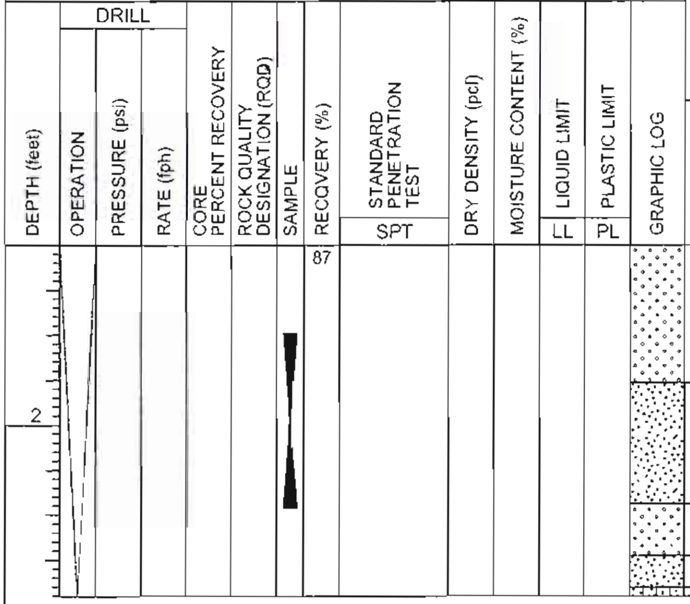
201 E Broadway STE C
Helena, MT 59602
Phone: 406-457-8252
Fax: 406-442-1158

PIONEER
TECHNICAL SERVICES, INC.

# LOG OF BORING

Project Name: Great Divide Geoprobe Drilling
Project Number: 3913
Borehole Location: Lower slope
Borehole Number: DH-07
Sheet 1 of 1
Drilling Equipment: Geoprobe
Hammer Type: Automatic
Driller: MSE
Logger: J. Maxwell
Drilling Fluid: N/A
Borehole Diameter (in): 3
Date Started: 7-10-06
Date Finished: 7-10-06
Elevation and Datum: Ground: Casing:

Notes: DROVE FIRST TUBE APPROX. 2.5' AND HIT REFUSAL. NO SAMPLE COLLECTED. SUBSEQUENT TUBE WAS SUCCESSFULLY DRIVEN FULL DEPTH. BACKFILLED HOLE WITH BENTONITE.



| MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|
| SURFICIAL TAILINGS.<br>SAMPLE COMPOSITED INTO DH1A-071006. | 1.5 | SAMPLE TUBE 1 OF 1. |
| CAP MATERIAL MIXED W/ SOME GRAVEL AND TAILINGS. | 2.9 | |
| TAILINGS.<br>SAMPLE COMPOSITED INTO DH1B-071006. | 3.5 | |
| NATIVE SOIL MIXED W/ TAILINGS AND SOME ROCK. | 3.8 | |
| NATIVE SOILS.<br>SAMPLE COMPOSITED INTO DH1C-071006. | 3.9 | |

Operation Types:
- Auger
- Casing Advancer
- Core Barrel
- Drive Casing

Sampler Types:
- Split Spoon
- Shelby
- Bulk Sample
- Grab Sample
- Penetrometer
- Vane Shear
- Special Samplers
- Testpit

WATER LEVEL OBSERVATIONS

While Drilling ▽ ft
Upon Completion of Drilling ▼ ft
Time After Drilling
Depth To Water (feet) ▼
Remarks:

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Helena, MT 59602
Phone: 406-457-8252
Fax: 406-442-1158

# LOG OF BORING

PIONEER
TECHNICAL SERVICES, INC.

Project Name: Great Divide Geoprobe Drilling
Project Number: 3913
Borehole Location: Lower slope
Borehole Number: DH-08
Sheet 1 of 1
Drilling Equipment: Geoprobe
Hammer Type: Automatic
Driller: MSE
Logger: J. Maxwell
Drilling Fluid: N/A
Borehole Diameter (in): 3
Date Started: 7-10-06
Date Finished: 7-10-06
Elevation and Datum: Ground: Casing:
Notes: BACKFILLED HOLE WITH BENTONITE.

| DEPTH (feet) | DRILL OPERATION | DRILL PRESSURE (psi) | DRILL RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT LL | PLASTIC LIMIT PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 83 | | | | | | | SURFICIAL TAILINGS.<br>SAMPLE COMPOSITED INTO DH1A-071006 AND DH1B-071006. | 1.7 | |
| 2 | | | | | | | | | | | | | | CAP MATERIAL. | 2.8 | SAMPLE TUBE 1 OF 1. |
| | | | | | | | | | | | | | | NATIVE SOILS.<br>SAMPLE COMPOSITED INTO DH1C-071006. | 3.9 | |

Operation Types:
- Auger
- Casing Advancer
- Core Barrel
- Drive Casing

Sampler Types:
- Split Spoon
- Shelby
- Bulk Sample
- Grab Sample
- Penetrometer
- Vane Shear
- Special Samplers
- Testpit

## WATER LEVEL OBSERVATIONS

While Drilling ∇ ____ ft Upon Completion of Drilling ▼ ____ ft
Time After Drilling ____ ____ ____ ____
Depth To Water (feet) ____ ____ ____ ____
Remarks:

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Helena, MT 59602
Phone: 406-457-8252
Fax: 406-442-1158

# LOG OF BORING

PIONEER
TECHNICAL SERVICES, INC.

Project Name: Great Divide Geoprobe Drilling
Project Number: 3913

Borehole Location: Lower slope
Borehole Number: DH-09
Sheet 1 of 1

Drilling Equipment: Geoprobe
Hammer: Type: Automatic
Driller: MSE
Logger: J. Maxwell

Drilling Fluid: N/A
Borehole Diameter (in): 3
Date Started: 7-10-06
Date Finished: 7-10-06

Elevation and Datum: Ground: Casing:

Notes: BACKFILLED HOLE WITH BENTONITE.

| DEPTH (feet) | DRILL OPERATION | DRILL PRESSURE (psi) | DRILL RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT LL | PLASTIC LIMIT PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 |  |  |  |  |  |  | 83 |  |  |  |  |  |  | SURFICIAL TAILINGS.<br>SAMPLE COMPOSITED INTO DH1A-071006 AND DH1B-071006. | 2.1 | SAMPLE TUBE 1 OF 1. |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | CAP MATERIAL. | 2.6 |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | TAILINGS MIXED W/ NATIVE SOIL. | 3.4 |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | NATIVE SOILS.<br>SAMPLE COMPOSITED INTO DH1C-071006. | 3.9 |  |

Operation Types:
- Auger
- Casing Advancer
- Core Barrel
- Drive Casing

Sampler Types:
- Split Spoon
- Shelby
- Bulk Sample
- Grab Sample
- Penetrometer
- Vane Shear
- Special Samplers
- Testpit

WATER LEVEL OBSERVATIONS

While Drilling ▽ ______ ft Upon Completion of Drilling ▼ ______ ft
Time After Drilling ______ ______ ______ ______
Depth To Water (feet) ______ ______ ______ ______ ▼
Remarks:

201 E Broadway STE C
Helena, MT 59602
Phone: 406-457-8252
Fax: 406-442-1158

# LOG OF BORING

PIONEER
TECHNICAL SERVICES, INC.

|  |  |  |  |
|---|---|---|---|
| Project Name: Great Divide Geoprobe Drilling | | Project Number: 3913 | |
| Borehole Location: Lower slope | | Borehole Number: DH-10 | Sheet 1 of 1 |
| Drilling Equipment: Geoprobe | Hammer: Type: Automatic | Driller: MSE | Logger: J. Maxwell |
| Drilling Fluid: N/A | Borehole Diameter (in): 3 | Date Started: 7-10-06 | Date Finished: 7-10-06 |
| Elevation and Datum: Ground: | Casing: | Notes: BACKFILLED HOLE WITH SOIL AND 8" OF BENTONITE. | |

| DEPTH (feet) | DRILL | | | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT | PLASTIC LIMIT | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OPERATION | PRESSURE (psi) | RATE (fph) | | | | | SPT | | | LL | PL | | | | |
| | | | | | | | 83 | | | | | | | SURFICIAL TAILINGS.<br>SAMPLE COMPOSITED INTO<br>DH1A-071006. | 1.6 | |
| 2 | | | | | | | | | | | | | | CAP MATERIAL. | 2.5 | SAMPLE TUBE 1 OF 1. |
| | | | | | | | | | | | | | | TAILINGS.<br>SAMPLE COMPOSITED INTO<br>DH18-071006. | 3.1 | |
| | | | | | | | | | | | | | | NATIVE SOILS.<br>SAMPLE COMPOSITED INTO<br>DH1C-071006. | 3.9 | |

Operation Types:
- Auger
- Casing Advancer
- Core Barrel
- Drive Casing

Sampler Types:
- Split Spoon
- Shelby
- Bulk Sample
- Grab Sample
- Penetrometer
- Vane Shear
- Special Samplers
- Testpit

## WATER LEVEL OBSERVATIONS

While Drilling ▽ ____ ft Upon Completion of Drilling ▼ ____ ft
Time After Drilling ____ ____ ____ ____
Depth To Water (feet) ____ ____ ____ ____
Remarks:

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Phone: 406-457-8252
Fax: 406-442-1158

# LOG OF BORING

PIONEER TECHNICAL SERVICES, INC.

Project Name: Great Divide Geoprobe Drilling
Project Number: 3913
Borehole Location: Upper NW slope
Borehole Number: DH-11
Sheet 1 of 1
Drilling Equipment: Geoprobe
Hammer Type: Automatic
Driller: MSE
Logger: J. Maxwell
Drilling Fluid: N/A
Borehole Diameter (in): 3
Date Started: 7-10-06
Date Finished: 7-10-06
Elevation and Datum: Ground: Casing:
Notes: BACKFILLED HOLE WITH SOIL AND 8" OF BENTONITE.

| DEPTH (feet) | DRILL OPERATION | DRILL PRESSURE (psi) | DRILL RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT LL | PLASTIC LIMIT PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 85 | | | | | | | SURFICIAL TAILINGS.<br>SAMPLE COMPOSITED INTO DH2A-071106. | 1.3 | |
| 2 | | | | | | | | | | | | | | FINE ORANGE SANDY MATERIAL.<br>SAMPLE COMPOSITED INTO DH2B-071106. | 3.4 | SAMPLE TUBE 1 OF 2. |
| | | | | | | | | | | | | | | TAILINGS-FIZZES W/ 10% HCl.<br>SAMPLE COMPOSITED INTO DH2B-071106. | 3.9 | |
| 4 | | | | | | | 70 | | | | | | | TAILINGS MATERIAL-ORANGISH.<br>SAMPLE COMPOSITED INTO DH2B-071106. | | |
| 6 | | | | | | | | | | | | | | BOTTOM 1-2' OF TAILINGS SAMPLED AS DH11-FA-071106 FOR FIRE ASSAY. | 6.9 | SAMPLE TUBE 2 OF 2. |
| | | | | | | | | | | | | | | NATIVE SOILS.<br>SAMPLE COMPOSITED INTO DH2C-071106. | 7.8 | |

Operation Types:
- Auger
- Casing Advancer
- Core Barrel
- Drive Casing

Sampler Types:
- Split Spoon
- Shelby
- Bulk Sample
- Grab Sample
- Penetrometer
- Vane Shear
- Special Samplers
- Testpit

## WATER LEVEL OBSERVATIONS

While Drilling ∇ ________ ft Upon Completion of Drilling ▼ ________ ft
Time After Drilling ________ ________ ________ ________
Depth To Water (feet) ________ ________ ________ ________ ▼
Remarks:

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Helena, MT 59602
Phone: 406-457-8252
Fax: 406-442-1158

# LOG OF BORING

PIONEER TECHNICAL SERVICES, INC.

| | | | |
|---|---|---|---|
| Project Name: Great Divide Geoprobe Drilling | | Project Number: 3913 | |
| Borehole Location: Upper NW slope | Borehole Number: DH-12 | Sheet 1 of 1 | |
| Drilling Equipment: Geoprobe | Hammer: Type: Automatic | Driller: MSE | Logger: J. Maxwell |
| Drilling Fluid: N/A | Borehole Diameter (in): 3 | Date Started: 7-10-06 | Date Finished: 7-10-06 |
| Elevation and Datum: Ground: | Casing: | Notes: BACKFILLED HOLE WITH SOIL AND 8" OF BENTONITE. | |

| DEPTH (feet) | DRILL<br>OPERATION | <br>PRESSURE (psi) | <br>RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST<br>SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT<br>LL | PLASTIC LIMIT<br>PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | ▽ | | | | | ⧗ | 91 | | | | | | | TAILINGS-FIZZES W/ 10% HCl.<br>SAMPLE COMPOSITED INTO<br>DH2A-071106. | 3.9 | SAMPLE TUBE 1 OF 2. |
| 4 | ▽ | | | | | ⧗ | 77 | | | | | | | TAILINGS.<br>SAMPLE COMPOSITED INTO<br>DH2B-071106.<br><br>BOTTOM 1-2' OF TAILINGS SAMPLED AS<br>DH12-FA-071106 FOR FIRE ASSAY. | 5.9 | |
| 6 | | | | | | | | | | | | | | NATIVE SOILS.<br>SAMPLE COMPOSITED INTO<br>DH2C-071106. | 7.8 | SAMPLE TUBE 2 OF 2. |

| Operation Types: | | Sampler Types: | | |
|---|---|---|---|---|
| | Auger | | Split Spoon | Penetrometer |
| | Casing Advancer | | Shelby | Vane Shear |
| | Core Barrel | | Bulk Sample | Special Samplers |
| | Drive Casing | | Grab Sample | Testpit |

## WATER LEVEL OBSERVATIONS

While Drilling ▽ ____ ft Upon Completion of Drilling ▼ ____ ft
Time After Drilling ____ ____ ____ ____
Depth To Water (feet) ____ ____ ____ ____ ▼
Remarks:

201 E Broadway STE C
Helena, MT 59602
Phone: 406-457-8252
Fax: 406-442-1158

# LOG OF BORING

**PIONEER** TECHNICAL SERVICES, INC.

Project Name: Great Divide Geoprobe Drilling
Project Number: 3913
Borehole Location: Upper SW slope
Borehole Number: DH-13
Sheet 1 of 1
Drilling Equipment: Geoprobe
Hammer: Type: Automatic
Driller: MSE
Logger: J. Maxwell
Drilling Fluid: N/A
Borehole Diameter (in): 3
Date Started: 7-10-06
Date Finished: 7-10-06
Elevation and Datum: Ground: Casing:
Notes: BACKFILLED HOLE WITH SOIL AND 8" OF BENTONITE.

| DEPTH (feet) | DRILL OPERATION | DRILL PRESSURE (psi) | DRILL RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT LL | PLASTIC LIMIT PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 |  |  |  |  |  |  | 91 |  |  |  |  |  |  | TAILINGS-FIZZES W/ 10% HCl. SAMPLE COMPOSITED INTO DH2A-071106. | 3.9 | SAMPLE TUBE 1 OF 3. |
| 4 |  |  |  |  |  |  | 91 |  |  |  |  |  |  | TAILINGS. SAMPLE COMPOSITED INTO DH2B-071106.<br>BOTTOM 1-2' OF TAILINGS SAMPLED AS DH13-FA-071106 FOR FIRE ASSAY. | 5.6 |  |
| 6 |  |  |  |  |  |  |  |  |  |  |  |  |  | SOIL. | 6.5 | SAMPLE TUBE 2 OF 3. |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | TAILINGS. | 7.6 |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | SOIL. | 7.8 |  |
| 8 |  |  |  |  |  |  | 68 |  |  |  |  |  |  | TAILINGS. | 9.0 |  |
| 10 |  |  |  |  |  |  |  |  |  |  |  |  |  | NATIVE SOILS. SAMPLE COMPOSITED INTO DH2C-071106. | 11.7 | SAMPLE TUBE 3 OF 3. |

Operation Types:
- Auger
- Casing Advancer
- Core Barrel
- Drive Casing

Sampler Types:
- Split Spoon
- Shelby
- Bulk Sample
- Grab Sample
- Penetrometer
- Vane Shear
- Special Samplers
- Testpit

## WATER LEVEL OBSERVATIONS

While Drilling ▽ ____ ft Upon Completion of Drilling ▽ ____ ft
Time After Drilling ____ ____ ____ ____
Depth To Water (feet) ____ ____ ____ ____ ▼
Remarks:

201 E Broadway STE C
Helena, MT 59602
Phone: 406-457-8252
Fax: 406-442-1158

# LOG OF BORING

PIONEER TECHNICAL SERVICES, INC.

| | | | |
|---|---|---|---|
| Project Name: Great Divide Geoprobe Drilling | | Project Number: 3913 | |
| Borehole Location: Upper SW slope | | Borehole Number: DH-14 | Sheet 1 of 1 |
| Drilling Equipment: Geoprobe | Hammer: Type: Automatic | Driller: MSE | Logger: J. Maxwell |
| Drilling Fluid: N/A | Borehole Diameter (in): 3 | Date Started: 7-10-06 | Date Finished: 7-10-06 |
| Elevation and Datum: Ground: | Casing: | Notes: BACKFILLED HOLE WITH SOIL AND 8" OF BENTONITE. | |

| DEPTH (feet) | DRILL OPERATION | DRILL PRESSURE (psi) | DRILL RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT LL | PLASTIC LIMIT PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | | | | | | | 89 | | | | | | | TAILINGS.<br>SAMPLE COMPOSITED INTO DH2A-071106. | 3.9 | SAMPLE TUBE 1 OF 3. |
| 4<br>6 | | | | | | | 91 | | | | | | | TAILINGS.<br>SAMPLE COMPOSITED INTO DH2B-071106. | 7.8 | SAMPLE TUBE 2 OF 3. |
| 8 | | | | | | | 55 | | | | | | | TAILINGS.<br>SAMPLE COMPOSITED INTO DH2B-071106. | 8.9 | SAMPLE TUBE 3 OF 3. |
| 10 | | | | | | | | | | | | | | NATIVE SOILS.<br>SAMPLE COMPOSITED INTO DH2C-071106. | 11.7 | |

Operation Types: Auger; Casing Advancer; Core Barrel; Drive Casing

Sampler Types: Split Spoon; Shelby; Bulk Sample; Grab Sample; Penetrometer; Vane Shear; Special Samplers; Testpit

## WATER LEVEL OBSERVATIONS

While Drilling ▽ ______ ft    Upon Completion of Drilling ▼ ______ ft
Time After Drilling ______ ______ ______ ______
Depth To Water (feet) ______ ______ ______ ______ ▼
Remarks:

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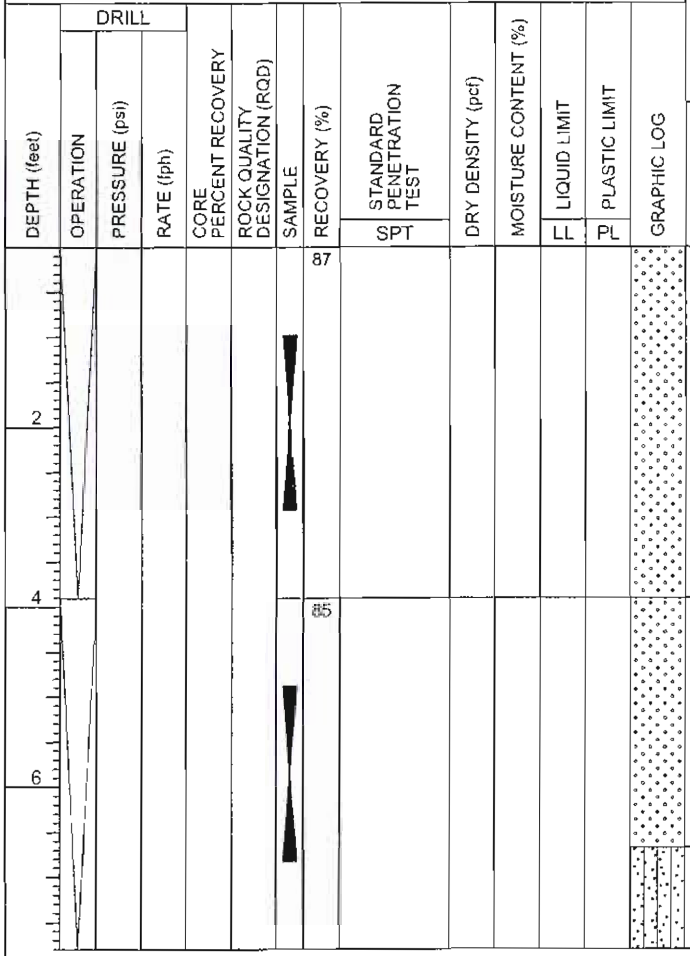
Phone: 406-457-8252
Fax: 406-442-1158

# LOG OF BORING

PIONEER TECHNICAL SERVICES, INC.

Project Name: Great Divide Geoprobe Drilling
Project Number: 3913
Borehole Location: Upper SW slope
Borehole Number: DH-15
Sheet 1 of 1
Drilling Equipment: Geoprobe
Hammer Type: Automatic
Driller: MSE
Logger: J. Maxwell
Drilling Fluid: N/A
Borehole Diameter (in): 3
Date Started: 7-11-06
Date Finished: 7-11-06
Elevation and Datum: Ground: Casing:
Notes: BACKFILLED HOLE WITH SOIL AND 8" OF BENTONITE.



| RECOVERY (%) | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|
| 87 | TAILINGS.<br>SAMPLE COMPOSITED INTO DH2A-071106. | 3.9 | SAMPLE TUBE 1 OF 2. |
| 85 | TAILINGS.<br>SAMPLE COMPOSITED INTO DH2B-071106. | 6.7 | SAMPLE TUBE 2 OF 2. |
| | NATIVE SOILS.<br>SAMPLE COMPOSITED INTO DH2C-071106. | 7.8 | |

Operation Types: Auger; Casing Advancer; Core Barrel; Drive Casing

Sampler Types: Split Spoon; Shelby; Bulk Sample; Grab Sample; Penetrometer; Vane Shear; Special Samplers; Testpit

## WATER LEVEL OBSERVATIONS

While Drilling ▽ ____ ft Upon Completion of Drilling ▼ ____ ft
Time After Drilling
Depth To Water (feet)
Remarks:

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Phone: 406-457-8252
Fax: 406-442-1158

# LOG OF BORING

PIONEER
TECHNICAL SERVICES, INC.

Project Name: Great Divide Geoprobe Drilling
Project Number: 3913
Borehole Location: Upper SW slope
Borehole Number: DH-16
Sheet 1 of 1
Drilling Equipment: Geoprobe
Hammer: Type: Automatic
Driller: MSE
Logger: J. Maxwell
Drilling Fluid: N/A
Borehole Diameter (in): 3
Date Started: 7-11-06
Date Finished: 7-11-06
Elevation and Datum: Ground: Casing:
Notes: BACKFILLED HOLE WITH SOIL AND 8" OF BENTONITE.

| DEPTH (feet) | DRILL OPERATION | DRILL PRESSURE (psi) | DRILL RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT LL | PLASTIC LIMIT PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 81 | | | | | | | TAILINGS.<br>SAMPLE COMPOSITED INTO<br>DH2A-071106 AND DH2B-071106. | | |
| 2 | | | | | | | | | | | | | | | | SAMPLE TUBE 1 OF 1. |
| | | | | | | | | | | | | | | | 3.2 | |
| | | | | | | | | | | | | | | NATIVE SOILS.<br>SAMPLE COMPOSITED INTO<br>DH2C-071106. | 3.9 | |

Operation Types:
- Auger
- Casing Advancer
- Core Barrel
- Drive Casing

Sampler Types:
- ☒ Split Spoon
- ■ Shelby
- Bulk Sample
- Grab Sample
- Penetrometer
- Vane Shear
- Special Samplers
- Testpit

## WATER LEVEL OBSERVATIONS

While Drilling ∇ ______ ft Upon Completion of Drilling ▼ ______ ft
Time After Drilling ______ ______ ______ ______
Depth To Water (feet) ______ ______ ______ ______
Remarks:

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Helena, MT 59602
Phone: 406-457-8252
Fax: 406-442-1158

# LOG OF BORING

PIONEER
TECHNICAL SERVICES, INC.

Project Name: Great Divide Geoprobe Drilling
Project Number: 3913
Borehole Location: Upper SW slope
Borehole Number: DH-17
Sheet 1 of 1
Drilling Equipment: Geoprobe
Hammer: Type: Automatic
Driller: MSE
Logger: J. Maxwell
Drilling Fluid: N/A
Borehole Diameter (in): 3
Date Started: 7-11-06
Date Finished: 7-11-06
Elevation and Datum: Ground: Casing:
Notes: BACKFILLED HOLE WITH SOIL AND 8" OF BENTONITE.

| DEPTH (feet) | DRILL OPERATION | DRILL PRESSURE (psi) | DRILL RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT LL | PLASTIC LIMIT PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0–4 | | | | | | | 87 | | | | | | | TAILINGS.<br>SAMPLE COMPOSITED INTO DH2A-071106. | 3.9 | SAMPLE TUBE 1 OF 3. |
| 4–8 | | | | | | | 85 | | | | | | | TAILINGS.<br>SAMPLE COMPOSITED INTO DH2B-071106. | 8.2 | SAMPLE TUBE 2 OF 3. |
| 8–11.7 | | | | | | | 23 | | | | | | | NATIVE SOILS.<br>SAMPLE COMPOSITED INTO DH2C-071106. | 11.7 | SAMPLE TUBE 3 OF 3. |

Operation Types:
- Auger
- Casing Advancer
- Core Barrel
- Drive Casing

Sampler Types:
- Split Spoon
- Shelby
- Bulk Sample
- Grab Sample
- Penetrometer
- Vane Shear
- Special Samplers
- Testpit

WATER LEVEL OBSERVATIONS

While Drilling ▽ ______ ft Upon Completion of Drilling ▼ ______ ft
Time After Drilling ______ ______ ______ ______
Depth To Water (feet) ______ ______ ______ ______
Remarks:

201 E Broadway STE C
Helena, MT 59602
Phone: 406-457-8252
Fax: 406-442-1158

# LOG OF BORING

PIONEER TECHNICAL SERVICES, INC.

| | | | |
|---|---|---|---|
| Project Name: Great Divide Geoprobe Drilling | | | Project Number: 3913 |
| Borehole Location: Upper SW slope | | Borehole Number: DH-18 | Sheet 1 of 1 |
| Drilling Equipment: Geoprobe | Hammer: Type: Automatic | Driller: MSE | Logger: J. Maxwell |
| Drilling Fluid: N/A | Borehole Diameter (in): 3 | Date Started: 7-11-06 | Date Finished: 7-11-06 |
| Elevation and Datum: Ground: | Casing: | | |

Notes: SECOND SAMPLE TUBE BOUND UP IN CASING. VERY SOFT MAT'L, ONLY 16" RECOVERY. MOVED APPX. 3' DOWN SLOPE AND RE-SAMPLED. BACKFILLED HOLE WITH SOIL AND 8" OF BENTONITE.

| DEPTH (feet) | DRILL OPERATION | DRILL PRESSURE (psi) | DRILL RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT LL | PLASTIC LIMIT PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0–4 | Drive Casing | | | | | Special Samplers | 83 | | | | | | ⁘ | TAILINGS.<br>SAMPLE COMPOSITED INTO DH2A-071106. | 3.9 | SAMPLE TUBE 1 OF 3. |
| 4–8 | Drive Casing | | | | | Special Samplers | 83 | | | | | | ⁘ | TAILINGS.<br>SAMPLE COMPOSITED INTO DH2B-071106. | 7.8 | SAMPLE TUBE 2 OF 3. |
| 8–11.7 | Drive Casing | | | | | Special Samplers | 51 | | | | | | ⁘ | TAILINGS.<br>SAMPLE COMPOSITED INTO DH2B-071106. | 9.5 | |
| | | | | | | | | | | | | | ⁝ | NATIVE SOILS-VERY WET.<br>SAMPLE COMPOSITED INTO DH2C-071106. | 11.7 | SAMPLE TUBE 3 OF 3. |

Operation Types:
- Auger
- Casing Advancer
- Core Barrel
- Drive Casing

Sampler Types:
- Split Spoon
- Shelby
- Bulk Sample
- Grab Sample
- Penetrometer
- Vane Shear
- Special Samplers
- Testpit

## WATER LEVEL OBSERVATIONS

While Drilling ▽ ______ ft Upon Completion of Drilling ▽ ______ ft
Time After Drilling ______ ______ ______ ______
Depth To Water (feet) ______ ______ ______ ______ ▼
Remarks:

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Helena, MT 59602
Phone: 406-457-8252
Fax: 406-442-1158

# LOG OF BORING

PIONEER TECHNICAL SERVICES, INC.

Project Name: Great Divide Geoprobe Drilling
Project Number: 3913
Borehole Location: Upper SW slope
Borehole Number: DH-19
Sheet 1 of 1
Drilling Equipment: Geoprobe
Hammer: Type: Automatic
Driller: MSE
Logger: J. Maxwell
Drilling Fluid: N/A
Borehole Diameter (in): 3
Date Started: 7-11-06
Date Finished: 7-11-06
Elevation and Datum: Ground: Casing:
Notes: BACKFILLED HOLE WITH SOIL AND 8" OF BENTONITE.

| DEPTH (feet) | DRILL OPERATION | DRILL PRESSURE (psi) | DRILL RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT LL | PLASTIC LIMIT PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 87 | | | | | | | TAILINGS.<br>SAMPLE COMPOSITED INTO DH2A-071106 AND DH2B-071106. | | |
| 2 | | | | | | | | | | | | | | BOTTOM 1-2' OF TAILINGS SAMPLED AS DH19-FA-071106 FOR FIRE ASSAY. | | SAMPLE TUBE 1 OF 2. |
| 4 | | | | | | | 87 | | | | | | | | 4.3 | |
| | | | | | | | | | | | | | | NATIVE SOILS-DAMP.<br>SAMPLE COMPOSITED INTO DH2C-071106. | | |
| 6 | | | | | | | | | | | | | | | | SAMPLE TUBE 2 OF 2. |
| | | | | | | | | | | | | | | | 7.8 | |

Operation Types: Auger; Casing Advancer; Core Barrel; Drive Casing

Sampler Types: Split Spoon; Shelby; Bulk Sample; Grab Sample; Penetrometer; Vane Shear; Special Samplers; Testpit

## WATER LEVEL OBSERVATIONS

While Drilling ____ ft  Upon Completion of Drilling ____ ft
Time After Drilling
Depth To Water (feet)
Remarks:

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Helena, MT 59602
Phone: 406-457-8252
Fax: 406-442-1158

# LOG OF BORING

PIONEER TECHNICAL SERVICES, INC.

Project Name: Great Divide Geoprobe Drilling
Project Number: 3913
Borehole Location: Upper SW slope
Borehole Number: DH-20
Sheet 1 of 1
Drilling Equipment: Geoprobe
Hammer: Type: Automatic
Driller: MSE
Logger: J. Maxwell
Drilling Fluid: N/A
Borehole Diameter (in): 3
Date Started: 7-11-06
Date Finished: 7-11-06
Elevation and Datum: Ground: Casing:
Notes: BACKFILLED HOLE WITH SOIL AND 8" OF BENTONITE.

| DEPTH (feet) | DRILL<br>OPERATION | DRILL<br>PRESSURE (psi) | DRILL<br>RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST<br>SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT<br>LL | PLASTIC LIMIT<br>PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ▽ | | | | | ⧗ | 74 | | | | | | ▒ | TAILINGS.<br>SAMPLE COMPOSITED INTO DH2A-071106 AND DH2B-071106. | | |
| 2 | | | | | | | | | | | | | | BOTTOM 1-2' OF TAILINGS SAMPLED AS DH20-FA-071106 FOR FIRE ASSAY. | | SAMPLE TUBE 1 OF 2. |
| | | | | | | | | | | | | | | | 3.9 | |
| 4 | ▽ | | | | | ⧗ | 49 | | | | | | ▥ | NATIVE SOIL, HIT REFUSAL. UPPER 12" WET.<br>SAMPLE COMPOSITED INTO DH2C-071106. | | |
| 6 | | | | | | | | | | | | | | | | SAMPLE TUBE 2 OF 2. |
| | | | | | | | | | | | | | | | 7.8 | |

Operation Types:
- Auger
- Casing Advancer
- Core Barrel
- Drive Casing

Sampler Types:
- Split Spoon
- Shelby
- Bulk Sample
- Grab Sample
- Penetrometer
- Vane Shear
- Special Samplers
- Testpit

## WATER LEVEL OBSERVATIONS

While Drilling ▽ ______ ft  Upon Completion of Drilling ▼ ______ ft
Time After Drilling ______ ______ ______ ______
Depth To Water (feet) ______ ______ ______ ______ ▼
Remarks:

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Helena, MT 59602
Phone: 406-457-8252
Fax: 406-442-1158

# LOG OF BORING

PIONEER TECHNICAL SERVICES, INC.

Project Name: Great Divide Geoprobe Drilling
Project Number: 3913
Borehole Location: Lower slope
Borehole Number: DH-21
Sheet 1 of 1
Drilling Equipment: Geoprobe
Hammer: Type: Automatic
Driller: MSE
Logger: J. Maxwell
Drilling Fluid: N/A
Borehole Diameter (in): 3
Date Started: 7-11-06
Date Finished: 7-11-06
Elevation and Datum: Ground:
Casing:
Notes: BACKFILLED HOLE WITH SOIL AND 8" OF BENTONITE.

| DEPTH (feet) | DRILL<br>OPERATION | DRILL<br>PRESSURE (psi) | DRILL<br>RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST<br>SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT<br>LL | PLASTIC LIMIT<br>PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | ▽ |  |  |  |  | ⧗ | 79 |  |  |  |  |  |  | TAILINGS.<br>SAMPLE COMPOSITED INTO DH2A-071106 AND DH2B-071106. | 2.3 | SAMPLE TUBE 1 OF 1. |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | NATIVE SOILS.<br>SAMPLE COMPOSITED INTO DH2C-071106. | 3.9 |  |

Operation Types:
- Auger
- Casing Advancer
- Core Barrel
- Drive Casing

Sampler Types:
- Split Spoon
- Shelby
- Bulk Sample
- Grab Sample
- Penetrometer
- Vane Shear
- Special Samplers
- Testpit

## WATER LEVEL OBSERVATIONS

While Drilling ∇ ______ ft Upon Completion of Drilling ▼ ______ ft
Time After Drilling ______ ______ ______ ______
Depth To Water (feet) ______ ______ ______ ______ ▼
Remarks:

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Phone: 406-457-8252
Fax: 406-442-1158

# LOG OF BORING

PIONEER TECHNICAL SERVICES, INC.

Project Name: Great Divide Geoprobe Drilling
Project Number: 3913
Borehole Location: Lower slope
Borehole Number: DH-22
Sheet 1 of 1
Drilling Equipment: Geoprobe
Hammer Type: Automatic
Driller: MSE
Logger: J. Maxwell
Drilling Fluid: N/A
Borehole Diameter (in): 3
Date Started: 7-11-06
Date Finished: 7-11-06
Elevation and Datum: Ground: Casing:
Notes: BACKFILLED HOLE WITH SOIL AND 8" OF BENTONITE.

| DEPTH (feet) | DRILL OPERATION | DRILL PRESSURE (psi) | DRILL RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT LL | PLASTIC LIMIT PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | ⧗ | 68 | | | | | | | SURFICIAL TAILINGS.<br>SAMPLE COMPOSITED INTO DH2A-071106 AND DH2B-071106. | 1.7 | |
| 2 | | | | | | | | | | | | | | NATIVE SOILS.<br>SAMPLE COMPOSITED INTO DH2C-071106. | 3.9 | SAMPLE TUBE 1 OF 1. |

Operation Types:
- Auger
- Casing Advancer
- Core Barrel
- Drive Casing

Sampler Types:
- Split Spoon
- Shelby
- Bulk Sample
- Grab Sample
- Penetrometer
- Vane Shear
- Special Samplers
- Testpit

WATER LEVEL OBSERVATIONS

While Drilling ▽ ft Upon Completion of Drilling ▼ ft
Time After Drilling
Depth To Water (feet) ▼
Remarks:

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Helena, MT 59602
Phone: 406-457-8252
Fax: 406-442-1158

# LOG OF BORING

PIONEER
TECHNICAL SERVICES, INC.

Project Name: Great Divide Geoprobe Drilling
Project Number: 3913
Borehole Location: Lower slope
Borehole Number: DH-23
Sheet 1 of 1
Drilling Equipment: Geoprobe
Hammer: Type: Automatic
Driller: MSE
Logger: J. Maxwell
Drilling Fluid: N/A
Borehole Diameter (in): 3
Date Started: 7-11-06
Date Finished: 7-11-06
Elevation and Datum: Ground: Casing:
Notes: BACKFILLED HOLE WITH SOIL AND 8" OF BENTONITE.

| DEPTH (feet) | DRILL OPERATION | DRILL PRESSURE (psi) | DRILL RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT LL | PLASTIC LIMIT PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 70 | | | | | | | SURFICIAL TAILINGS.<br>SAMPLE COMPOSITED INTO DH2A-071106 AND DH2B-071106. | 1.2 | |
| 2 | | | | | | | | | | | | | | NATIVE SOILS W/ROCK.<br>SAMPLE COMPOSITED INTO DH2C-071106. | 3.9 | SAMPLE TUBE 1 OF 1. |

| | | | |
|---|---|---|---|
| Operation Types: | Auger | Sampler Types: | Split Spoon |
| | Casing Advancer | | Shelby |
| | Core Barrel | | Bulk Sample |
| | Drive Casing | | Grab Sample |
| | | | Penetrometer |
| | | | Vane Shear |
| | | | Special Samplers |
| | | | Testpit |

## WATER LEVEL OBSERVATIONS

While Drilling ▽ ______ ft Upon Completion of Drilling ▼ ______ ft
Time After Drilling ______ ______ ______ ______
Depth To Water (feet) ______ ______ ______ ______ ▼
Remarks:

# APPENDIX D

# GREAT DIVIDE SAND TAILINGS SITE
# FINAL GEOTECHNICAL REPORT
(Provided electronically in pdf format)

# FINAL
# GEOTECHNICAL INVESTIGATION REPORT FOR THE GREAT DIVIDE SAND TAILINGS SITE

Prepared for:

Ms. Jodi D. Kountz
***U.S. Department of Interior***
***Bureau of Land Management***
106 North Parkmont
Butte, Montana 59701

and

Mr. John Cataldo
***U.S. Army Corps of Engineers***
***Omaha District***
215 North 17th Street
Omaha, Nebraska 68102

Prepared by:

***Pioneer Technical Services, Inc.***
P.O. Box 3445
Butte, Montana 59702

**October 11, 2006**

# RESPONSES TO COMMENTS
# FOR
# THE DRAFT GREAT DIVIDE SAND TAILINGS SITE
# GEOTECHNICAL INVESTIGATION REPORT

Prepared by:

***Pioneer Technical Services, Inc.***
August 24, 2006

Comments Provided by:

Jodi D. Kountz
***Bureau of Land Management (BLM) Butte***
August 21, 2006

## GENERAL COMMENTS

### Comment #1:

*Please include any and all photographs collected during the geotechnical investigation.*

### Response to Comment #1:

Photographs from the investigation will be included in Appendix D of the report.

### Comment #2:

*Please include a copy of the field notes collected during the geotechnical investigation.*

### Response to Comment #2:

All field notes from the investigation will be provided in Appendix E of the report.

### Comment #3:

*Section 1.1, Second Paragraph, Second to Last Sentence*

*Please reword to as follows:*
*The* previously reclaimed *tailings impoundment is vegetated but has developed numerous….*

**Response to Comment #3:**

Requested text has been incorporated.

**Comment #4:**

*Section 1.1*
*Add a short summary of the history of the site and that it has been previously reclaimed by the BLM.*

**Response to Comment #4:**

A brief summary of the history at the site has been added to the report. Pioneer has very little information on the previous reclamation completed by the BLM.

**Comment #5:**

*Figure 1-2*

1. *Did Pioneer's 2006 survey get included on this map?*
2. *Is the "Tailings Boundary" the actual limits of tailings based on the 2006 investigations?*

**Response to Comment #5:**

1. All survey data collected by Pioneer in 2006 was included on Figure 1-2.
2. This geotechnical report was completed prior to the site investigation. Figure 1-2 will be updated with actual limits of tailings from the site investigation.

**Comment #6:**

*Section 1.2, First Sentence*
*Please reword to as follows:*
*The purpose of this geotechnical investigation was to determine the extent of tailings in the area surrounding Ski Towers #5 and #6* and determine the structural integrity of the two towers *(see Figure 1-3).*

**Response to Comment #6:**

Text has been added to reflect that the purpose of this geotechnical investigation was to determine the extent of tailings in the area and determine the underlying soil integrity surrounding Ski Towers #5 and #6.

**Comment #7:**

*Section 1.2, Second Sentence*
*Please reword to as follows:*
*Additionally, strength parameters for the in-place soils were evaluated to determine slope stability for possible excavation around the towers* if *removal of all tailings is* evaluated *as* a reclamation *alternative* in the upcoming EEE/CA.

**Response to Comment #7:**

Requested text has been incorporated.

**Comment #8:**

*Section 2.0*
*Please define CME.*

**Response to Comment #8:**

CME – Central Mine Equipment Company.

**Comment #9:**

*Table 1-1*
*For the column "Depth of Split Spoon Refusal". Should the unit be "ft bgs"?*

**Response to Comment #9:**

Table 1-1 units have been corrected.

**Comment #10:**

*Table 1-2*

1. *For the column "Depth of Split Spoon Refusal". Should the unit be "ft bgs"?*
2. *For the "N-Value". Should the unit be (blows/ft)?*

**Response to Comment #10:**

Table 1-2 units have been corrected.

**Comment #11:**

*Section 2.2, Last Paragraph, First Sentence*
*Please state how thick the soil cap ranged.*

**Response to Comment #11:**

Text has been added that the soil cap ranged from 3 to 6 inches.

**Comment #12:**

*Section 3.0, First Paragraph*
*Even though Pioneer has not been able to obtain As-Builts, please describe how they look, their dimensions, is rebar is present, how deep the concrete is, etc.*

*If known, please identify when they were constructed, by whom, etc.*

**Response to Comment #12:**

All available information concerning tower foundation has been included in the report. Information concerning when they were constructed and by whom is unknown. Measurements of footings at Ski Towers #5 and #6 are included in Appendix F.

**Comment #13:**

*Section 3.0, Third Paragraph*
*Should the units for micromhos per centimeter be (μmhos/cm) not mmhos/cm? Throughout report and on Boring Logs.*

**Response to Comment #13:**

Electrical conductivity units have been corrected to reflect microhms per centimeter (μohs/cm) in the text and tables of the report.

**Comment #14:**

*Table 3-1*
*What is Marble pH?*

**Response to Comment #14:**

Marble pH is one of the tests used to determine the corrosivity to metal and concrete. A change of 0.2 units from the original pH is an indication that soils may have a detrimental effect to steel and concrete.

**Comment #15:**

*Section 5.0, First Sentence*
*Please reword to as follows:*
*The purpose of this investigation was* to *determine the depth of tailings and evaluate the foundation soils for strength parameters for the area surrounding the Ski Towers #5 and*

*#6 in the event that* tailings removal is evaluated as a reclamation alternative *for the forthcoming EEE/CA.*

**Response to Comment #15:**

Requested text has been incorporated.

**Comment #16:**

*Section 5.0, Last Sentence*
*So how does this recommendation affect potential alternatives for the project? Please provide a short summary.*

**Response to Comment #15:**

Additional text has been incorporated into the summary.

## TABLE OF CONTENTS

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# 1.0 INTRODUCTION

This document has been prepared for the U.S. Army Corps of Engineers (USACE) and the U.S. Department of Interior/Bureau of Land Management (BLM) by Pioneer Technical Services, Inc. (Pioneer) under Contract Number W9128F-04-D-0013, Delivery Order Number 0001. This report documents the results of the geotechnical investigation completed by Pioneer on May 23 and 24, 2006 as part of the forthcoming Expanded Engineering Evaluation/Cost Analysis (EEE/CA). The EEE/CA will propose and provide justification for the preferred reclamation alternative applicable to the Great Divide Sand Tailings Site.

## 1.1 PROJECT DESCRIPTION

The Great Divide Sand Tailings Site is the remnants of the abandoned Belmont Mine Site that is listed on the Montana Department of Environmental Quality/Mine Waste Cleanup Bureau (DEQ/MWCB) Abandoned Hardrock Mine Priority Site List (DEQ/MWCB-Pioneer, 1993). The Great Divide Sand Tailings Site was ranked #248 out of 273 sites by the DEQ/MWCB on the state-wide reclamation priority list using the Abandoned and Inactive Mines Scoring System (AIMSS). The Great Divide Sand Tailings Site was also listed #71 out of 276 sites by the DEQ/MWCB using its safety scoring system.

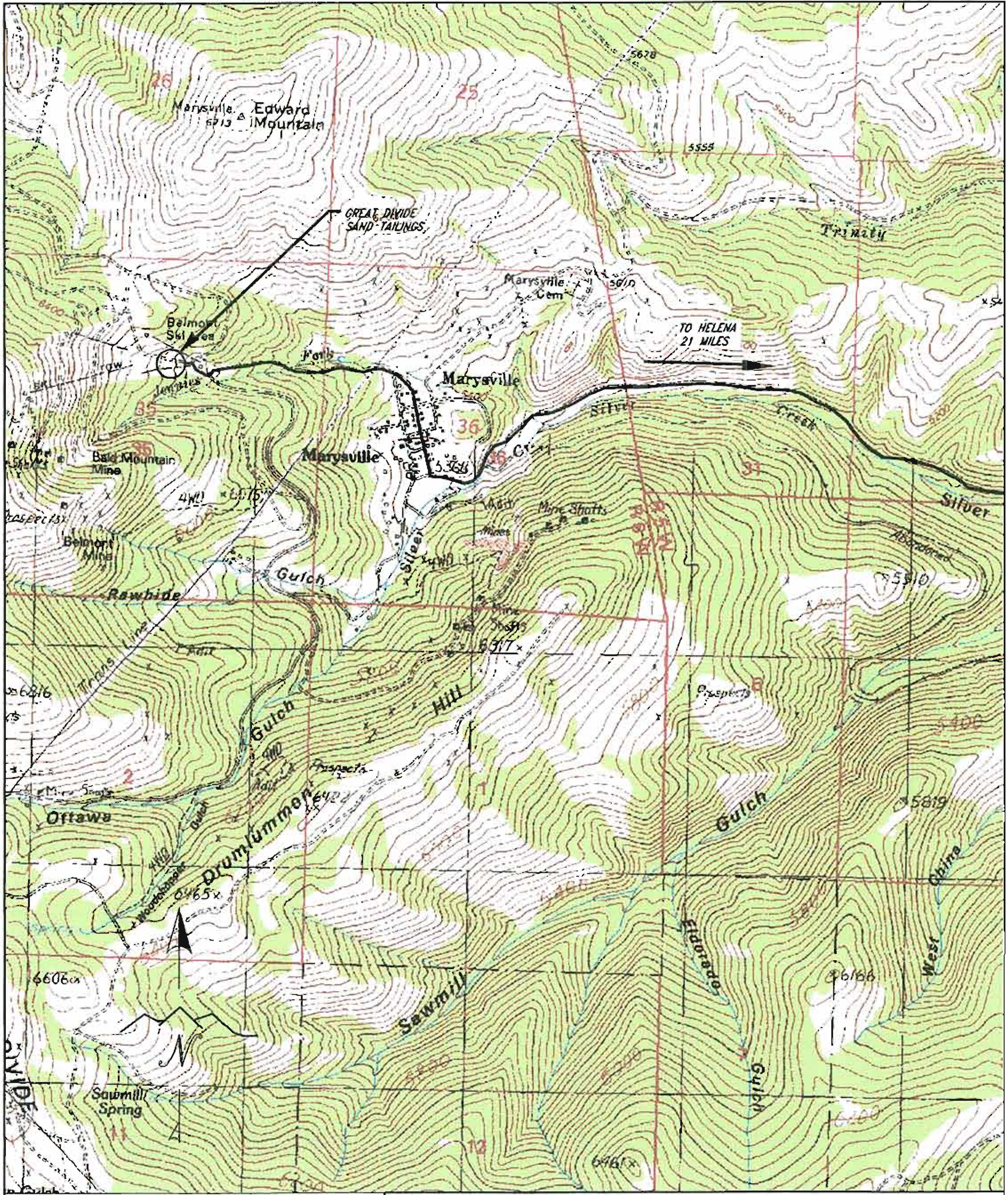
The Great Divide Sand Tailings Site is located within an unnamed drainage upgradient of the Great Divide Ski Lodge and the town of Marysville, Montana. The milling equipment and buildings have been removed from the site. The previously reclaimed tailings impoundment is vegetated but has developed numerous rills and gullies from storm water runoff. Potentially contaminated sediment materials are occasionally being carried off-site and deposited near the ski lodge and parking lot areas during storm events.

Tasks to be completed during the site investigation as part of the EEE/CA include sampling (soil, surface water with co-located sediment and groundwater); and surveying and mapping. A geotechnical investigation was completed to determine the structural properties of the soils surrounding the existing ski tower foundations at Ski Towers #5 and #6. Engineering soil properties to be evaluated include in-place moisture content, soil classification, grain size distribution and Atterberg Limits. These tests will be conducted on samples at and below the foundation bearing surfaces of the ski towers.

## 1.2 MINING HISTORY

The Great Divide Sand Tailings Site is located on the eastern slopes of Mt. Belmont. The sand tailings were produced from the historic processing of gold ore extracted from the adjacent Belmont Mine located in Jennies Fork Drainage in the historic Marysville Mining District. The Belmont was located in 1878 by William Frue and Nate Vestal. The first four years of the mine's history were its most productive years, and it operated with a 30 stamp mill. In 1882, the mine shut down and was not reopened until 1892 by the Belmont Mining Co. A few years later, in 1898, the mine was taken over by Penobscot Mining Co., run by the Longmaid family out of Helena, Montana. The Longmaids were successful in their first few years, producing a steady 90-100 tons per day until an eight month long shut down in 1902. In 1909, the mine was bought back by Belmont Mining Co., now know as W.T. Cruse Mining Co. The gold from the mine

STA1:D:DATA\GREATDIVIDESANDTAILINGS\FIGURES\GD-F100-06.DWG

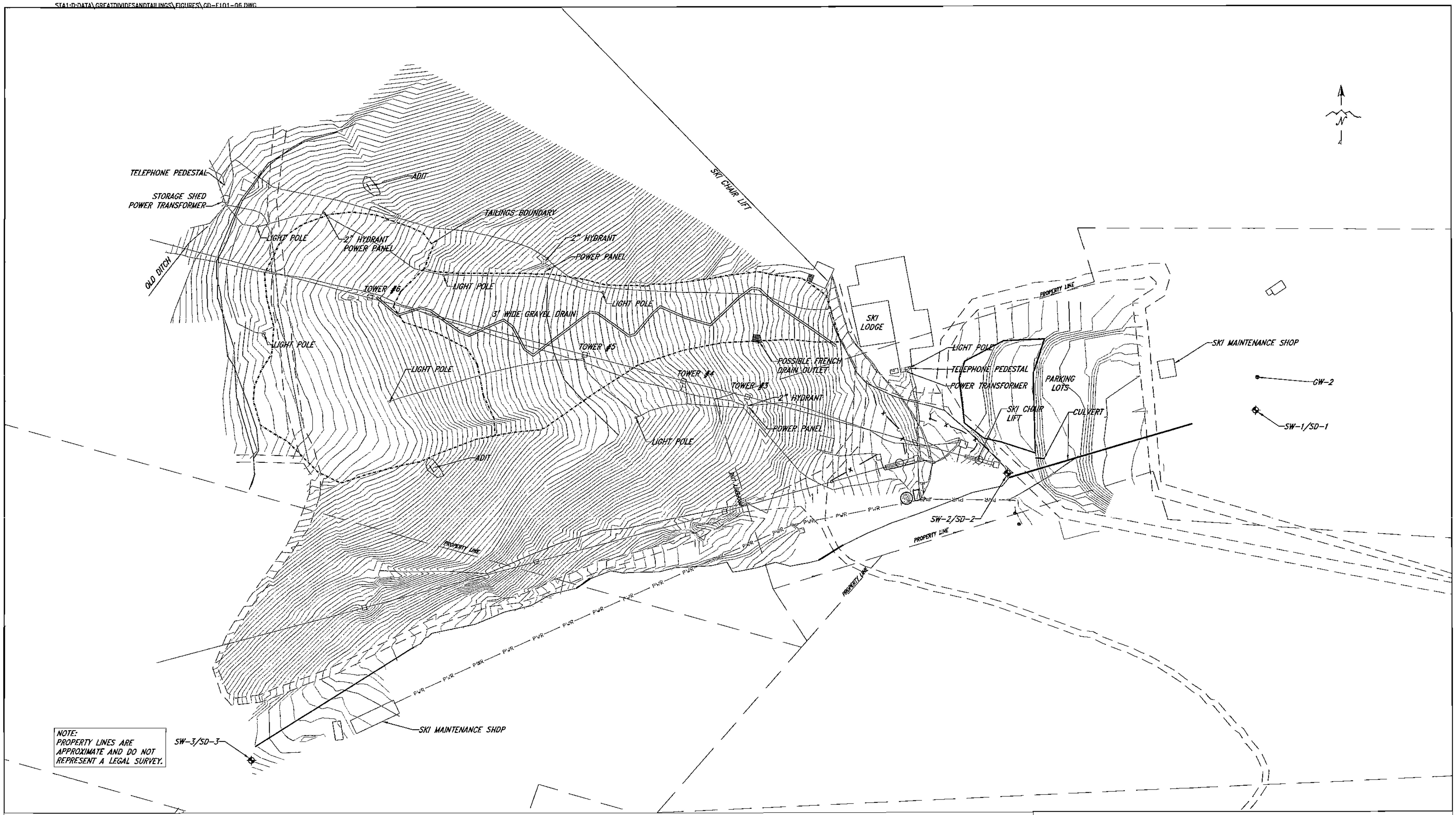


PIONEER
TECHNICAL SERVICES, INC.

FIGURE 1-1
GREAT DIVIDE SAND
TAILINGS
GENERAL VICINITY MAP

SCALE: 1"=2000'
DATE: 9/15/06

STA1:D:DATA\GREATDIVIDESANDTAILINGS\FIGURES\GD-F101-06.DWG



NOTE:
PROPERTY LINES ARE
APPROXIMATE AND DO NOT
REPRESENT A LEGAL SURVEY.

PIONEER
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FIGURE 1-2
GREAT DIVIDE
SAND TAILINGS SITE

SCALE: 1"=150'
DATE: 9/15/06

was processed by a combination of amalgamation and cyanide treatment.

In 1995, the BLM completed reclamation of the tailings through in-place containment by placement of six inches of growth media over the tailings. Drainage features were also constructed to prevent storm water erosion of the cap and tailings.

### 1.2.1 Location and Topography

The project area includes the Great Divide Sand Tailings located in the Marysville Mining District in Lewis and Clark County, Montana. The Great Divide Sand Tailings impoundment is located approximately 21 miles west/northwest of Helena, Montana, in the Northeast ¼ of the Southeast ¼ of Section 35 in Township 12 North Range 6 West of the Montana Principal Meridian (see Figure 1-1). The four-acre tailings impoundment is located within an unnamed drainage directly upgradient of the Great Divide Ski Lodge (see Figure 1-2). The site is located on land administered by the BLM Butte Field Office and Mr. Kevin Taylor, President of the Great Divide Ski Area.

### 1.3 PROJECT OBJECTIVES

The purpose of this geotechnical investigation was to determine the extent of tailings in the area and determine the underlying soil integrity surrounding Ski Towers #5 and #6 located within the tailings boundary (see Figure 1-3). Additionally, strength parameters for the in-place soils were evaluated to determine slope stability for possible excavation around the towers if removal of all tailings is evaluated as a reclamation alternative in the upcoming EEE/CA.

## 2.0 INVESTIGATION

The geotechnical foundation investigation was conducted on May 23 and 24, 2006. Boland Drilling of Great Falls, Montana, performed the drilling activities using a truck-mounted CME 55 drill rig. Mr. Dave Peitz, Mr. Todd Lorenzen, and Mr. Mike Hatten (Pioneer) logged the completed boreholes and collected samples. Eight-inch diameter hollow stem augers were used to advance the boreholes to their completion. Standard split spoon samplers were used for the Standard Penetration Test (SPT) and for collecting samples at specific depths. The SPT is performed in a soil to estimate a granular soil's relative density or a cohesive soil's consistency. A 2-inch outside diameter steel split spoon sampler is driven into the soil at prescribed sampling depths using a 140-pound hammer free-falling from a height of 30 inches onto an anvil fixed to the top of a drill rod. The sampler is driven into the soil for a maximum depth of 18 inches. The drill rod at the top of the hollow stem auger is marked by the driller in three 6-inch increments and the number of blows required to advance each of the increments below the top of the auger is recorded. If the entire 18 inches of sampler has been driven, the last 2 increments are added together and termed the 'N-value'. The N-value represents blows per foot and is used to correlate the relative density or consistency of the soil. The incremental blows appear on the logs of borings (Appendix A). A safety hammer was used to advance the split spoon sampler. Bulk composite samples were also collected from the auger cuttings in representing the entire soil profile of the borehole.

STA1:D:DATA\GREATDIVIDESANDTAILINGS\FIGURES\GD-F102-06.DWG

PIONEER TECHNICAL SERVICES, INC.

FIGURE 1-3
GREAT DIVIDE
SAND TAILINGS SITE
BOREHOLE SAMPLE LOCATIONS
SCALE: 1"=100'
DATE: 9/15/06

The split spoon and composite samples were transported to Pioneer's materials laboratory in Helena, Montana, for analysis. The samples were analyzed for the following parameters and the results are provided in Appendix B:

- Particle size;
- Atterberg limits;
- Moisture content; and
- Corrosivity.

Bulk composite samples were tested for standard Proctor moisture-density relationships following the American Association of State and Highway Transportation Officials (AASHTO) T99 Method C. The bulk composite sample results are provided in Appendix C.

## 2.1 SKI TOWER # 5

Five boreholes were drilled in the vicinity of the foundation surrounding Ski Tower #5 on May 23 and May 24, 2006. Auger refusal was encountered at a depth of 9 feet below ground surface (bgs) in borehole (BH)-1. Subsequent borings, BH-2, BH-3, and BH-4 were sampled to depths from 15.3 feet to 26.5 feet bgs. BH-9 was drilled approximately 10 feet directly north of BH-1 in an effort to sample deeper depths than originally obtained at BH-1, but was advanced only to a depth of 10.5 feet bgs. Table 1-1 summarizes the borehole total depth and/or refusal for each borehole completed at Ski Tower #5.

In general, the area near the northwest corner (BH-2) of the ski tower had the least dense material. Typically split spoon refusal was encountered at depths ranging from 10 to 15 feet bgs for BH-3, BH-4, and BH-9. Refusal was not encountered at BH-2 until a depth of 26 feet bgs. No tailings were encountered in any of the 5 borings surrounding Ski Tower #5. The soils encountered were generally sand with varying amounts of silt and gravel. The relative densities increased from loose to very dense with depth. The moisture contents of the sampled soils from Ski Tower #5 were relatively low ranging from 6 to 11%.

**TABLE 1-1**
**SKI TOWER #5**
**TOTAL DEPTH SUMMARY**

| Borehole Number | Location | Total Depth of BH (ft bgs) | Standard Penetration Test (Blows/ft) | Depth of Split Spoon Refusal (ft bgs) |
|---|---|---|---|---|
| 1 | NE Corner | 9.0 | 50+ | Auger refusal at 9.0 |
| 2 | NW Corner | 26.3 | 50+ | 26 |
| 3 | SW Corner | 20.2 | 50+ | 15.5 |
| 4 | SE Corner | 15.0 | 25+ | 15 |
| 9 | NE Corner | 10.6 |  | 10.5 |

ft bgs- feet below ground surface

## 2.2 SKI TOWER # 6

Four boreholes were drilled in the immediate area surrounding the foundation of Ski Tower #6 on May 24, 2006. Split spoon refusal was encountered in 2 of the boreholes, BH-7 and BH-8, respectively. Table 2-1 summarizes the borehole total depth and/or refusal for each borehole completed at Ski Tower #6. Also included is the depth at which the split spoon sampler either reached refusal during the SPT or the corresponding N-value at the bottom of the borehole.

**TABLE 2-1**
**SKI TOWER #6**
**TOTAL DEPTH SUMMARY**

| Borehole Number | Location | Total Depth of BH (ft bgs) | Standard Penetration Test (Blows/ft) | Depth of Split Spoon Refusal (ft bgs) |
|---|---|---|---|---|
| 5 | SW Corner | 26.5 | 79 | 26.5 |
| 6 | SE Corner | 26.5 | 49 | 26.5 |
| 7 | NW Corner | 25.0 | 25+ | 25.0 |
| 8 | NE Corner | 25.0 | 25+ | 25.0 |

ft bgs- feet below ground surface

At each borehole location a thin layer of tailings was encountered beneath a surficial cap of topsoil. The cap material ranged between 3 to 6 inches in depth. The tailings were generally between 1.5 to 2.5 feet in thickness. Native materials beneath the tailings were sand with varying amounts of silt and gravel. The relative densities increased from loose to very dense with depth. Decomposed sandstone or rock was encountered at the 25-foot depth in each of the 4 boreholes. The moisture contents of the sampled soils were relatively low ranging from 6 to 19% with the exception of BH-8 at 5 feet bgs which had a moisture content of 45%.

## 2.3 GROUNDWATER CONDITIONS

No groundwater was encountered in any of the boreholes completed for this investigation.

# 3.0 DISCUSSION

Pioneer was unable to obtain As-Built or design plan sheets for either of the tower foundations. The exact size of the tower foundations or the depth to which they extend is unknown. Therefore, the following recommendations are relatively conservative in allowable earthwork in the areas surrounding either of the ski tower foundations.

Corrosion testing of the soils consisted of determining pH, electrical conductivity and sulfate content to determine if soils will have negative impacts to metals and concrete.

Corrosivity values for 21 samples ranged from an electrical conductivity of 42.9 micromhos per centimeter (µmhos/cm) in BH-4 at a depth of 10 feet bgs to 1,203 µmhos/cm at BH-5 at a depth of 5 feet bgs. The pH values for the 21 samples ranged from 5.99 Standard Units (su) in BH-5 at a depth of 5 feet bgs to 7.45 su in BH-8 at a depth of 5 feet bgs. The samples were analyzed for soluble sulfates. No sulfates were detected. Table 3-1 summarizes the electrical conductivity results.

When the electrical conductivity is less than 450 µmhos/cm and the pH of the soil is between 6.0 and 8.5 su, little or no detrimental effects to steel and concrete are observed. As the electrical conductivity increases and/or the pH becomes lower, the levels of corrosivity to metal and concrete increase. The results of the corrosion testing are provided in Table 3-1.

### TABLE 3-1
### SUMMARY OF
### CORROSIVITY TEST VALUES

| Laboratory Sample Number | Borehole Number | Sample Depth (ft) | Electrical Conductivity (µmhos/cm) | pH (su) | Marble pH |
|---|---|---|---|---|---|
| 3479 | BH-1 | 5 | 692.0 | 6.06 | 6.67 |
| 3482 | BH-2 | 5 | 64.2 | 7.13 | 7.25 |
| 3484 | BH-2 | 10 | 327.0 | 5.88 | 6.62 |
| 3486 | BH-2 | 15 | 632.0 | 5.31 | 6.67 |
| 3494 | BH-3 | 5 | 250.0 | 6.49 | 6.67 |
| 3495 | BH-3 | 10 | 397.0 | 5.10 | 6.53 |
| 3497 | BH-3 | 15 | 320.0 | 5.82 | 6.61 |
| 3499 | BH-4 | 5 | 86.4 | 7.15 | 7.25 |
| 3501 | BH-4 | 10 | 42.9 | 7.20 | 7.45 |
| 3505 | BH-5 | 5 | 1,203.0 | 5.76 | 5.99 |
| 3506 | BH-5 | 10 | 235.0 | 5.84 | 6.71 |
| 3508 | BH-5 | 15 | 345.0 | 6.63 | 6.83 |
| 3518 | BH-6 | 5 | 181.1 | 6.71 | 6.74 |
| 3521 | BH-6 | 10 | 136.0 | 6.54 | 6.95 |
| 3524 | BH-6 | 15 | 498.0 | 5.88 | 6.54 |
| 3529 | BH-7 | 5 | 352.0 | 6.50 | 6.57 |
| 3530 | BH-7 | 10 | 150.8 | 6.85 | 7.16 |
| 3535 | BH-8 | 5 | 106.3 | 7.21 | 7.36 |
| 3536 | BH-8 | 10 | 193.9 | 6.93 | 7.20 |
| 3537 | BH-8 | 15 | 121.9 | 7.04 | 7.36 |
| 3540 | BH-9 | 5 | 105.7 | 6.98 | 7.31 |

ft – feet
µmhos/cm – microhoms per centimeter
su – standard units

Table 3-1 depicts 4 samples (3479, 3486, 3505, and 3524) that have electrical conductivity values greater than 450 μmhos/cm; and 7 samples (3484, 3486, 3495, 3497, 3505, 3506, and 3524) that have pH values less than 6.0 su. These could present some corrosive concerns with the concrete foundations supporting the towers.

## 4.0 CONSTRUCTION

Bulk samples were collected from the boreholes and composited for soil classification testing and for moisture/density relationships. Results are summarized in Table 4-1.

### TABLE 4-1
### SOIL CLASSIFICATION PROCTOR RESULTS

| Borehole Number | Sample Type | Unified Soil Classification | AASHTO Soil Classification | Maximum Dry Density (pcf) | Optimum Moisture Content (%) |
|---|---|---|---|---|---|
| BH-01<br>BH-09 | Composite Sample | Poorly Graded Gravel with Sand (GP) | A-1-a(0) | 127.2 | 11.0 |
| BH-02<br>BH-05<br>BH-07 | Composite Sample | Silty Sand with Gravel (SM) | A-2-4(0) | 127.5 | 11.1 |
| BH-06<br>BH-08 | Composite Sample | Silty Sand (SM) | A-2-4(0) | 127.8 | 9.0 |

AASHTO - American Association of State and Highway Transportation Officials
pcf – pounds per cubic foot

## 5.0 CONCLUSIONS

The purpose of this investigation was to determine the depth of tailings and evaluate the foundation soils for strength parameters for the area surrounding Ski Towers #5 and #6 in the event that tailings removal is evaluated as a reclamation alternative for the forthcoming EEE/CA. No tailings were encountered at Ski Tower #5. A relatively thin layer of tailings was encountered within the upper 3 feet of material beneath a thin topsoil cap at Ski Tower #6. In general, the soils encountered are considered to be good quality materials generally consisting of sand with varying amounts of silt and gravel. The relative densities increased from loose to very dense with depth at each of the towers. The moisture contents ranged from 6 to 19% with a maximum dry density of 127.5 pounds per cubic foot (pcf).

Based on the results from this investigation and the above conclusions only limited removal of tailings would be considered under any of the potential reclamation alternatives. The native soil materials surrounding Ski Tower #5 are considered to have relatively high strength parameters. Because no tailings were encountered in any of the borings, it is not expected at this time that any excavation near this tower will be necessary under any proposed reclamation alternative.

The in-place native materials underlying Ski Tower #6 foundation are considered to have moderate strength parameters. Therefore, the removal of the surficial tailings (<3 feet) and replacement with a compacted granular backfill will not compromise the integrity of the foundation if this is evaluated as a reclamation alternative.

Based on the corrosivity result values of some of the samples, it may be beneficial to the ski lodge owner to investigate the existing concrete foundation footings by hand digging along one side to determine if any of the concrete has eroded away and has exposed aggregate. However, the structural integrity of the concrete footing is beyond the scope of this investigation.

## 6.0 REFERENCES

ASTM, 1985. American Society of Testing Materials.

AASHTO - American Association of State and Highway Transportation Officials.

BLM, 1994. Great Divide Sand Tailings Reclamation Project Removal Site Evaluation

BLM/USACE-Pioneer 2006. Final Field Sampling Plan for the Great Divide Sand Tailings Site Project. May 2006.

DEQ/MWCB-Pioneer, 1993. Montana Department of State Lands, Abandoned Mine Reclamation Bureau, Abandoned Hardrock Mine Priority Sites, 1995 Summary Report.

SSSA, 1982. Methods of Soil Analysis. Part 2: Chemical and Microbiological Properties. Soil Science Society of America.

# APPENDIX A

# BORING LOGS

201 E Broadway STE C
Helena, MT 59602
Phone: 406-457-8252
Fax: 406-442-1158

# LOG OF BORING

PIONEER TECHNICAL SERVICES, INC.

Project Name: BLM- Great Divide
Project Number: 10301
Borehole Location: NE Corner of Tower 5
Borehole Number: BH-01
Sheet 1 of 1
Drilling Equipment: CME 55
Hammer Type: Safety
Driller: Boland Drilling
Logger: T. Lorenzen
Drilling Fluid: N/A
Borehole Diameter (in): 8
Date Started: 5-23-06
Date Finished: 5-23-06
Elevation and Datum: Ground: 5986.90 Casing:
Notes: N925100.014; E1263312.419

| DEPTH (feet) | DRILL OPERATION | DRILL PRESSURE (psi) | DRILL RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT LL | PLASTIC LIMIT PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 300 | | | | | | | | NP | NP | | GRAVEL with Sand (GP); damp to moist; brown; medium dense; no reaction to 10% HCl. | | 8-inch OD Hollow Stem Augers. |
| | | | 196 | | | ☒ | 50 | 7-8-5 | | 6 | | | | | | |
| 5 | | | | | | | | | | | | | | | | Standard Split Spoon used for all Samples. |
| | | | 108 | | | ☒ | 67 | 8-12-10 | | 9<br>8 | | | | At 5-ft sample depth:<br>pH: 6.06<br>Marble pH: 6.67<br>Conductivity: 0.69 mmhos<br>% Sulfates: None | | |
| | | | | | | | | | | | | | | | 9.0 | Auger Refusal at 9 feet. |

Operation Types: Auger; Casing Advancer; Core Barrel; Drive Casing

Sampler Types: Split Spoon; Shelby; Bulk Sample; Grab Sample; Penetrometer; Vane Shear; Special Samplers; Testpit

WATER LEVEL OBSERVATIONS

While Drilling ∇ ____ ft Upon Completion of Drilling ▼ ____ ft
Time After Drilling ____ ____ ____ ____
Depth To Water (feet) ____ ____ ____ ____ ▼
Remarks: Groundwater Not Encountered

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# LOG OF BORING

PIONEER TECHNICAL SERVICES, INC.

| | | | |
|---|---|---|---|
| Project Name: BLM- Great Divide | | | Project Number: 10301 |
| Borehole Location: NW Corner of Tower 5 | | Borehole Number: BH-02 | Sheet 1 of 1 |
| Drilling Equipment: CME 55 | Hammer: Type: Safety | Driller: Boland Drilling | Logger: D. Peitz |
| Drilling Fluid: N/A | Borehole Diameter (in): 8 | Date Started: 5-23-06 | Date Finished: 5-23-06 |
| Elevation and Datum: Ground: 5984.08 | Casing: | Notes: N925095.879; E1263326.791 | |

| DEPTH (feet) | DRILL OPERATION | DRILL PRESSURE (psi) | DRILL RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT LL | PLASTIC LIMIT PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 171 | | | | | | | | NP | NP | | Silty SAND with Gravel (SM); damp; brown; medium dense; no reaction to 10% HCl. | | 8-inch OD Hollow Stem Augers. |
| | | | 135 | | | ☒ | 28 | 8-12-9 | | 7 | | | | | | |
| 5 | | | 121 | | | ☒ | 83 | 10-11-12 | | 8<br>9 | | | | SAND with Gravel; damp; brown with white mottling to tan; medium dense to very dense; no reaction to 10% HCl.<br>At 5-ft sample septh:<br>pH: 7.13<br>Marble pH: 7.25<br>Conductivity: 0.06 mmhos<br>% Sulfates: None | 5.0 | Standard Split Spoon used for all Samples. |
| 10 | | | 87 | | | ☒ | 83 | 8-14-15 | | 6<br>7 | NP | NP | | At 10-ft sample depth:<br>pH: 5.88<br>Marble pH: 6.62<br>Conductivity: 0.33 mmhos<br>% Sulfates: None | | |
| 15 | | | 78 | | | ☒ | 87 | 6-8-9 | | 6<br>5 | | | | At 15-ft sample depth:<br>pH: 5.31<br>Marble pH: 6.67<br>Conductivity: 0.63 mmhos<br>% Sulfates: None | | |
| 20 | | | 149 | | | ☒ | 67 | 15-13-13 | | | | | | | | |
| 25 | | | | | | ☒ | 83 | 42-46-50R(.3") | | | | | | | 26.5 | |

Operation Types: Auger; Casing Advancer; Core Barrel; Drive Casing

Sampler Types: ☒ Split Spoon; Shelby; Bulk Sample; Grab Sample; Penetrometer; Vane Shear; Special Samplers; Testpit

## WATER LEVEL OBSERVATIONS

While Drilling ∇ ______ ft    Upon Completion of Drilling ▼ ______ ft
Time After Drilling ______ ______ ______ ______
Depth To Water (feet) ______ ______ ______ ______ ▼
Remarks: Groundwater Not Encountered

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# LOG OF BORING

PIONEER TECHNICAL SERVICES, INC.

Project Name: BLM- Great Divide
Project Number: 10301
Borehole Location: SW Corner of Tower 5
Borehole Number: BH-03
Sheet 1 of 1
Drilling Equipment: CME 55
Hammer Type: Safety
Driller: Boland Drilling
Logger: T. Lorenzen
Drilling Fluid: N/A
Borehole Diameter (in): 8
Date Started: 5-24-06
Date Finished: 5-24-06
Elevation and Datum: Ground: 5989.39 Casing:
Notes: N925065.155; E1263308.776

| DEPTH (feet) | DRILL OPERATION | DRILL PRESSURE (psi) | DRILL RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT LL | PLASTIC LIMIT PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | Silty SAND with Gravel; damp to moist; brown; loose; weak to no reaction to 10% HCl; slightly plastic. |  | 8-inch OD Hollow Stem Augers. |
|  |  |  | 360 |  |  | ☒ | 78 | 3-3-4 |  | 10<br>11 |  |  |  |  |  |  |
| 5 |  |  | 200 |  |  | ☒ | 56 | 1-1-4 |  | 10 |  |  |  | At 5-ft sample depth:<br>pH: 6.49<br>Marble pH: 6.67<br>Conductivity: 0.25 mmhos<br>% Sulfates: None |  | Standard Split Spoon used for all Samples. |
| 10 |  |  | 136 |  |  | ☒ | 56 | 9-10-32 |  | 5<br>5 |  |  |  | At 10-ft sample depth:<br>pH: 5.10<br>Marble pH: 6.53<br>Conductivity: 0.40 mmhos<br>% Sulfates: None | 11.0 |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | SAND with Gravel; damp; brown to light brown; dense to very dense; no reaction to 10% HCl. |  |  |
| 15 |  |  | 71 | 100 |  | ☒ | 100 | 28-50R(.4') |  | 4 |  |  |  | At 15-ft sample depth:<br>pH: 5.82<br>Marble pH: 6.61<br>Conductivity: 0.32 mmhos<br>% Sulfates: None |  |  |
| 20 |  |  |  |  |  | ☒ | 0 | 50R(.2') |  |  |  |  |  |  | 20.3 |  |

Operation Types:
- Auger
- Casing Advancer
- Core Barrel
- Drive Casing

Sampler Types:
- Split Spoon
- Shelby
- Bulk Sample
- Grab Sample
- Penetrometer
- Vane Shear
- Special Samplers
- Testpit

## WATER LEVEL OBSERVATIONS

While Drilling ∇ ______ ft Upon Completion of Drilling ▼ ______ ft
Time After Drilling ______ ______ ______ ______
Depth To Water (feet) ______ ______ ______ ______ ▼
Remarks: Groundwater Not Encountered

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# LOG OF BORING

PIONEER TECHNICAL SERVICES, INC.

Project Name: BLM- Great Divide
Project Number: 10301
Borehole Location: SE Corner of Tower 5
Borehole Number: BH-04
Sheet 1 of 1
Drilling Equipment: CME 55
Hammer: Type: Safety
Driller: Boland Drilling
Logger: T. Lorenzen
Drilling Fluid: N/A
Borehole Diameter (in): 8
Date Started: 5-24-06
Date Finished: 5-24-06
Elevation and Datum: Ground: 5986.33 Casing:
Notes: N925060.185; E1263325.479

| DEPTH (feet) | DRILL OPERATION | DRILL PRESSURE (psi) | DRILL RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT LL | PLASTIC LIMIT PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ◗ | | | | | | | | | | | | | COBBLE, 12" rock near surface. | 2.0 | 8-inch OD Hollow Stem Augers. |
| | ◗ | | 67 | | | ☒ | 0 | 25R(0') | | | | | | SAND with Silt; damp to moist; brown; medium dense; non-plastic. | | |
| 5 | ◗ | | 120 | | | ☒ | 87 | 6-6-6 | | 7<br>8 | | | | At 5-ft sample depth:<br>pH: 7.15<br>Marble pH: 7.25<br>Conductivity: 0.09 mmhos<br>% Sulfates: None | | Standard Split Spoon used for all Samples. |
| 10 | ◗ | | 90 | | | ☒ | | 20-17-22 | | 4<br>5 | NP | NP | | Silty SAND (SM); brown; dense to very dense; no reaction to 10% HCl.<br>At 5-ft sample depth:<br>pH: 7.20<br>Marble pH: 7.45<br>Conductivity: 0.04 mmhos<br>% Sulfates: None | 10.0 | |
| 15 | | | | | | ☒ | | 25R(0') | | | | | | | 15.3 | |

Operation Types:
- ◗ Auger
- ≋ Casing Advancer
- ▯ Core Barrel
- ▽ Drive Casing

Sampler Types:
- ☒ Split Spoon
- ■ Shelby
- ▨ Bulk Sample
- ✋ Grab Sample
- ≚ Penetrometer
- ▯ Vane Shear
- ⧗ Special Samplers
- ☰ Testpit

## WATER LEVEL OBSERVATIONS

While Drilling ▽ ______ ft Upon Completion of Drilling ▼ ______ ft
Time After Drilling ______ ______ ______ ______
Depth To Water (feet) ______ ______ ______ ______ ▼
Remarks: Groundwater Not Encountered

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# LOG OF BORING

PIONEER TECHNICAL SERVICES, INC.

Project Name: BLM- Great Divide
Project Number: 10301
Borehole Location: SW Corner of Tower 6
Borehole Number: BH-05
Sheet 1 of 1
Drilling Equipment: CME 55
Hammer Type: Safety
Driller: Boland Drilling
Logger: T. Lorenzen
Drilling Fluid: N/A
Borehole Diameter (in): 8
Date Started: 5-24-06
Date Finished: 5-24-06
Elevation and Datum: Ground: 6051.51
Casing:
Notes: N925165.643; E1262966.175

| DEPTH (feet) | DRILL OPERATION | DRILL PRESSURE (psi) | DRILL RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT LL | PLASTIC LIMIT PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | ▮ |  |  |  |  |  |  |  |  |  |  |  |  | CAP, Silty Sand, Organincs; damp; brown. | 0.5 | 8-inch OD Hollow Stem Augers. |
|  | ▮ |  |  |  |  | ☒ | 78 | 2-2-1 |  | 13<br>17 |  |  |  | TAILINGS; Silty Sand; damp; brown; very loose; strong reaction to 10% HCl. | 3.2 |  |
| 5 | ▮ |  |  |  |  | ☒ | 28 | 6-4-6 |  | 8 | NP | NP |  | Silty SAND with Gravel (SM); damp to moist; dark brown to brown; loose to dense; no to weak reaction to 10% HCl.<br>Gravels are subangular.<br>A5 5-ft sample depth:<br>pH: 5.76<br>Marble pH: 5.99<br>Conductivity: 1.20 mmhos<br>% Sulfates: None |  | Standard Split Spoon used for all Samples.<br>Auger Refusal at 9 feet. |
| 10 | ▮ |  | 278 |  |  | ☒ | 78 | 12-16-13 |  | 7<br>7 |  |  |  | At 10-ft sample depth:<br>pH: 5.84<br>Marble pH: 6.71<br>Conductivity: 0.24 mmhos<br>% Sulfates: None | 15.0 |  |
| 15 | ▮ |  | 61 |  |  | ☒ | 78 | 8-9-8 |  | 8<br>9 |  |  |  | Sand with Gravel, trace Clay; moist; brown; medium dense; no reaction to 10% HCl; slightly plastic.<br>At 15-ft sample depth:<br>pH: 6.63<br>Marble pH: 6.83<br>Conductivity: 0.35 mmhos<br>% Sulfates: None | 20.0 |  |
| 20 | ▮ |  | 125 |  |  | ☒ | 78 | 6-4-5 |  | 11<br>10 |  |  |  | SAND with Gravel; moist; brown to light brown; loose to dense; no reaction to 10% HCl. | 25.0 |  |
| 25 |  |  |  |  |  | ☒ | 100 | 19-32-47 |  | 9<br>9 |  |  |  | SANDSTONE, completely weathered; moist; brown with white mottling, dark brown staining; soft field hardness. | 26.5 |  |

| Operation Types: | Sampler Types: |  |
|---|---|---|
| ◧ Auger | ☒ Split Spoon | ▨ Penetrometer |
| ▨ Casing Advancer | ■ Shelby | ▯ Vane Shear |
| ▯ Core Barrel | ▨ Bulk Sample | ⧗ Special Samplers |
| ▽ Drive Casing | ✋ Grab Sample | ☰ Testpit |

## WATER LEVEL OBSERVATIONS

While Drilling ▽ ____ ft Upon Completion of Drilling ▼ ____ ft
Time After Drilling ____ ____ ____ ____
Depth To Water (feet) ____ ____ ____ ____ ▼
Remarks: Groundwater Not Encountered

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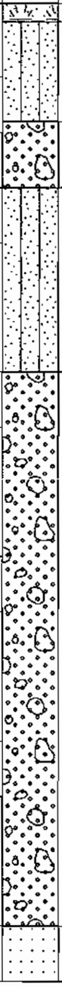
# LOG OF BORING

PIONEER TECHNICAL SERVICES, INC.

Project Name: BLM- Great Divide
Project Number: 10301
Borehole Location: SE Corner of Tower 6
Borehole Number: BH-06
Sheet 1 of 1
Drilling Equipment: CME 55
Hammer: Type: Safety
Driller: Boland Drilling
Logger: M. Hatten
Drilling Fluid: N/A
Borehole Diameter (in): 8
Date Started: 5-24-06
Date Finished: 5-24-06
Elevation and Datum: Ground: 6055.10
Casing:
Notes: N925170.165; E1262948.906



| DEPTH (feet) | DRILL OPERATION | DRILL PRESSURE (psi) | DRILL RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT LL | PLASTIC LIMIT PL | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 285 | | | | | | | | | | CAP, Silty Sand, Organincs; damp; brown. | 0.5 | 8-inch OD Hollow Stem Augers. |
| | | | 180 | | | ☒ | 80 | 1-2-3 | | 17<br>19 | | | TAILINGS, Silty Sand; damp; gray; very loose; strong reaction to 10% HCl. | 3.2 | |
| 5 | | | | | | | | | | | | | SAND with Gravel, trace Clay; damp to moist; dark brown; no reaction to 10% HCl; slightly plastic. | 5.0 | |
| | | | 200 | | | ☒ | 87 | 6-6-5 | | 13<br>12 | NP | NP | Silty SAND (SM); damp to moist; brown; medium dense; no reaction to 10% HCl; non-plastic.<br>pH: 6.71<br>Marble pH: 6.74<br>Conductivity: 0.18 mmhos<br>% Sulfates: None | 10.0 | Standard Split Spoon used for all Samples. |
| 10 | | | 80 | | | ☒ | 100 | 14-16-15 | | 8<br>8 | | | SAND with Gravel, some Clay; damp; brown; dense to medium dense; no reaction to 10% HCl; non-plastic.<br>pH: 6.54<br>Marble pH: 6.95<br>Conductivity: 0.14 mmhos<br>% Sulfates: None | | |
| 15 | | | 78 | | | ☒ | 93 | 11-8-7 | | 9 | | | pH: 5.88<br>Marble pH: 6.54<br>Conductivity: 0.50 mmhos<br>% Sulfates: None | | |
| 20 | | | 80 | | | ☒ | 40 | 6-10-8 | | 8 | | | | 25.0 | |
| 25 | | | | | | ☒ | 73 | 16-25-24 | | 8 | | | SANDSTONE; completley weathered; damp; brown; soft field hardness; no reaction to 10% HCl solution. | 26.5 | |

Operation Types: Auger, Casing Advancer, Core Barrel, Drive Casing

Sampler Types: ☒ Split Spoon, Shelby, Bulk Sample, Grab Sample, Penetrometer, Vane Shear, Special Samplers, Testpit

## WATER LEVEL OBSERVATIONS

While Drilling ▽ ____ ft Upon Completion of Drilling ▼ ____ ft
Time After Drilling ____
Depth To Water (feet) ____
Remarks: Groundwater Not Encountered

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# LOG OF BORING

PIONEER TECHNICAL SERVICES, INC.

| | | | |
|---|---|---|---|
| Project Name: BLM- Great Divide | | Project Number: 10301 | |
| Borehole Location: NW Corner of Tower 6 | | Borehole Number: BH-07 | Sheet 1 of 1 |
| Drilling Equipment: CME 55 | Hammer: Type: Safety | Driller: Boland Drilling | Logger: M. Hatten |
| Drilling Fluid: N/A | Borehole Diameter (in): 8 | Date Started: 5-24-06 | Date Finished: 5-24-06 |
| Elevation and Datum: Ground: 6056.03 | Casing: | Notes: N925196.704; E1262953.173 | |

| DEPTH (feet) | DRILL OPERATION | DRILL PRESSURE (psi) | DRILL RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT LL | PLASTIC LIMIT PL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Auger | | 218 | | | | | | | | NP | NP |
| 2 | Auger | | 545 | | | ☒ | 80 | 3-3-3 | | 11<br>10 | NP | NP |
| 5 | Auger | | 600 | | | ☒ | 53 | 4-4-10 | | 9 | | |
| 10 | Auger | | 84 | | | ☒ | 67 | 5-10-12 | | 10<br>10 | | |
| 15 | Auger | | 71 | | | ☒ | 87 | 17-11-38 | | 6 | | |
| 20 | | | | | | ☒ | | 25R(0") | | | | |

| MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|
| CAP, Silty Sand, Organincs; damp; brown. | 0.5 | 8-inch OD Hollow Stem Augers. |
| TAILINGS, Silty Sand with Gravel (SM); damp; brown; strong reaction to 10% HCl. | 2.3 | |
| Silty SAND with Gravel (SM); damp to moist; brown; medium dense; no reaction to 10% HCl; non-plastic.<br>At 5-ft sample depth:<br>pH: 6.50<br>Marble pH: 6.57<br>Conductivity: 0.35 mmhos<br>% Sulfates: None<br>At 10-ft sample depth:<br>pH: 6.85<br>Marble pH: 7.16<br>Conductivity: 0.15 mmhos<br>% Sulfates: None | 11.0 | Standard Split Spoon used for all Samples. |
| Gravelly SAND; damp; brown; dense; no reaction to 10% HCl. | 18.0 | |
| SANDSTONE; completley weathered; damp; brown; soft field hardness; no reaction to 10% HCl solution. | 20.0 | |

Operation Types: Auger; Casing Advancer; Core Barrel; Drive Casing

Sampler Types: Split Spoon; Shelby; Bulk Sample; Grab Sample; Penetrometer; Vane Shear; Special Samplers; Testpit

## WATER LEVEL OBSERVATIONS

While Drilling ∇ ______ ft   Upon Completion of Drilling ▼ ______ ft
Time After Drilling ______ ______ ______ ______
Depth To Water (feet) ______ ______ ______ ______ ▼
Remarks: Groundwater Not Encountered

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# LOG OF BORING

PIONEER TECHNICAL SERVICES, INC.

Project Name: BLM- Great Divide
Project Number: 10301
Borehole Location: NE Corner of Tower 6
Borehole Number: BH-08
Sheet 1 of 1
Drilling Equipment: CME 55
Hammer Type: Safety
Driller: Boland Drilling
Logger: M. Hatten
Drilling Fluid: N/A
Borehole Diameter (in): 8
Date Started: 5-24-06
Date Finished: 5-24-06
Elevation and Datum: Ground: 6052.39
Casing:
Notes: N925193.762; E1262971.964

| DEPTH (feet) | DRILL OPERATION | DRILL PRESSURE (psi) | DRILL RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT LL | PLASTIC LIMIT PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ▮ | | 480 | | | | | | | | NP | NP | | CAP, Silty Sand, Organincs; damp; brown. | 0.5 | 8-inch OD Hollow Stem Augers. |
| | ▮ | | | | | | | | | | | | | TAILINGS, Silty Sand (SM); damp; brown; strong reaction to 10% HCl. | 2.0 | |
| | ▮ | | 360 | | | ☒ | 60 | 3-4-4 | | 9 | | | | SAND with Gravel, trace Clay; damp to moist; brown; loose to very loose; no reaction to 10% HCl; non-plastic. | | |
| 5 | ▮ | | 400 | | | ☒ | 53 | 1-1-1 | | 45 | | | | At 5-ft sample depth:<br>pH: 7.21<br>Marble pH: 7.36<br>Conductivity: 0.11 mmhos<br>% Sulfates: None | 8.0 | Standard Split Spoon used for all Samples. |
| | ▮ | | | | | | | | | | | | | SAND with Gravel, trace Clay; damp to moist; brown; medium dense to dense; no reaction to 10% HCl; non-plastic. | | |
| 10 | ▮ | | 190 | | | ☒ | 73 | 10-14-12 | | 9 | | | | At 10-ft sample depth:<br>pH: 6.93<br>Marble pH: 7.20<br>Conductivity: 0.19 mmhos<br>Sulfate %: None | | |
| 15 | ▮ | | 63 | | | ☒ | 87 | 7-12-9 | | 6 | | | | At 15-ft sample depth:<br>pH: 7.04<br>Marble pH: 7.36<br>Conductivity: 0.12 mmhos<br>% Sulfates: None | 20.0 | |
| 20 | ▮ | | 57 | | | ☒ | 93 | 25-17-24 | | 5 | | | | SANDSTONE; completley weathered; damp; brown; soft field hardness; no reaction to 10% HCl solution. | 25.0 | |
| 25 | | | | | | ☒ | | 25R(0') | | | | | | | | |

Operation Types:
▮ Auger
▨ Casing Advancer
▯ Core Barrel
▽ Drive Casing

Sampler Types:
☒ Split Spoon
■ Shelby
▨ Bulk Sample
▨ Grab Sample
▽ Penetrometer
▯ Vane Shear
⧗ Special Samplers
☰ Testpit

## WATER LEVEL OBSERVATIONS

While Drilling ▽ ____ ft
Upon Completion of Drilling ▼ ____ ft
Time After Drilling ____ ____ ____ ____
Depth To Water (feet) ____ ____ ____ ____ ▼
Remarks: Groundwater Not Encountered

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# LOG OF BORING

**PIONEER**
TECHNICAL SERVICES, INC.

Project Name: BLM- Great Divide
Project Number: 10301
Borehole Location: NE Corner of Tower 5
Borehole Number: BH-09
Sheet 1 of 1
Drilling Equipment: CME 55
Hammer: Type: Safety
Driller: Boland Drilling
Logger: M. Hatten
Drilling Fluid: N/A
Borehole Diameter (in): 8
Date Started: 5-24-06
Date Finished: 5-24-06
Elevation and Datum: Ground: 5687.00 Casing:
Notes: Redrill of BH-01

| DEPTH (feet) | DRILL<br>OPERATION | DRILL<br>PRESSURE (psi) | DRILL<br>RATE (fph) | CORE PERCENT RECOVERY | ROCK QUALITY DESIGNATION (RQD) | SAMPLE | RECOVERY (%) | STANDARD PENETRATION TEST SPT | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | LIQUID LIMIT LL | PLASTIC LIMIT PL | GRAPHIC LOG | MATERIAL DESCRIPTION | DEPTH (feet) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 480 | | | | | | | | | | | SAND with Gravel, trace Clay; damp to moist; brown; loose to very dense; no reaction to 10% HCl; non-plastic. | | 8-inch OD Hollow Stem Augers. |
| | | | 240 | | | ☒ | 73 | 9-6-4 | | 6 | | | | | | |
| 5 | | | 78 | | | ☒ | 80 | 6-8-9 | | 9 | | | | At 5-ft sample depth:<br>pH: 6.98<br>Marble pH: 7.31<br>Conductivity: 0.11 mmhos<br>% Sulfates: None | | Standard Split Spoon used for all Samples. |
| 10 | | | | | | ☒ | 100 | 27-50R(.1') | | 1 | | | | | 10.6 | |

Operation Types: Auger; Casing Advancer; Core Barrel; Drive Casing

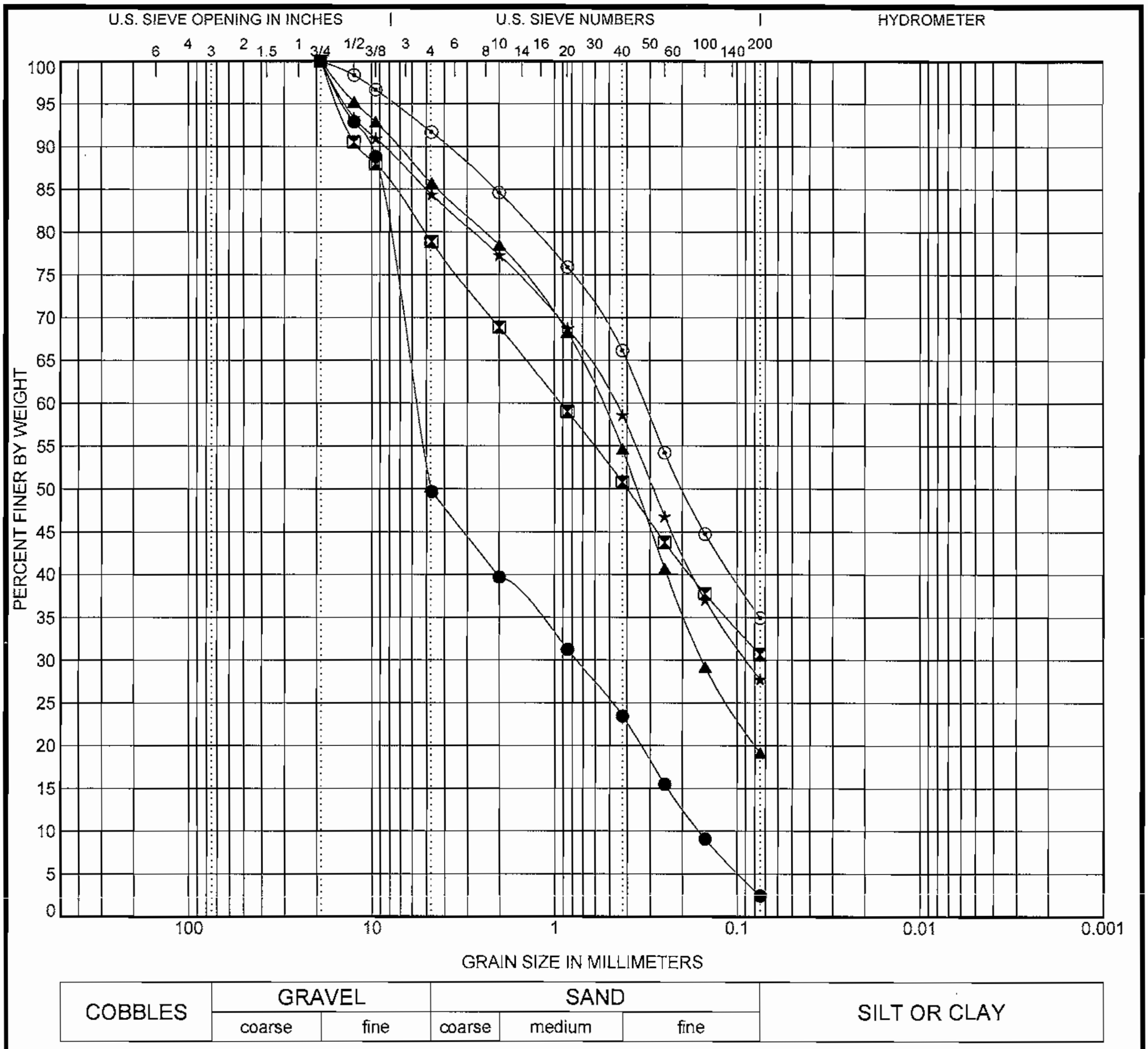
Sampler Types: ☒ Split Spoon; Shelby; Bulk Sample; Grab Sample; Penetrometer; Vane Shear; Special Samplers; Testpit

## WATER LEVEL OBSERVATIONS

While Drilling ∇ ______ ft Upon Completion of Drilling ▼ ______ ft
Time After Drilling ______ ______ ______ ______
Depth To Water (feet) ______ ______ ______ ______ ▼
Remarks: Groundwater Not Encountered

# APPENDIX B

# GRAIN SIZE DISTRIBUTION RESULTS



| | Specimen Identification | | Classification | LL | PL | PI | Cc | Cu |
|---|---|---|---|---|---|---|---|---|
| ● | **BH-01** | **0.0** | **POORLY GRADED GRAVEL with SAND(GP)** | **NP** | **NP** | **NP** | **0.63** | **35.07** |
| ⊠ | **BH-02** | **0.0** | **SILTY SAND with GRAVEL(SM)** | **NP** | **NP** | **NP** | | |
| ▲ | **BH-04** | **10.5** | **SILTY SAND(SM)** | **NP** | **NP** | **NP** | | |
| ★ | **BH-05** | **5.0** | **SILTY SAND with GRAVEL(SM)** | **NP** | **NP** | **NP** | | |
| ⊙ | **BH-06** | **5.0** | **SILTY SAND(SM)** | **NP** | **NP** | **NP** | | |

| | Specimen Identification | | D100 | D50 | D15 | D10 | %Gravel | %Sand | %Silt | %Clay |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | **BH-01** | **0.0** | **19** | **4.727** | **0.24** | **0.161** | **49.7** | **47.8** | **2.5** | |
| ⊠ | **BH-02** | **0.0** | **19** | **0.4** | | | **21.0** | **48.3** | **30.7** | |
| ▲ | **BH-04** | **10.5** | **19** | **0.356** | | | **14.2** | **66.7** | **19.2** | |
| ★ | **BH-05** | **5.0** | **19** | **0.288** | | | **15.5** | **56.7** | **27.8** | |
| ⊙ | **BH-06** | **5.0** | **19** | **0.199** | | | **8.2** | **56.8** | **34.9** | |

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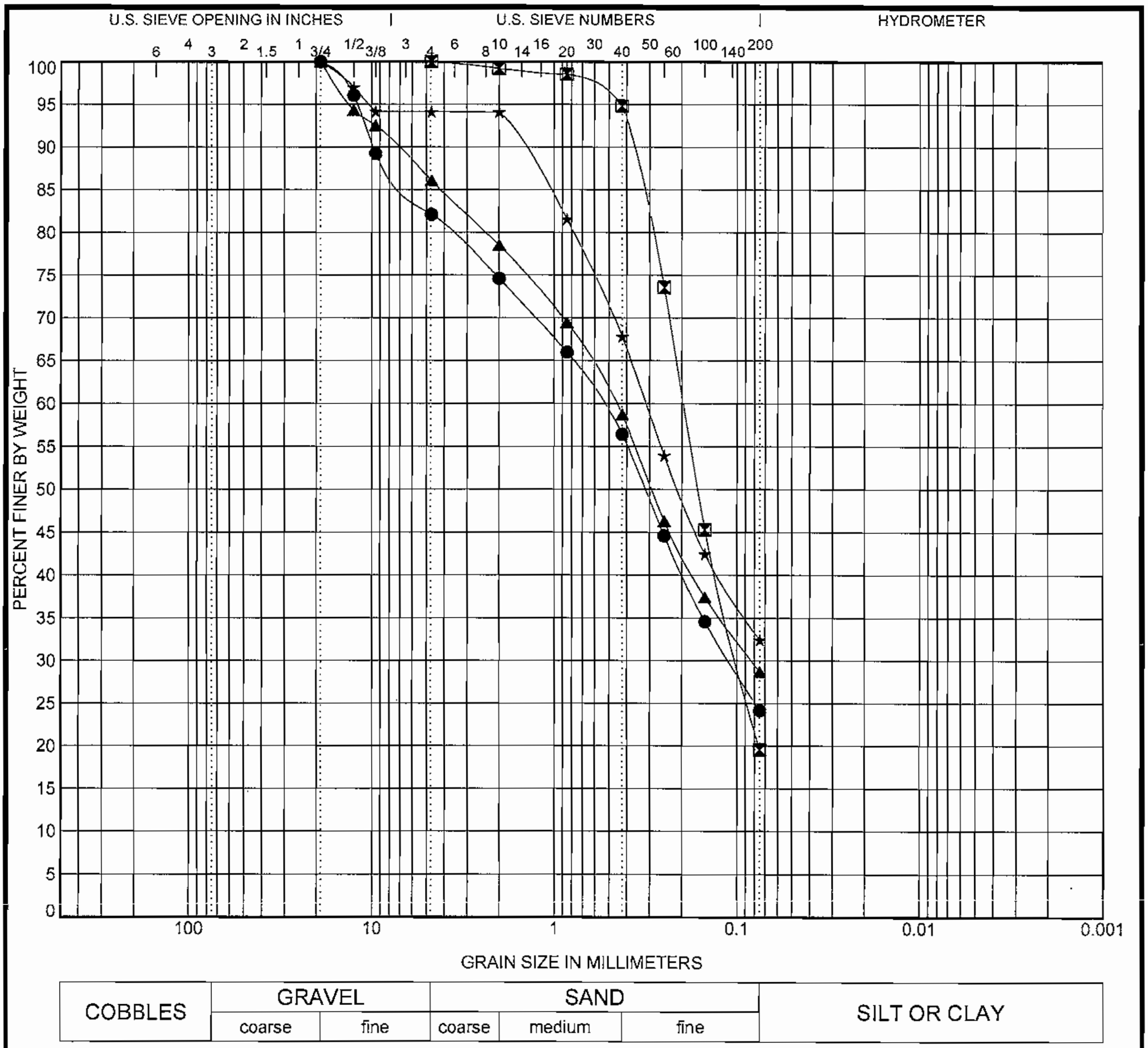
## GRAIN SIZE DISTRIBUTION

Project: BLM- Great Divide

Number: 10301



| | Specimen Identification | | Classification | LL | PL | PI | Cc | Cu |
|---|---|---|---|---|---|---|---|---|
| ● | **BH-07** | **0.0** | **SILTY SAND with GRAVEL(SM)** | **NP** | **NP** | **NP** | | |
| ☒ | **BH-07** | **2.5** | **SILTY SAND(SM)** | **NP** | **NP** | **NP** | | |
| ▲ | **BH-08** | **0.0** | **SILTY SAND(SM)** | **NP** | **NP** | **NP** | | |
| ★ | **BH-08** | **10.0** | | | | | | |
| | | | | | | | | |

| | Specimen Identification | | D100 | D50 | D15 | D10 | %Gravel | %Sand | %Silt | %Clay |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | **BH-07** | **0.0** | **19** | **0.318** | | | **17.8** | **58.1** | **24.2** | |
| ☒ | **BH-07** | **2.5** | **4.699** | **0.163** | | | **0.0** | **80.4** | **19.6** | |
| ▲ | **BH-08** | **0.0** | **19** | **0.293** | | | **13.8** | **57.5** | **28.7** | |
| ★ | **BH-08** | **10.0** | **19** | **0.21** | | | **5.9** | **61.7** | **32.4** | |
| | | | | | | | | | | |

PIONEER
TECHNICAL SERVICES, INC.

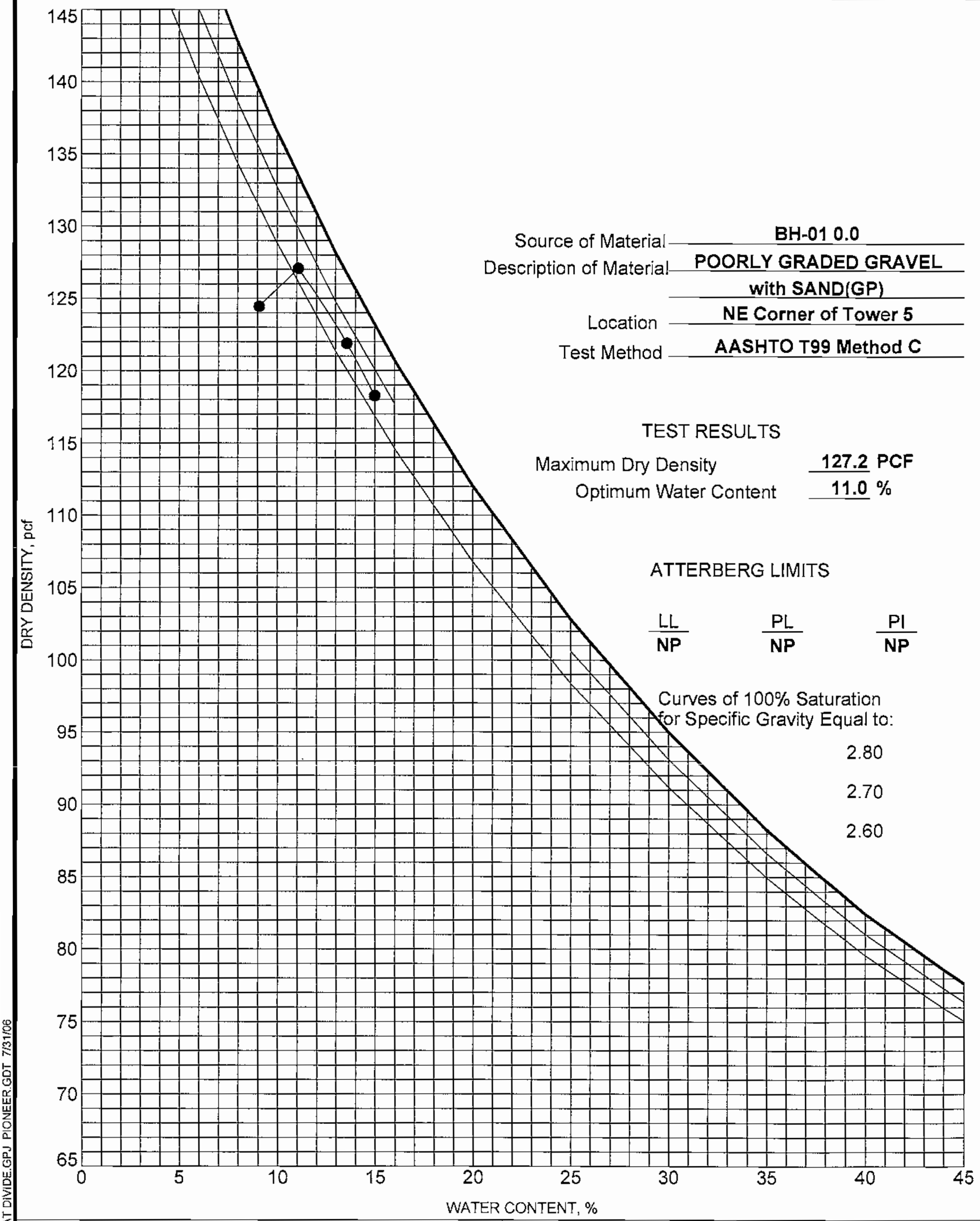
## GRAIN SIZE DISTRIBUTION

Project: BLM- Great Divide

Number: 10301

# APPENDIX C

# STANDARD PROCTOR MOISTURE DENSITY RELATIONSHIPS



Source of Material **BH-01 0.0**

Description of Material **POORLY GRADED GRAVEL with SAND(GP)**

Location **NE Corner of Tower 5**

Test Method **AASHTO T99 Method C**

TEST RESULTS

Maximum Dry Density **127.2** **PCF**

Optimum Water Content **11.0** **%**

ATTERBERG LIMITS

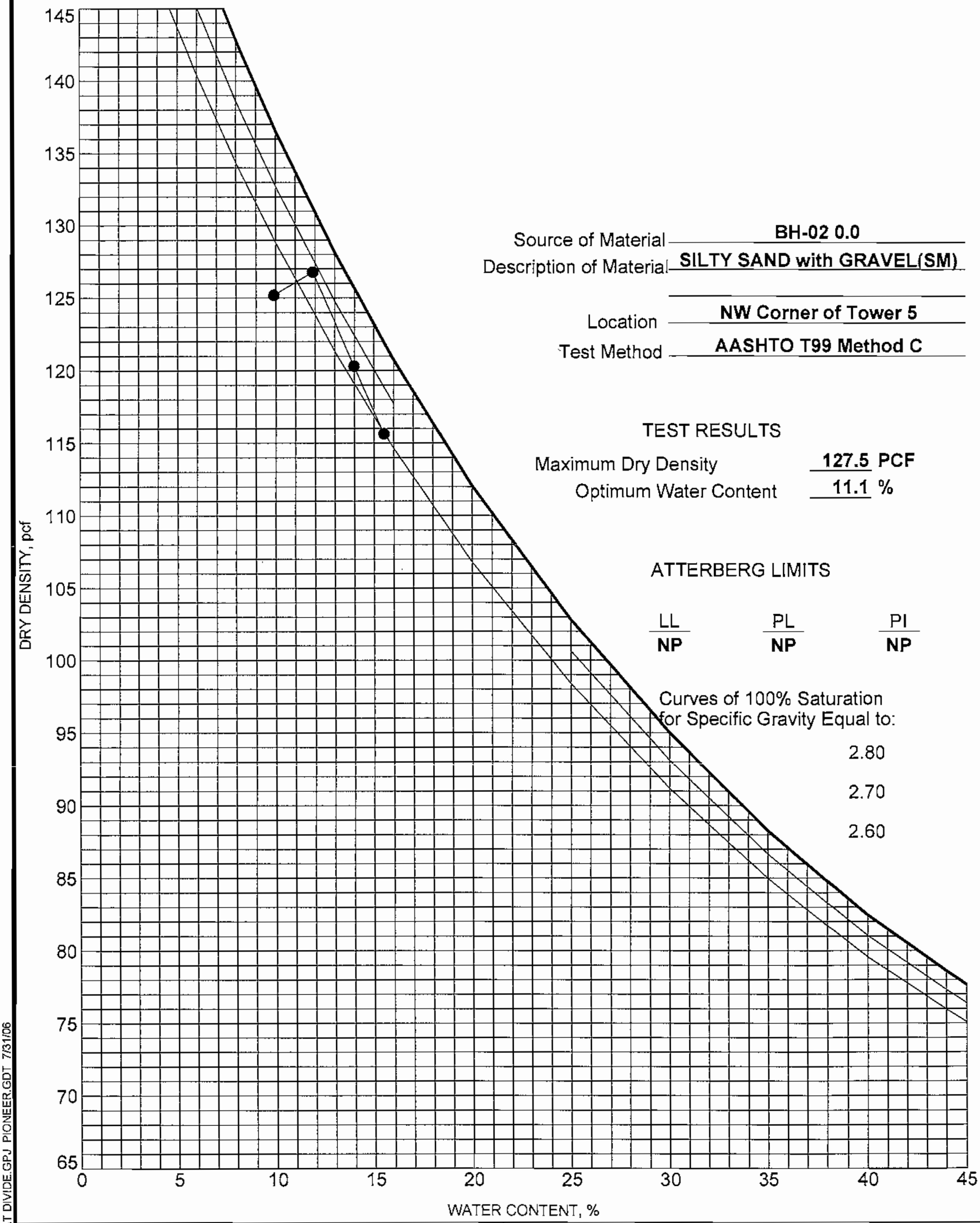
| LL | PL | PI |
|---|---|---|
| **NP** | **NP** | **NP** |

PIONEER
TECHNICAL SERVICES, INC.

## MOISTURE-DENSITY RELATIONSHIP

Project: BLM- Great Divide

Number: 10301



Source of Material **BH-02 0.0**

Description of Material **SILTY SAND with GRAVEL(SM)**

Location **NW Corner of Tower 5**

Test Method **AASHTO T99 Method C**

TEST RESULTS

| | | |
|---|---|---|
| Maximum Dry Density | **127.5** | PCF |
| Optimum Water Content | **11.1** | % |

ATTERBERG LIMITS

| LL | PL | PI |
|---|---|---|
| **NP** | **NP** | **NP** |

Curves of 100% Saturation
for Specific Gravity Equal to:

2.80

2.70

2.60

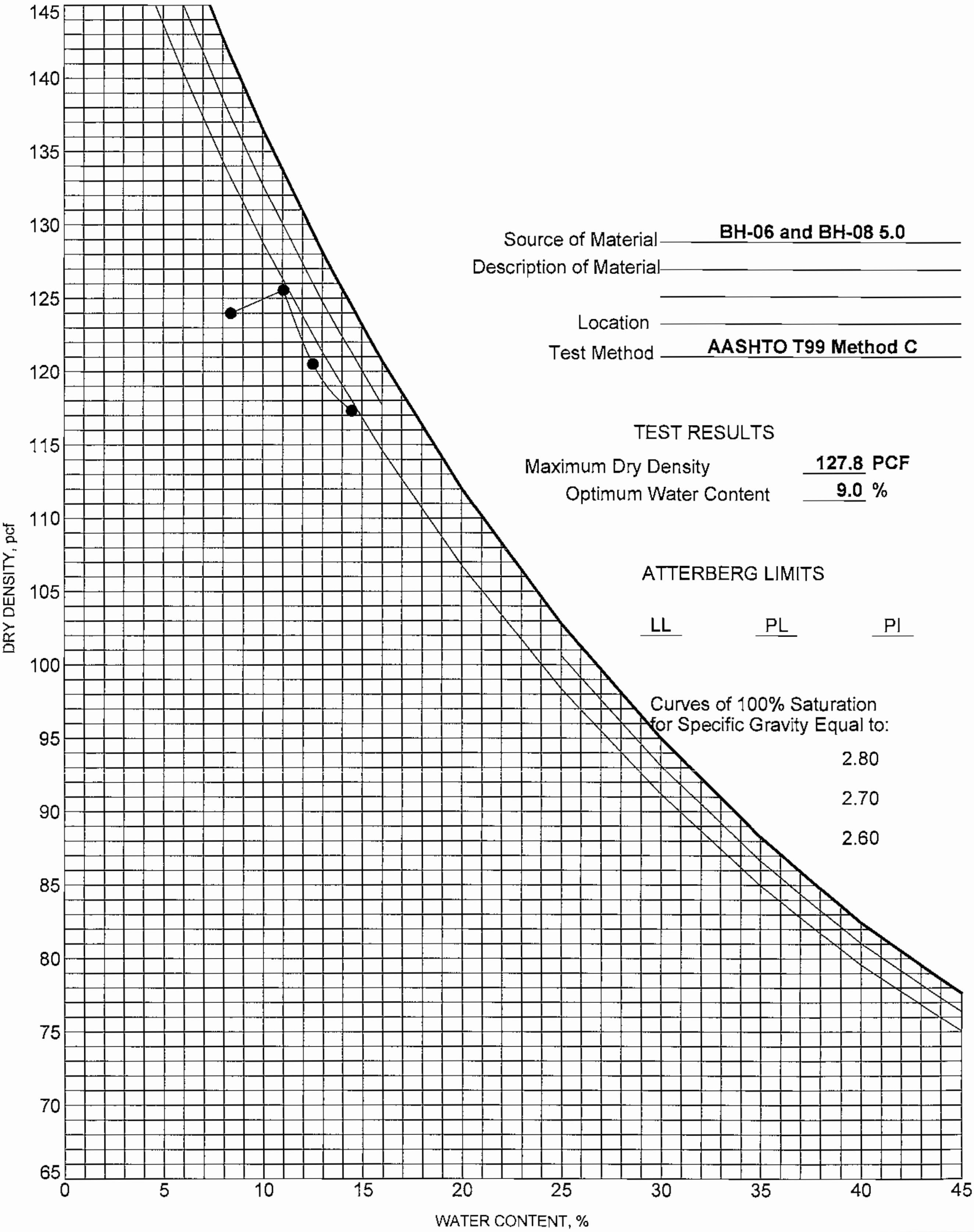
PIONEER
TECHNICAL SERVICES, INC.

## MOISTURE-DEPTH RELATIONSHIP

Project: BLM- Great Divide

Number: 10301

US COMPACTION GREAT DIVIDE.GPJ PIONEER.GDT 7/31/06



Source of Material **BH-06 and BH-08 5.0**

Description of Material

Location

Test Method **AASHTO T99 Method C**

TEST RESULTS

Maximum Dry Density **127.8** **PCF**

Optimum Water Content **9.0** **%**

ATTERBERG LIMITS

| LL | PL | PI |
|---|---|---|

Curves of 100% Saturation
for Specific Gravity Equal to:

2.80

2.70

2.60

PIONEER TECHNICAL SERVICES, INC.

## MOISTURE-DENSITY RELATIONSHIP

Project: BLM- Great Divide

Number: 10301

# APPENDIX D

# FIELD NOTES

Lodge

1 down hill

1 ☒

**PROJECT / BOREHOLE #** 1 NE corner Towers

**Depth** 0 - 2 **Time Started** 11:07:26 **Time Stopped** 11:07:50

(300)

2.0 - 3.5 SPT 4 - 8 - 5

% Recovery 9" (50%)

Main Constituent ~% sand

PP =

Minor Constituents ~% gravel

sand catcher

bailing [illegible]

Moisture Condition damp

Color brown

Angularity

Plasticity non

HCl Reaction non

**Depth** 2 - 5 **Time Started** 11:14:18 **Time Stopped** 11:15:13

(156)

Main Constituent ~% sand

Bulk sample

5.0 - 6.5 SPT 8 - 12 - 10

% Recovery 12" (67%)

PP =

Minor Constituents ~% gravel

gravels in cuttings

Moisture Condition damp

Color brown

Angularity flat angular

Plasticity none

HCl Reaction non

**Depth** 5 - ~~10~~ 9 ft **Time Started** 11:24:04 **Time Stopped** 11:26:50

(108)

SPT - -

% Recovery

Main Constituent ~%

@ 9 ft - hand change out center bit

PP =

Minor Constituents ~%

Moisture Condition

Color

Angularity

Plasticity

HCl Reaction

**Depth** 9 - 10 **Time Started** 3:16 **Time Stopped** 3:24

SPT - -

% Recovery

Main Constituent ~%

AUGER REFUSAL

PP =

Minor Constituents ~%

Moisture Condition

Color

Angularity

Plasticity

HCl Reaction

John Ernst 286-4707 281-3665

Will 490-9456

**PROJECT / BOREHOLE #** 2 Northwest corner Towers

**Depth** 0-2 **Time Started** ~~3:45:12~~ 3:46:01 **Time Stopped** 3:46:23

(171) 2-3.5'

Main Constituent ~% SAND

SPT 8-12-9

% Recovery 5" (28%)

PP =

Minor Constituents ~% GRAVEL

Moisture Condition DAMP Color BROWN

Angularity Plasticity NON HCl Reaction NON

**Depth** 2 5 **Time Started** **Time Stopped**

W/ 1 MIN 20 SEC (135)

Main Constituent ~% SAND

SPT 10-11-12

% Recovery 15" (83%)

PP =

Minor Constituents ~% GRAVEL

Moisture Condition DAMP Color BROWN - WHITE MOTTLE

Angularity Plasticity HCl Reaction NON

**Depth** 5 - 10 **Time Started** **Time Stopped**

2:28:50 (121)

SAND CATCHER

Main Constituent ~% SAND

SPT 8-14-15

% Recovery 15" (83%)

PP =

Minor Constituents ~% GRAVEL

Moisture Condition DAMP Color BROWN - TAN

Angularity Plasticity NON HCl Reaction NON

**Depth** ? 15 **Time Started** 3:27:84 **Time Stopped**

(87)

Main Constituent ~% SAND

SPT 6-8-9

% Recovery 12"

PP =

Minor Constituents ~% GRAVEL

GRAVEL IN CUTTINGS

Moisture Condition DAMP Color BROWN - TAN

Angularity Plasticity NON HCl Reaction NON

**PROJECT / BOREHOLE #** 2

15

**Depth** 20 - ~~25~~ **Time Started** N/ 3:50 **Time Stopped** A

20 - 21.5 SPT 15 - 13 - 13

Main Constituent ~% SAND

% Recovery 12" 67%

PP =

Minor Constituents ~% GRAVEL

SAND CATCHER

Moisture Condition DAMP

Color TAN

Angularity

Plasticity NON

HCl Reaction NON

20

**Depth** 25 - ~~30~~ **Time Started** 2:01:14 **Time Stopped** PM

25 - 26.5 SPT 42-46 50 (REFUSAL)

Main Constituent ~% SAND

% Recovery 15" 83%

PP =

Minor Constituents ~% GRAVEL

SAND CATCHER

Moisture Condition DAMP

Color TAN

Angularity

Plasticity NON

HCl Reaction NON

25 - 27.5

**Depth** ~~30~~ **Time Started** STOPPED @ 4:01:13 **Time Stopped** 15

SPT - -

Main Constituent ~%

% Recovery

PP =

Minor Constituents ~%

Moisture Condition

Color

Angularity

Plasticity

HCl Reaction

**Depth** **Time Started** **Time Stopped**

SPT - -

Main Constituent ~%

% Recovery

PP =

Minor Constituents ~%

Moisture Condition

Color

Angularity

Plasticity

HCl Reaction

**PROJECT / BOREHOLE #** 3 SW corner of tower 5

**Depth** 0 – 2 **Time Started** ~~8:58:27~~ **Time Stopped** ~~8:5~~

Main Constituent ~% Sand/silt

2.0 – 3.5 SPT 3 - 3 4

% Recovery 14" 78%

PP =

Minor Constituents ~% fine gravel

Moisture Condition damp/moist

Color brown

Angularity

Plasticity slight LL<25

HCl Reaction weak

**Depth** 2 – 5 **Time Started** 9:06:20 **Time Stopped** 9:06:56

Main Constituent ~% Silt/sand

300

5 – 7.5 SPT 1 - 1 - 4

% Recovery 10" 56%

PP =

Minor Constituents ~%

Moisture Condition moist

Color brown

Angularity

Plasticity slight

HCl Reaction none

**Depth** 5 – 10 **Time Started** 9:16:59 **Time Stopped** 9:18:12

300

Main Constituent ~% sand

Started to drill harder @ ~9 ft

10 – 11.5 SPT 9 - 10 - 32

% Recovery 10" 56%

PP =

Minor Constituents ~% gravel fine rock fragments

Moisture Condition damp

Color brown

Angularity

Plasticity non

HCl Reaction non

**Depth** 10 – 15 **Time Started** 28:05 **Time Stopped** 29:18

130

.4

15 – 15.5 SPT 28 - 50 -

% Recovery 100

Main Constituent ~% Sand

PP =

Minor Constituents ~% fine gravel

Moisture Condition damp

Color lt brown

Angularity

Plasticity

HCl Reaction no

**PROJECT / BOREHOLE #** 3

**Depth** 15-20 **Time Started** 37:50 **Time Stopped** 41:05 ⑦

Main Constituent ~% 20 — 20.3 SPT 3 50/2 - -

% Recovery

PP = 12". 50 blows 0

Minor Constituents ~%

Moisture Condition

Color

Angularity

Plasticity

HCl Reaction

**Depth** **Time Started** **Time Stopped**

Main Constituent ~%

SPT - -

% Recovery

PP =

Minor Constituents ~%

Moisture Condition

Color

Angularity

Plasticity

HCl Reaction

**Depth** **Time Started** **Time Stopped**

SPT - -

Main Constituent ~%

% Recovery

PP =

Minor Constituents ~%

Moisture Condition

Color

Angularity

Plasticity

HCl Reaction

**Depth** **Time Started** **Time Stopped**

SPT - -

Main Constituent ~%

% Recovery

PP =

Minor Constituents ~%

Moisture Condition

Color

Angularity

Plasticity

HCl Reaction

**PROJECT / BOREHOLE #** 4 SE Corner

**Depth** 0 - 2 **Time Started** **Time Stopped**

2.0 - 3.5

No Pen

SPT 25 -

% Recovery

Main Constituent ~%

12" rock near surface

PP =

Minor Constituents ~%

Moisture Condition

Color

Angularity

Plasticity

HCl Reaction

---

**Depth** 2 - 5 **Time Started** 22:05 **Time Stopped** 56:30 107

5 - 6.5

5-6.5

SPT 6 - 6 - 6

% Recovery

1.3 ft

87%

Main Constituent ~% silt/sand

PP =

Minor Constituents ~% silt

Moisture Condition damp to moist

Color brown

Angularity

Plasticity non

HCl Reaction

---

**Depth** 5 - 10 **Time Started** 34:01 **Time Stopped** 36:38 120

10 - 11.5

10-11.5

SPT 20-17-22

% Recovery

Main Constituent ~% sand

PP =

Minor Constituents ~% fine gravel

Moisture Condition

Color brown

Angularity

Plasticity non

HCl Reaction none

---

**Depth** 10 - 15 **Time Started** 59:44 **Time Stopped** 11:03 .05 90

15 -

15-16.5

no pen

SPT 25 -

% Recovery

0

Main Constituent ~%

BOH

PP =

Minor Constituents ~%

Moisture Condition

Color

Angularity

Plasticity

HCl Reaction

**PROJECT / BOREHOLE #** 5 Tower 6 SW corner

**Depth** 0 - 2 **Time Started** **Time Stopped**

Main Constituent ~% 0 - 6" inches cap 2 - 3.5 SPT 2 - 2 - 1

% Recovery 14" 18%

PP =

Minor Constituents ~%

Moisture Condition damp to moist

Color dk brown @ ~ 3.2 → tailing

brown to 3.2

Plasticity ↳ old top soil

Angularity

HCl Reaction 1' brown tailing - notes in old topsoil

**Depth** 2 - 5 **Time Started** 11:56:11 **Time Stopped**

Main Constituent ~% sand 5.0 - 6.5 SPT 6 - 4 - 6

% Recovery 5" 28%

PP =

Minor Constituents ~% gravel

Moisture Condition moist

Color brown

Angularity

Plasticity

HCl Reaction none

**Depth** 5 - 10 **Time Started** **Time Stopped**

Main Constituent ~% Sand 10 - 11.5 SPT 12 - 16 - 18

% Recovery 14" 42%

PP =

Minor Constituents ~% fine gravel

Moisture Condition damp

Color brown

Angularity sub angular

Plasticity non

HCl Reaction non to weak

**Depth** 10 - 15 **Time Started** 12:08:00 **Time Stopped** 12:09:05 278

15 -

Main Constituent ~% Sand SPT 8 - 9 - 8

% Recovery 12" 18%

PP =

Minor Constituents ~% Gravel

Clay

Moisture Condition moist

Color brown

Angularity

Plasticity slight

HCl Reaction non

4 - 10

10 - 30 => medium dense

30 - 50 dense

> 50 very dense

**PROJECT / BOREHOLE #** 5

**Depth** 15-20 **Time Started** 17:34 **Time Stopped** 22:28 (ui)

Main Constituent ~% Sand

20 - 21.5 SPT 6 - 4 - 5

% Recovery 14" (282)

PP =

Minor Constituents ~% fine gravel

Moisture Condition moist

Color brown to light brown

Angularity

Plasticity

HCl Reaction non

**Depth** 20-25 **Time Started** ~~33:40~~ 12:39:49 **Time Stopped** 41:38 (125)

Main Constituent ~% sand

25 - 26.5 SPT 19 - 32 - 47

% Recovery 100 %

PP =

Minor Constituents ~% completely weathered sand stone

Moisture Condition

Color brown w/ white mottling dk brown staining

Angularity

Plasticity

HCl Reaction weak

**Depth** **Time Started** **Time Stopped**

SPT - -

Main Constituent ~%

% Recovery

PP =

Minor Constituents ~%

Moisture Condition

Color

Angularity

Plasticity

HCl Reaction

**Depth** **Time Started** **Time Stopped**

SPT - -

Main Constituent ~%

% Recovery

PP =

Minor Constituents ~%

Moisture Condition

Color

Angularity

Plasticity

HCl Reaction

GREAT DODGE

5-24-06

**PROJECT / BOREHOLE #** 6 - SE CORNER OF TOWER

**Depth** 0-2'
**Time Started** 1530
**Time Stopped** 233
Main Constituent ~% TAILINGS - SAND - GRAY DAMP - STRONG REACTION
CHANGE @ 3.2' NO HCL
Minor Constituents ~% SAND WITH GRAVEL - CLAY - OLD TOPSOIL
Moisture Condition DAMP/MOIST
Color DK BROWN
Angularity —
Plasticity SLIGHT
HCl Reaction NONE
2-3.5'
SPT 1-2-3
% Recovery 1.2' 80%

**Depth** 2-5
**Time Started** 100
**Time Stopped** 180
Main Constituent ~% CLAYEY SAND
Minor Constituents ~%
Moisture Condition DAMP/MOIST
Color BROWN
Angularity —
Plasticity SLIGHT
HCl Reaction NONE
5-6.5
SPT 6-6-5
% Recovery 1.3' 87%

**Depth** 5-10
**Time Started** 1:50
**Time Stopped** 200
HARD DRILLING @ 5'
Main Constituent ~% SAND
Minor Constituents ~% ~~FINE~~ GRAVEL
CLAY
Moisture Condition DAMP
Color BROWN
Angularity
Plasticity SLIGHT
HCl Reaction NONE
10-11.5
SPT 14-16-15
% Recovery 100%

**Depth** 10-15
**Time Started** 3:45
**Time Stopped** 80
Main Constituent ~% SAND
Minor Constituents ~% GRAVEL
CLAY
Moisture Condition DAMP
Color BROWN
Angularity GRAVELS ARE SUBROUNDED
Plasticity SLIGHT
HCl Reaction NONE
15-16.5
SPT 11-8-7
% Recovery 1.4' 93%

PROJECT / BOREHOLE # 6

**Depth** 15-20 **Time Started** 3:51 **Time Stopped** 78

Main Constituent ~% SAND

20-21.5'
SPT 6-10 -8
% Recovery
0.6'
40%

Minor Constituents ~% FINE GRAVELS

Moisture Condition Damp/Moist Color Brown

Angularity Plasticity SLIGHT HCl Reaction NONE

**Depth** 20-25 **Time Started** 3:45 **Time Stopped** 80

Main Constituent ~% SAND - DECOMPOSED ROCK - SANDSTONE

25-26.5'
SPT 16-25-24
% Recovery
1.1'
73%

Minor Constituents ~%

Moisture Condition Damp Color Brown

Angularity — Plasticity — HCl Reaction NONE

**Depth** **Time Started** **Time Stopped**

SPT - -
% Recovery

Main Constituent ~%

Minor Constituents ~%

Moisture Condition Color

Angularity Plasticity HCl Reaction

**Depth** **Time Started** **Time Stopped**

SPT - -
% Recovery

Main Constituent ~%

Minor Constituents ~%

Moisture Condition Color

Angularity Plasticity HCl Reaction

Great Divide 5-24-06

**PROJECT / BOREHOLE #** 7 - NW Corner

**Depth** 0-2' **Time Started** 33 sec **Time Stopped** 218

2-3.5'
SPT 3 - 3 - 3
% Recovery
1.2' 80%

Main Constituent -% 0-2.8' Tailings - Sand - Brown - Damp
Rotted wood @ bottom of tailings - Strong HCl

Minor Constituents -% Sand with Gravel
Clay

Moisture Condition

Color Dk Brown

Angularity —

Plasticity Slight

HCl Reaction None

**Depth** 2-5' **Time Started** 20 sec **Time Stopped** 545

5-6.5
SPT 4 - 4 - 10
% Recovery
0.8 53%

Main Constituent -% Sand

Minor Constituents -% Fine Gravel
Clay

Moisture Condition Damp/Moist

Color Brown

Angularity

Plasticity Slight

HCl Reaction None

**Depth** 5-10 **Time Started** 80 sec **Time Stopped** 600

10-11.5'
SPT 5 - 10 - 12
% Recovery

Main Constituent -% Sand
Fine Gravel } Damp Brown Slightly Rounded
Clay

Minor Constituents -%
Change @ 11 - Sand with Gravel - Decomposed Rock

Moisture Condition Damp

Color Brown

Angularity Subrounded

Plasticity —

HCl Reaction None

**Depth** 10-25 **Time Started** 3:35 **Time Stopped** 84

15-16.5'
SPT 17 - 11 - 38
% Recovery
1.3'
Bottom 87%

Main Constituent -% Sand

Minor Constituents -% Gravel

Moisture Condition Damp

Color Brown

Angularity Subangular

Plasticity NP

HCl Reaction

PROJECT / BOREHOLE # 7

**Depth** 15-20 **Time Started** 4:15 **Time Stopped** 71

20-21.5
SPT 25R(0")
% Recovery

Main Constituent ~%

Minor Constituents ~%

Moisture Condition
Color

Angularity
Plasticity
HCl Reaction

**Depth** **Time Started** **Time Stopped**

SPT - -
% Recovery

Main Constituent ~%

Minor Constituents ~%

Moisture Condition
Color

Angularity
Plasticity
HCl Reaction

**Depth** **Time Started** **Time Stopped**

SPT - -
% Recovery

Main Constituent ~%

Minor Constituents ~%

Moisture Condition
Color

Angularity
Plasticity
HCl Reaction

**Depth** **Time Started** **Time Stopped**

SPT - -
% Recovery

Main Constituent ~%

Minor Constituents ~%

Moisture Condition
Color

Angularity
Plasticity
HCl Reaction

GREAT DIVIDE 5-24-06

**PROJECT / BOREHOLE # 8** – NE CORNER

**Depth** 0-2' **Time Started** 15 sec **Time Stopped** 480

Main Constituent -% SAND

2-3.5'
SPT 3-4-4
% Recovery
0.9' 60%

Minor Constituents -% GRAVEL, CLAY

Moisture Condition DAMP/MOIST Color BROWN

Angularity Plasticity SLIGHT HCl Reaction NONE

**Depth** 2-5 **Time Started** 30 sec **Time Stopped** 360

Main Constituent -% SAND

5-6.5
SPT 1-1-1
% Recovery
0.8' 53%

Minor Constituents -% GRAVEL, CLAY

Moisture Condition DAMP/MOIST Color BROWN

Angularity — Plasticity SLIGHT HCl Reaction NONE

**Depth** 5-10 **Time Started** 55 sec **Time Stopped** 400

Main Constituent -% SAND

10-11.5'
SPT 10-14-12
% Recovery
1.1' 73%

Minor Constituents -% GRAVELS/CLAY

Moisture Condition DAMP/MOIST Color BROWN

Angularity Plasticity SLIGHT HCl Reaction NON

**Depth** 10-15 **Time Started** 1:55 **Time Stopped** 190

Main Constituent -% SAND

15-16.5'
SPT 7-12-9
% Recovery
1.3' 87%

Minor Constituents -% GRAVELS/CLAY

Moisture Condition DAMP Color BROWN

Angularity — Plasticity SLIGHT HCl Reaction NONE

**PROJECT / BOREHOLE #** 5

**Depth** 15-20 **Time Started** 4:45 **Time Stopped** 63

20-21.5'

Main Constituent ~% SAND

SPT 25-17-24

% Recovery 1.4' 93%

Minor Constituents ~% Gravel / Clay

Moisture Condition Damp

Color Brown

Angularity —

Plasticity Slightly

HCl Reaction None

**Depth** 20-25 **Time Started** 5:15 **Time Stopped** 57

25-26.5'

Main Constituent ~% Sandstone ?

SPT 25 (0")

% Recovery —

Minor Constituents ~%

Moisture Condition

Color

Angularity

Plasticity

HCl Reaction

**Depth** **Time Started** **Time Stopped**

SPT - -

Main Constituent ~%

% Recovery

Minor Constituents ~%

Moisture Condition

Color

Angularity

Plasticity

HCl Reaction

**Depth** **Time Started** **Time Stopped**

SPT - -

Main Constituent ~%

% Recovery

Minor Constituents ~%

Moisture Condition

Color

Angularity

Plasticity

HCl Reaction

Great Divide 5-24-04 1

**PROJECT / BOREHOLE #** ~~1~~ 9 → Redrill of BH-1 NE Corner

**Depth** 0-2' **Time Started** 1500 **Time Stopped** 480

Main Constituent ~% Sand

SPT 2-3.5' 9-6-5

% Recovery 1.4' 93%

Minor Constituents ~% Gravel / Clay

Moisture Condition Damp Color Brown

Angularity

Plasticity Slight HCl Reaction None

**Depth** 2-5 **Time Started** 450 **Time Stopped** 240

Main Constituent ~% Sand

SPT 5-6.5' 6-8-7

% Recovery 1.2' 80%

Minor Constituents ~% Gravels/Clay

Moisture Condition Damp Color Brown

Angularity —

Plasticity Slight HCl Reaction None

**Depth** 5-10 **Time Started** 3:50 **Time Stopped** 78

Main Constituent ~% Change @ 10.5' Same as above

Rock at Bottom – Sandstone

SPT 10-11.5 27-50(1")

% Recovery 100%

Minor Constituents ~%

Moisture Condition Color

Angularity Plasticity HCl Reaction

**Depth** **Time Started** **Time Stopped**

Main Constituent ~%

SPT - -

% Recovery

Minor Constituents ~%

Moisture Condition Color

Angularity Plasticity HCl Reaction

# APPENDIX E

# PHOTOGRAPHS

PIONEER
TECHNICAL SERVICES, INC.

Picture: 10301-01

Description: General Site Photo

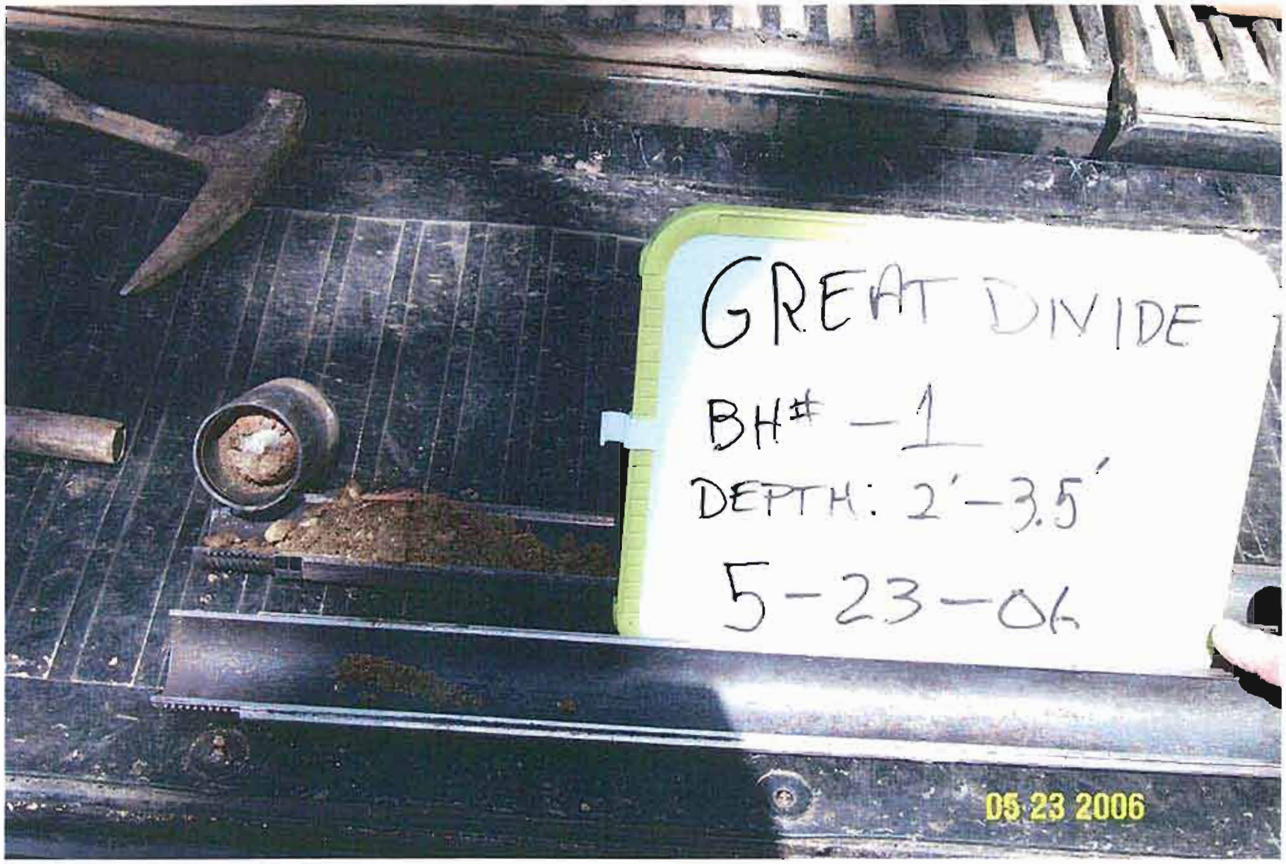
Project: Great Divide

PIONEER
TECHNICAL SERVICES, INC.

Picture: 10301-02

Description: BH-01 Site Photo

Project: Great Divide

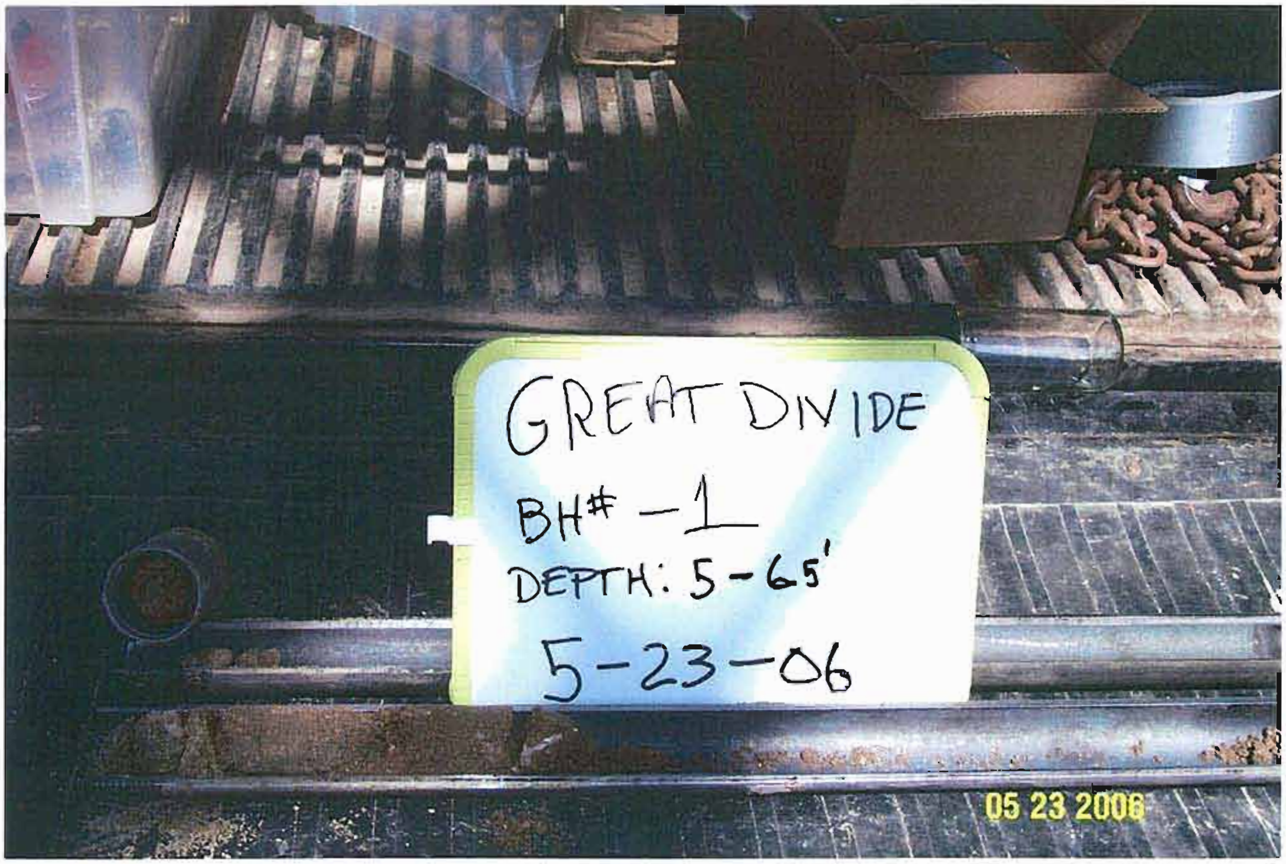


PIONEER TECHNICAL SERVICES, INC.

Picture: 10301-03

Description: BH-01 Depth: 2-3.5'

Project: Great Divide



PIONEER TECHNICAL SERVICES, INC.

Picture: 10301-04

Description: BH-01 Depth: 5-6.5'

Project: Great Divide

PIONEER TECHNICAL SERVICES, INC.

Picture: 10301-05

Description: BH-02 Site Photo

Project: Great Divide

PIONEER
TECHNICAL SERVICES, INC.

Picture: 10301-06

Description: BH-02 Depth: 5-6.5`

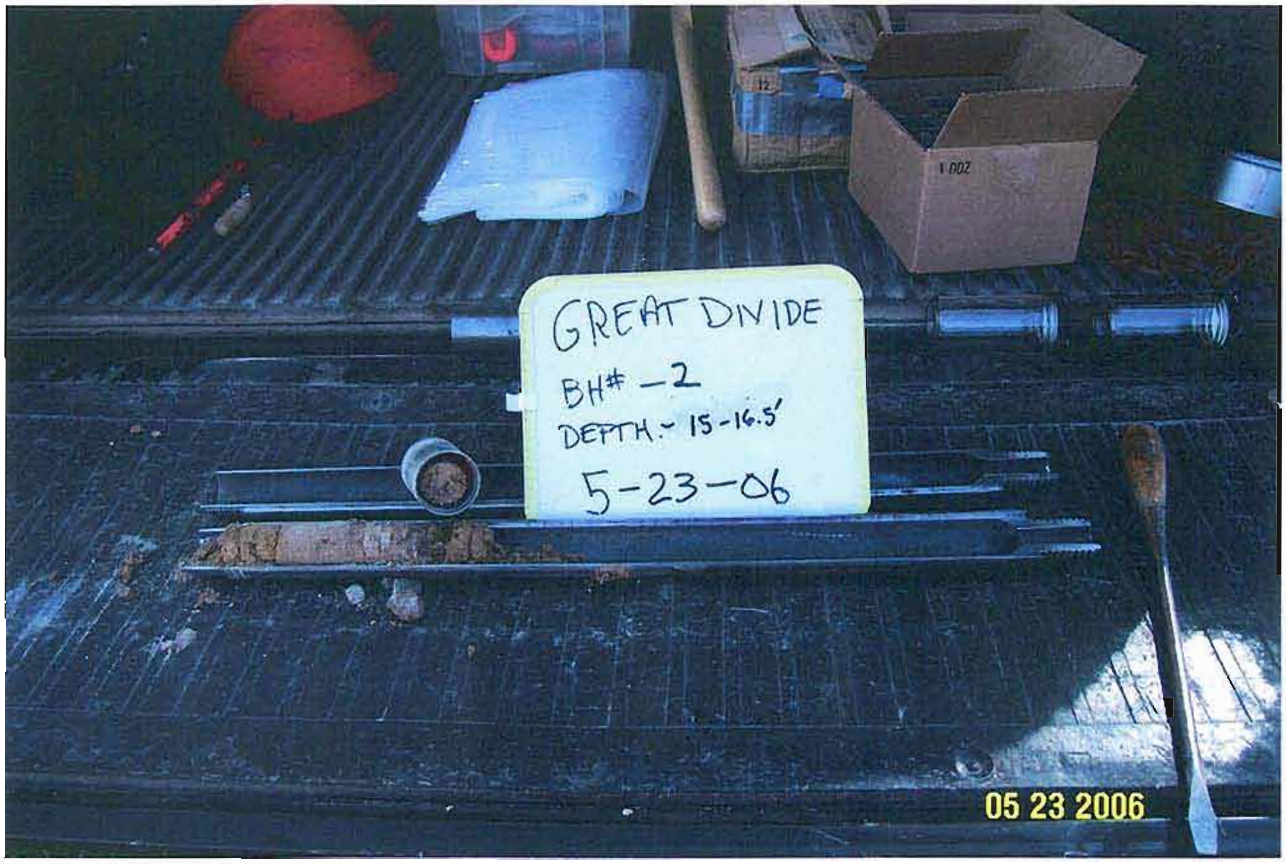
Project: Great Divide

PIONEER TECHNICAL SERVICES, INC.

Picture: 10301-07

Description: BH-02 Depth: 10-11.5'

Project: Great Divide



Picture: 10301-08

Description: BH-02 Depth: 15-16.5

Project: Great Divide

PIONEER TECHNICAL SERVICES, INC.

**PIONEER**
**TECHNICAL SERVICES, INC.**

Picture: 10301-09

Description: BH-02 Depth:20-21.5'

Project: Great Divide

PIONEER TECHNICAL SERVICES, INC.

Picture: 10301-10

Description: BH-02 Depth: 25-26.5'

Project: Great Divide

PIONEER
TECHNICAL SERVICES, INC.

Picture: 10301-11

Description: BH-03 Site Photo

Project: Great Divide

Picture: 10301-12

Description: BH-03 Depth: 2-3.5'

Project: Great Divide

PIONEER TECHNICAL SERVICES, INC.

PIONEER
TECHNICAL SERVICES, INC.

Picture: 10301-13

Description: BH-03 Depth: 5-6.5'

Project: Great Divide

PIONEER TECHNICAL SERVICES, INC.

Picture: 10301-14

Description: BH-03 Depth: 10-11.5'

Project: Great Divide

**PIONEER TECHNICAL SERVICES, INC.**

Picture: 10301-15

Description: BH-03 Depth: 15-15.9'

Project: Great Divide

PIONEER
TECHNICAL SERVICES, INC.

Picture: 10301-16

Description: BH-04 Site Photo

Project: Great Divide

PIONEER TECHNICAL SERVICES, INC.

Picture: 10301-17

Description: BH-04 Depth: 5-6.5'

Project: Great Divide

PIONEER
TECHNICAL SERVICES, INC.

Picture: 10301-18

Description: BH-04 Depth:10-11.5'

Project: Great Divide


05 24 2006

PIONEER TECHNICAL SERVICES, INC.

Picture: 10301-19

Description: BH-05 Site Photo

Project: Great Divide

PIONEER TECHNICAL SERVICES, INC.

Picture: 10301-20
Description: BH-05 Depth: 2-3.5'
Project: Great Divide

PIONEER
TECHNICAL SERVICES, INC.

Picture: 10301-21

Description: BH-5 Depth: 10-11.5'

Project: Great Divide

PIONEER TECHNICAL SERVICES, INC.

Picture: 10301-22

Description: BH-05 Depth: 15-16.5'

Project: Great Divide

PIONEER TECHNICAL SERVICES, INC.

Picture: 10301-23

Description: BH-05 Depth: 20-21.5'

Project: Great Divide

PIONEER
TECHNICAL SERVICES, INC.

Picture: 10301-24

Description: BH-05 Depth: 25-26.5'

Project: Great Divide

PIONEER TECHNICAL SERVICES, INC.

Picture: 10301-25

Description: BH-06 Depth: 5-6.5'

Project: Great Divide

PIONEER TECHNICAL SERVICES, INC.

Picture: 10301-26

Description: BH-6 Depth: 10-11.5'

Project: Great Divide

05/21/2006 1:23 pm

PIONEER
TECHNICAL SERVICES, INC.

Picture: 10301-27

Description: BH-06 Depth: 15-16.5'

Project: Great Divide

PIONEER
TECHNICAL SERVICES, INC.

Picture: 10301-28
Description: BH-06 Depth: 20-21.5'

Project: Great Divide

PIONEER
TECHNICAL SERVICES, INC.

Picture: 10301-29

Description: BH-07 Depth: 2-2.5'

Project: Great Divide

PIONEER
TECHNICAL SERVICES, INC.

Picture: 10301-30

Description: BH-08 Site Photo

Project: Great Divide

05/21/2006 3:30 pm

PIONEER
TECHNICAL SERVICES, INC.

Picture: 10301-31

Description: BH-08 Depth: 2-3.5'

Project: Great Divide

PIONEER
TECHNICAL SERVICES, INC.

Picture: 10301-32

Description: BH-08 Depth: 5-6.5'

Project: Great Divide

PIONEER
TECHNICAL SERVICES, INC.

Picture: 10301-33

Description: BH-08 Depth: 10-11.5'

Project: Great Divide

PIONEER
TECHNICAL SERVICES, INC.

Picture: 10301-34
Description: BH-08 Depth: 15-16.5'

Project: Great Divide

PIONEER
TECHNICAL SERVICES, INC.

Picture: 10301-35

Description: BH-09 Depth: 5-6.5'

Project: Great Divide

PIONEER TECHNICAL SERVICES, INC.

Picture: 10301-36

Description: Eroded Tailings

Project: Great Divide

# APPENDIX F

# SKI TOWER FOUNDATION LOG

9/7/06 J. MAXWELL

1000 AM MOBED TO SITE TO
MEASURE TOWER FOUNDATIONS
& TAKE PHOTOGRAPHS

1045 AM ARRIVED ON-SITE

TOWER #5
2- CONCRETE FOOTINGS
8.0' LONG (ACROSS-SLOPE)
0.9' WIDE (UP-SLOPE)
APPX. 1-2' EXPOSED ABOVE GROUND
TOWER BASE MEASURES 4.7' x 4.7'
W/ 2 - 1" ANCHOR BOLTS @ EACH
CORNER. TOWER IS CONSTRUCTED
OF ~~4"x4"x1/4~~" ANGLE IRON &
9½" x 3" x 3/4" BASE PLATES.
PHOTO 1080 - N.E. CORNER
1081 - S.W. CORNER
→(3½" x 3½" x 5/16")

TOWER #6

2- CONCRETE FOOTINGS
8.0' LONG (ACROSS-SLOPE)
1.2' WIDE (UP-SLOPE)
FOOTINGS ARE FLUSH W/GROUND
TOWER BASE MEASURES 5.8' X 5.8'
W/ 2 - 1" ANCHOR BOLTS @ EACH
CORNER. TOWER IS CONSTRUCTED
OF 3"X3" X 5/16" ANGLE IRON, &
9 1/2" X 3" X 3/4" BASE PLATES.
PHOTO 1082 - N.E. CORNER
1083 - S.W. CORNER
WEST FOOTING IS BURIED
APPX 4-6" W/ HEADCUT
MATERIAL.

1145 AM OFF-SITE
1230 PM RETURNED TO OFFICE
TO FORWARD INFO TO MARTY.
50 MILES ROUND TRIP

[redacted]

**PIONEER**
**TECHNICAL SERVICES, INC.**

Picture: 1080

Description: North east corner of Ski Tower #5

Project: Great Divide Sand Tailings Site. Geotechnical Investigation September 7, 2007.

PIONEER TECHNICAL SERVICES, INC.

Picture: 1081

Description: South west corner Ski Tower #5.

Project: Great Divide Sand Tailings Site. Geotechnical Investigation September 7, 2007.

PIONEER TECHNICAL SERVICES, INC.

Picture: 1082

Description: North east corner of Ski Tower #6

Project: Great Divide Sand Tailings Site. Geotechnical Investigation September 7, 2007.

Picture: 1083

Description: South west corner of Ski Tower #6.

Project: Great Divide Sand Tailings Site. Geotechnical Investigation September 7, 2007.

PIONEER TECHNICAL SERVICES, INC.

# APPENDIX E

# GREAT DIVIDE SAND TAILINGS SITE
FEDERAL AND STATE ARARs

# INTRODUCTION

Section 121(d) of CERCLA, 42 U.S.C. § 9621(d), certain provisions of the current National Contingency Plan (the NCP), 40 CFR Part 300 (1990), and guidance and policy issued by the Environmental Protection Agency (EPA) require that remedial actions taken pursuant to CERCLA authority shall require or achieve compliance with substantive provisions of applicable or relevant and appropriate standards, requirements, criteria, or limitations from state environmental and facility siting laws, and from federal environmental laws at the completion of the remedial action, and/or during the implementation of the remedial action, unless a waiver is granted. These requirements are threshold standards that any selected remedy must meet. See Section 122(d)(4) of CERCLA, 42 U.S.C. § 9621(d)(4); 40 CFR § 300.430(f)(1). EPA calls standards, requirements, criteria, or limitations identified pursuant to section 121(d) "ARARs," or applicable or relevant and appropriate requirements.

ARARs are either applicable or relevant and appropriate. Applicable requirements are those standards, requirements, criteria, or limitations promulgated under federal or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, or contaminant, remedial action, location, or other circumstance found at a CERCLA site. Relevant and appropriate requirements are those standards, requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to hazardous substances, pollutants, contaminants, remedial actions, locations, or other circumstances found at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site such that their use is well suited to the particular site. Factors which may be considered in making this determination are presented in CFR § 300.400(g)(2). Compliance with both applicable and relevant and appropriate requirements is mandatory.

Each ARAR or group of related ARARs identified here is followed by a specific statutory or regulatory citation, a classification describing whether the ARAR is applicable or relevant and appropriate, and a description which summarizes the requirements, and addresses how and when compliance with the ARAR will be measured (some ARARs will govern the conduct of the remedial action, some will define the measure of success of the remedial action, and some will do both). The descriptions given here are provided to allow the user a reasonable understanding of the requirements without having to refer constantly to the statute or regulation itself. However, in the event of any inconsistency between the law and the summary provided in this document, the applicable or relevant and appropriate requirement is ultimately the requirement as set out in the law, rather than any paraphrase of the law provided here.

Finally, this list contains a non-exhaustive list of other legal provisions or requirements which should be complied with. ARARs are divided into contaminant specific, location specific, and action specific requirements, as described in the NCP and EPA guidance. For contaminant specific ARARs, ARARs are listed according to the appropriate media.

Contaminant specific ARARs include those laws and regulations governing the release to the environment of materials possessing certain chemical or physical characteristics or containing specific chemical compounds. Contaminant specific ARARs generally set health or risk based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount of concentration of a chemical that may be found in, or discharged to, the ambient environment.

Location specific ARARS are restrictions placed on the concentration of hazardous substances or the conduct of cleanup activities because they are in specific locations. Location specific ARARs relate to the geographic or physical position of the site, rather than to the nature of the site contaminants.

Action specific ARARs are usually technology or activity based requirements or limitations on actions taken with respect to hazardous substances.

Many requirements listed here are promulgated as identical or nearly identical requirements in both federal and state law, usually pursuant to delegated environmental programs administered by EPA and the states, such as the requirements of the federal Clean Water Act and the Montana Water Quality Act. The preamble to the new NCP states that such a situation results in citation to the State provision as the appropriate standard, but treatment of the provision as a federal requirement. ARARs and other laws which are unique to state law are identified separately by the State of Montana.

## FEDERAL ARARS

### 1. FEDERAL CONTAMINANT SPECIFIC REQUIREMENTS

#### a. Groundwater Standards – Safe Drinking Water Act (Relevant and Appropriate)[1]

The national primary drinking water standards (40 CFR part 141), better known as maximum contaminant levels and maximum contaminant level goals (MCLs and MCLGs), are applicable to the Great Divide Sand Tailings Site area because the aquifer underlying the area is a current public water system, as defined in the Safe Drinking Water Act, 42 U.S.C. § 300f(4). Groundwater use through private wells occurs in the area, and some of the groundwater in the area is a current source of drinking water.

Standards such as the MCL and MCLG standards are promulgated pursuant to both federal and state law. Under the Safe Drinking Water Act, EPA has granted the State of Montana primacy in implementation and enforcement of the Safe Drinking Water Act. Nevertheless, both federal and state promulgated standards are potential ARARs for the Great Divide Sand Tailings Site. Here, for ease of reference, for the primary contaminants of concern the more stringent of federal or state standards are listed, unless identical, in which case both standards are identified. Thus, the numerical standards identified by the State, which are applicable standards, are duplicated here where equivalent or more stringent.

| Chemical | MCLG | MCL |
|---|---|---|
| Antimony | 0.006 mg/l[2] | 0.006/l[3] |
| Arsenic | N.A.[4] | 0.05 milligrams per liter (mg/l)[5] |
| Cadmium | 0.005 mg/l[6] | 0.005 mg/l[7] |
| Copper | 1.3 mg/l[8] | 1.3 mg/l[9] |
| Lead | N.A. [10] | 0.015 mg/l[11] |
| Mercury | 0.002 mg/l[12] | 0.002 mg/l[13] |

These standards incorporate applicable Resource Conversation and Recovery Act (RCRA) standards for groundwater found at 40 CFR Part 264, Subpart F, which is incorporated pursuant to state law at ARM 17.54.702. The RCRA standards are the same or less stringent than the MCLs or MCLGs identified above.

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[1] 42 U.S.C. Sections 300f <u>et seq.</u>

[2] 40 CFR § 141.51.

[3] 40 CFR § 141.62.

[4] An MCLG and a revised MCL for arsenic may be promulgated by EPA in the near future. If promulgated prior to issuance of a decision document for the Great Divide Sand Tailings Site, these standards will be incorporated.

[5] 40 CFR § 141.11.

[6] 40 CFR § 141.51.

[7] 40 CFR § 141.62.

[8] 40 CFR § 141.51.

[9] 40 CFR § 141.80(c). The requirement is an action level rather than a simple numerical standard.

[10] The MCLG for lead is zero, which is not considered appropriate for Superfund site cleanups.

[11] 40 CFR § 141.80(c), which establishes an action level rather than a pure numerical standard.

[12] 40 CFR § 141.51.

[13] 40 CFR § 141.62.

b. Air Standards – Clean Air Act (Applicable)

Limitations on air emissions resulting from cleanup activities or emissions resulting from wind erosion of exposed hazardous substances are set forth in the action specific requirements, below.

## 2. FEDERAL LOCATION SPECIFIC REQUIREMENTS

### a. Fish and Wildlife Coordination Act (Applicable)

These standards are found at 16 U.S.C. §§ 1531 – 1566 and 40 CFR § 6.302(g). They require that federally funded or authorized projects ensure that any modification of any stream or other water body affected by a funded or authorized action provide for adequate protection of fish and wildlife resources. Compliance with this ARAR necessitates consultation with the U.S. Fish and Wildlife Service (USFWS) and the State of Montana Department of Fish, Wildlife, and Parks. Further consultation with these agencies will occur during cleanup selection and implementation, and specific mitigative or other measures may be identified to achieve compliance with this ARAR.

### b. Floodplain Management Order (Applicable)

This Requirement (40 CFR Part 6, Appendix A, Executive Order No. 11,988) mandated that federally funded or authorized actions within the 100 year flood plain avoid, to the maximum extent possible, adverse impacts associated with development of a floodplain. Compliance with this requirement in detailed in EPA's August 6, 1985 "Policy on Floodplains and Wetlands Assessments for CERCLA Actions." Specific measures to minimize adverse impacts may be identified following consultation with the appropriate agencies.

If the removal action selected for the Great Divide Sand Tailings Site is found to potentially affect the floodplain, the following information will be produced: a Statement of Findings which will set forth the reasons why the proposed action must be located in or affect the floodplain; a description of significant facts considered in making the decisions to locate in or affect the floodplain or wetlands including alternative sites or actions; a statement indicating whether the selected action conforms to applicable state or local floodplain protection standards; a description of the steps to be taken to design or modify the proposed action to minimize the potential harm to or within the floodplain; and a statement indicating how the proposed action affects the natural or beneficial values of the floodplain.

### c. Protection of Wetland Order (Relevant and Appropriate)

This requirement (40 CFR Part 6, Appendix A, Executive Order No. 11, 990) mandates that federal agencies and potentially responsible parties (PRPs) avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands and to avoid support of new construction in wetlands if a practicable alternative exists. Section 404(b)(1), 33 U.S.C. § 1344(b)(1), also prohibits the discharge of dredged or fill material into waters of the United States. Together, these requirements create a "no net loss" of wetlands standard. If wetlands are found to be potentially affected by the Great Divide Sand Tailings Site reclamation, this ARAR would be applicable.

### d. The Endangered Species Act (Applicable)

This statute and implementing regulations (16 U.S.C. §§ 1531 – 1543, 50CFR Part 402, and 40 CFR § 6.302(h)) require that any federal activity or federally authorized activity may not jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify a critical habitat. The area around the Great Divide Sand Tailings Site is not known to harbor endangered and threatened species. However the grey wolf, grizzly bear and bald eagle has been known to be present within a 5 mile radius of the site.

Compliance with this requirement involves consultation with USFWS, and a determination of whether there are listed or proposed species or critical habitats present at the site, and, if so, whether any proposed activities will impact such wildlife or habitat.

### e. The National Historic Preservation Act (Applicable)

This statute and implementing regulations (16 U.S.C. § 470, 40 CFR § 6.310(b), 36 CFR Part 800) require federal agencies or federal projects to take into account the effect of any federally assisted undertaking or licensing on any district, site building, structure, or object that is included in, or eligible for, the Register of Historic Places. If effects cannot be avoided reasonably, measures should be implemented to minimize or mitigate the potential effect. In order to comply with this ARAR, the BLM may consult with the State Historic Preservation Officer (SHPO), who can assist in identifying listed or eligible resources, and in assessing whether proposed cleanup actions will impact the resources and any appropriate mitigative measures.

### f. Archaeological and Historic Preservation Act (Applicable)

The statute and implementing regulations (16 U.S.C. § 469, 40 CFR § 6.301(c)) establish requirements for evaluation and preservation of historical and archaeological data, which may be destroyed through alteration of terrain as a result of federal construction projects or a federally licensed activity or program. If eligible scientific, prehistoric, or archaeological artifacts are discovered during site activities, they must be preserved in accordance with these requirements.

### g. Historic Sites, Buildings, and Antiquities Act (Applicable)

This requirement states that "in conducting an environmental review of a proposed action, the responsible official shall consider the existence and location of natural landmarks using information provided by the National Park Service pursuant to 36 CFR § 62.6(d) to avoid undesirable impacts upon such landmarks. The Programmatic Agreement activities described above should aid all parties in compliance with this ARAR.

### h. Migratory Bird Treaty Act (Applicable)

This requirement (16 U.S.C. §§ 703 et seq.) establishes a federal responsibility for the protection of the international migratory bird resource and requires continued consultation with the USFWS during remedial design and remedial construction to ensure that the cleanup of the site does not unnecessarily impact migratory birds. Specific mitigative measures may be identified for compliance with this requirement.

### i. Bald Eagle Protection Act (Applicable)

This requirement (16 U.S.C. §§ 668 et seq.) establishes a federal responsibility for protection of bald and golden eagles, and requires continued consultation with the USFWS during remedial design and remedial construction to ensure that any cleanup of the site does not unnecessarily adversely affect the bald and golden eagle. Specific mitigative measures may be identified for compliance with this requirement. The Bald Eagle has been known to be present within a 5 mile radius of the site.

### j. Resource Conservation and Recovery Act (Relevant and Appropriate)

Any discrete waste units created or retained by the Great Divide Sand Tailings cleanup must comply with the siting restrictions and conditions found at 40 CFR § 264.18(a) and (b). These sections require that waste repositories must not be located in seismic impact zones or in a 100 year flood plain. The repository planned for the Site is not indicated as being in a 100 year floodplain.

## 3. FEDERAL ACTION SPECIFIC REQUIREMENTS

### a. Solid Waste (Applicable), Surface Mining Control and Reclamation (Applicable), and RCRA (Relevant and Appropriate) Requirements.

The contamination at the Great Divide Sand Tailings Site is primarily mining waste form various man-made sources. This waste may not be RCRA hazardous waste, although EPA reserve its rights to make a more formal determination in this regard at a later date. For any management (i.e., treatment, storage, or disposal) or removal or retention of that contamination, the following requirements are ARARs.

1. Requirements described at 40 CFR §§ 257.3-1(a), 257.3-3, and257.3-4, governing waste handling, storage, and disposal, including retention of the waste, in general.[14]

2. For any discrete waste units which are addressed by the Great Divide Sand Tailings Site cleanup, reclamation and closure regulations found at 30 CFR Parts

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[14] Solid Waste regulations are promulgated pursuant to the federal Solid Waste Disposal Act, as amended by the Resource Conversation and Recovery Act, 42 U.S.C. 6901 et seq. They are applicable regulations, although the State of Montana has the lead role in regulating solid waste disposal in the State of Montana. These regulations are also applicable to the hazardous waste described in the section above.

816 and 784, governing coal and to a lesser extent, non-coal mining, are applicable requirements.[15]

b. Air Standards – Clean Air Act (Applicable)

These Standards, promulgated pursuant to section 109 of the Clean Air Act,[16] are applicable to releases into the air from any Great Divide Sand Tailings Site cleanup activities.

i. Lead: No person shall cause or contribute to concentrations of lead in the ambient air which exceed 1.5 micrograms per cubic meter ($\mu g/m^3$) of air, measured over a 90-day average.

These standards are promulgated at ARM 16.8.815 as part of a federally approved State Implementation Plan (SIP), pursuant to the Clean Air Act of Montana, §§ 75-2-101 et seq., MCA. Corresponding federal regulations are found at 40 CFR § 50.12.

ii. Particulate matter that is 10 microns in diameter or smaller (PM-10): No person shall cause of contribute to concentrations of PM-10 in the ambient air which exceed;

- 150 $\mu g/m^3$ 24 hour average, no mire than one expected exdeedance per calendar year;
- 50 $\mu g/m^3$ or air, annual average.

These regulations are promulgated at ARM 17.8.223 as part of a federally approved SIP, pursuant to the Clean Air Act of Montana, §§ 75-5-101 et seq., MCA. Corresponding federal regulations are found at 40 CFR § 50.6.

Ambient air standards under section 109 of the Clean Air Act are also promulgated for carbon monoxide, hydrogen sulfide, nitrogen dioxide, sulfur dioxide, and ozone. If emissions of these compounds were to occur at the site on connection with any cleanup action, these standards would also be applicable. See ARM 17.8.212 and 40 CFR Part 50.

c. Dredge and Fill Requirements (Applicable)

Regulations found at 40 CFR Part 230 address conditions or prohibitions against depositing dredge and fill material into water of the United States. If remediation activities would result in an activity subject to these regulations, they would be applicable.

d. Transportation of Hazardous or Contaminated Waste (Relevant and Appropriate)

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[15] The Surface Mining Control and Reclamation Act is promulgated at 30 U.S.C. Sections 1201 – 1326.

[16] 42 U.S.C. §§ 7401 et. seq.

40 CFR Part 263 establishes regulations for the transportation of hazardous waste. These regulations would govern any on-site transportation of material. Any off-site transportation would be subject to applicable regulations.

## STATE OF MONTANA ARARS

### 4. MONTANA CONTAMINANT SPECIFIC REQUIREMENT

### a. Water Quality

### i. Surface Water Quality Standards (Applicable)

Under the state Water Quality Act, §§ 75-5-101 et seq., MCA, the state has promulgated regulations to protect, maintain, and improve the quality of surface waters in the state. The requirements listed below are applicable water quality standards with which any remedial action must comply. The State of Montana has classified the surface water in the area of the Great Divide Sand Tailings Site as B-1. Silver Creek, which originates directly downgradient of the Site, is classified as B-1 but also is listed as impaired.

According to ARM 17.30.1310(3), MPDES permits are not necessary for any discharge that complies with the instructions of an on-scene coordinator pursuant to the MCP (40 CFR Part #)) et. Seq.). This exemption is identical to the federal exemption for NPDES permits. See 40 CFR section 122.3(d). The on-scene coordinator is the government official designated by the lead agency to coordinate and direct removal actions under the National Contingency Plan (NCP), subpart E. 40 CFR section 300.5. Removal actions include containment of hazardous substances form water and shorelines and taking other actions necessary to minimize or mitigate damage to public health or welfare or the environment. 40 CFR section 300.5. Removal also means cleaning up or removing hazardous substance releases from the environment, monitoring, assessing and evaluating releases or threats thereof, disposal of removed material, or other actions necessary to minimize or mitigate damage to public health or welfare or the environment. Id. Corey Meier is the BLM Project Officer of this site and is overseeing the reclamation work. As the government official of the lead agency of a federally approved Abandoned Mine Program directing and coordinating this removal action, Corey Meier is the on-scene coordinator. These activities are conducted pursuant to the NCP. Since this removal action will be conducted with the imprimatur of Corey Meier, the on-scene coordinator, and be executed pursuant to his instructions, the expected discharges of water from the planned tailings impoundment will not require an MPDES permit.

For the primary contaminants of concern, the Circular DEQ-7 levels are listed below. Circular DEQ-7 (applicable) provides that "whenever both Aquatic Life Standards and Human Health Standards exist for the same analyte, the more restrictive of these values will be used as the numeric Surface Water Quality Standard."

| Chemical | Circular DEQ-7 Standard (Surface Water) |
|---|---|
| Antimony | 5.6 μg/l |
| Arsenic | 10 μg/l |
| Cadmium | 5 μg/l |
| Copper | 1,300 μg/l |
| Lead | 15 μg/l |
| Manganese | 50 μg/l |
| Mercury | 0.05 μg/l |
| Zinc | 2,000 μg/l |

Additional restrictions on any discharge to surface waters are included in:

ARM 17.30.637 (Applicable), which prohibits discharges containing substances that will:

(a) Settle to form objectionable sludge deposits or emulsions beneath the surface of the water upon adjoining shorelines;
(b) Create floating debris, scum, a visible oil film (or be present in concentrations at or in excess of 10 milligrams per liter) or globules of grease or other floating materials;
(c) Produce odors, colors or other conditions which create a nuisance or render undesirable tastes to fish flesh or make fish inedible;
(d) Create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life;
(e) Create conditions which produce undesirable aquatic life.

ii Groundwater Pollution Control System (Applicable)

In addition to the standards set forth below, relevant and appropriate MCLs and MCLGs are included in the federal ARARs identified above.

ARM 17.30.1002 (Applicable) classifies groundwater into Classes I through IV based on the present and future most beneficial uses of the groundwater, and states that groundwater is to be classified according to actual quality or actual use, whichever places the groundwater in a higher class. Class I is the highest quality class; class IV the lowest.

ARM 17.30.1003 (Applicable) establishes the groundwater quality standards applicable with respect to each groundwater classification. Concentrations of dissolved substances in Class I or II groundwater (or Class III groundwater which is used as a drinking water source) may not exceed the human health standards listed in department Circular DEQ-7. For the primary contaminants of concern these levels are listed above.

Concentrations of other dissolved or suspended substances must not exceed levels that render the waters harmful, detrimental or injurious to public health. Maximum allowable concentration of these substances also must not exceed acute or chronic problem levels that would adversely affect existing or designated beneficial uses of groundwater of that classification. ARM 17.30.1003 specifies certain references that may be used as a guide in determining problem levels unless local conditions make these values inappropriate.

An additional concern with respect to ARARs for groundwater is the impact of groundwater upon the surface water. If significant loadings of contaminants form groundwater sources to surface water contribute to the inability of the stream to meet the classification standards, then alternatives to alleviate such groundwater loading must be evaluated and, if appropriate, implemented.

### b. Air Quality

In addition to the standards identified in the federal action specific ARARs above, the State of Montana has identified certain air quality standards in the action-specific section of the State ARARs below.

## 5. MONTANA LOCATION SPECIFIC REQUIREMENTS

### a. Solid Waste Management Regulations (Applicable)

Regulations promulgated under the Solid Waste Management Act, §§ 75-10-201 et seq., MCA, specify requirements that apply to the location of any solid waste management facility. Under ARM 17.50.505 (Applicable, a facility for the treatment, storage or disposal of solid wastes:

(a) must be located where a sufficient acreage of suitable land is available for solid waste management;

(b) may not be located in a 100-year floodplain;

(c) may be located only in areas which will prevent the pollution of ground and surface waters and public and private water supply systems;

(d) must be located to allow for reclamation and reuse of the land;

(e) drainage structures must be installed where necessary to prevent surface runoff from entering waste management areas; and

(f) where underlying geological formations contain rock fractures or fissures which may lead to pollution of the ground water or areas in which springs exist that are hydraulically connected to a proposed disposal facility, only Class III disposal facilities may be approved.

Even Class III landfills may not be located on the banks of or in a live or intermittent stream or water saturated areas, such as marshes or deep gravel pits which contain exposed ground water. ARM17.50.505(2)(j).

In addition, § 75-10-212 (Applicable) prohibits dumping or leaving any debris or refuse upon or within 200 yards of any highway, road, street, or alley of the State or other public property, or on privately owned property where hunting, fishing, or other recreation is permitted. However, the restriction relating to privately owned property does not apply to the owner, his agents, or those disposing of debris or refuse with the owner's consent.

### b. Natural streambed and Land Preservation Standards (Applicable)

Sections 87-5-502 and 504, MCA, (Applicable—substantive provisions only) provide that a state agency or subdivision shall not construct, modify, operate, maintain or fail to maintain any construction project or hydraulic project which may or will obstruct, damage, diminish, destroy, change, modify, or vary the natural existing shape and form of any stream or its banks or tributaries I a manner that will adversely affect any fish or game habitat. The requirement that any such project must eliminate or diminish any adverse effect on fish or game habitat is applicable to the state in approving remedial actions to be conducted.

ARM 36.2.404 (Applicable) establishes minimum standards which would be applicable if a remedial action alters or affects a streambed, including any channel change, new diversion, riprap or other streambank protection project, jetty, new dam or reservoir or other commercial, industrial or residential development. No such project may be approved unless reasonable efforts will be made consistent with the purpose of the project to minimize the amount of stream channel alteration, insure that the project will be as permanent a solution as possible and will create a reasonably permanent and stable situation, insure that the project will pass anticipated water flows without creating harmful erosion upstream or downstream, minimize turbidity, effects on fish and aquatic habitat, and adverse effects on the natural beauty of the area and insure that streambed gravels will not be used in the project unless there is no reasonable alternative. Soils erosion and sedimentation must be kept to a minimum. Such projects must also protect the use of water for any useful or beneficial purpose. <u>See</u> § 75-7-102, MCA.

## 6. MONTANA ACTION SPECIFIC REQUIREMENTS

### a. Air Quality

#### i. <u>Air Quality Regulations (Applicable)</u> Excavation/earth-moving transportation)

Dust suppression and control of certain substances likely to be released into the air as a result of earth moving, transportation and similar actions may be necessary to meet air quality requirements. Certain ambient air standards for specific contaminants and particulates are set forth in the federal action specific section above. Additional air quality regulations under the state Clean Air Act, §§ 75-2-101 <u>et seq.</u>, MCA, are discussed below.

ARM 17.8.308 (1) and (2) and 17.8.304 (Applicable) provides that no person shall cause or authorize the production, handling, transportation or storage of any material; or cause or authorize the use of any street, road, or parking lot; or operate a construction site or demolition project, unless reasonable precautions to control emissions of airborne particulate matter are taken. Emissions of airborne articulate matter must be controlled so that they do not "exhibit an opacity of twenty percent (20%) or greater averaged over six consecutive minutes."

In addition, state law provides an ambient air quality standard for settled particulate matter. Particulate matter concentrations in the ambient air shall not exceed the following 30-day average: 10 grams per square meter. ARM 17.8.220 (Applicable).

ARM 17.8.308(4) (Applicable) requires that any new source of airborne particulate matter that has the potential to emit <u>less</u> than 100 tons per year of particulates shall apply best available control technology (BACT); any new source of airborne particulate matter that has the potential to emit more than 100 tons per year of particulates shall apply lowest achievable emission rate (LAER). The BACT and LAER standards are defined in ARM 17.0.301.

ARM 26.4.761 (Applicable) specifies a range of measures for controlling fugitive dust emissions during mining and reclamation activities. Some of these measures could be considered relevant and appropriate to control fugitive dust emissions in connection with excavation, earth moving and transportation activities conducted as part of the remedy at the site. Such measures include, for example, paving, watering, chemically stabilizing, or frequently compacting and scraping roads, promptly removing rock, soil or other dust-forming debris from roads, restricting vehicle speeds, revegetating, mulching, or otherwise stabilizing the surface of areas adjoining roads, restricting unauthorized vehicle travel, minimizing the area of disturbed land, and promptly revegetating regraded lands.

### b. Solid Waste Regulations

Solid Waste Management Regulations are applicable to the management of the tailings and similar wastes within this Site. Certain of these regulations are identified in the state Location Specific ARARs above. Other applicable requirements are discussed here.

ARM 17.50.505(2) (Applicable) specifies standards for solid waste management facilities, including the requirements that:

1. if there is the potential for leachate migration, it must be demonstrated that leachate will only migrate to underlying formations which have no hydraulic continuity with any state waters;
2. adequate separation of such wastes from underlying or adjacent water must be provided considering terrain, type of underlying soil formations, and facility design; and
3. no new disposal units or lateral expansions may be located in wetlands.

ARM 17.50.523 (Applicable) requires that such waste must be transported in such a manner as to prevent its discharge, dumping, spilling, or leaking from the transport vehicle.

Section 75-10-206, MCA, (Applicable) allows variances to be granted from solid waste regulations if failure to comply with the rules does not result in a danger to public health or safety or compliance with specific rules would produce hardship without producing benefits to the health and safety of the public that outweigh the hardship. In light of the nature if the wastes at issue and the likelihood that any repository would contain only a single type of waste, i.e. tailings and related materials, many of the Solid Waste Regulations regarding design of landfills, ARM 17.50.510-511, and landfill closure requirements and post-closure care, ARM 17.50.530-531, may appropriately be subject to variance in selecting and implementing a remedy at this Site.

### c. Reclamation Requirements

#### i. Reclamation Activities – Hydrology Regulations (Applicable)
(Excavation, earth moving, altering drainage patterns)

The hydrology regulations promulgated under the Strip and Underground Mine Reclamation Act, §§ 82-4-201 et seq., MCA, provide detailed guidelines for addressing the hydrologic impacts of mine reclamation activities and earth moving projects and are applicable for addressing these impacts in the Great Divide Sand Tailings Site.

ARM 26.4.631 (Applicable) provides that long-term adverse changes in the hydrologic balance from mining and reclamation activities, such as changes in water quality and quantity, and location of surface water drainage channels shall be minimized. Water pollution must be minimized and, where necessary, treatment methods utilized. Diversions of drainages to avoid contamination must be used in preference to the use of water treatment facilities. Other pollution minimization devices must be used if appropriate, including stabilizing disturbed areas through land shaping, diverting runoff, planting quickly germinating and growing stands of temporary vegetation, regulating channel velocity of water, lining drainage channels with rock or vegetation, mulching, and control of acid-forming, and toxic-forming waste materials.

ARM 26.4.633 (Applicable) states that all surface drainage from a disturbed area must be treated by the best technology currently available (BTCA). Treatment must continue until the area is stabilized.

ARM 26.4.634 (Applicable) provides that, in reclamation of drainages, drainage design must emphasize channel and floodplain dimensions that approximate the pre-mining configuration and that will blend with the undisturbed drainage above and below the area to be reclaimed. The average stream gradient must be maintained with a concave longitudinal profile. This regulation provides specific requirements for designing the reclaimed drainage to:

1. meander naturally;
2. remain in dynamic equilibrium with the system;
3. improve unstable pre-mining conditions;
4. provide for floods; and
5. establish a pre-mining diversity of aquatic habitats and riparian vegetation.

ARM 26.4.635 through 26.4.637 (Applicable) set forth requirements for temporary and permanent diversions.

ARM 26.4.640 (Applicable) provides that discharge from sedimentation ponds, permanent and temporary impoundments, and diversions shall be controlled by energy dissipaters, riprap channels, and other devices, where necessary, to reduce erosion, prevent deepening or enlargement of stream channels, and to minimize disturbance of the hydrologic balance.

### ii. Reclamation and Revegetation Requirements (Applicable) (Excavation)

ARM 26.4.501 and 501A (Applicable) give general back-filling and final grading requirements.

ARM 26.4.504 (Applicable) provides that permanent impoundments that meet the requirements of ARM 26.4.642 may be retained in mined and reclaimed sites, provided that all highwalls are eliminated by grading to appropriate contours and the post-mining land use and protection of hydrologic balance provisions are satisfied. No impoundments may be constructed on top of areas in which excess materials are deposited.

ARM 26.4.514 (Applicable) sets out contouring requirements.

ARM 26.4.519 (Applicable) provides that an operator may be required to monitor settling of regraded areas.

ARM 26.4.520 (Applicable) provides that spoil material may be placed in a controlled (engineered) manner in a disposal area other than the mine workings or excavations. Also provides various other relevant requirements, including, but not limited to, those for water protection i.e., that leachate and surface runoff from the fill must not degrade surface or ground waters or exceed effluent limitations.

ARM 26.4.638 (Applicable) specifies sediment control measures to be implemented during operations.

ARM 26.4.641 (Applicable) provides that drainage from acid-and toxic-forming spoil ground and surface water must be avoided by several enumerated means, all of which are relevant.

ARM 26.4.642 (Applicable) prohibits permanent impoundments except under certain circumstances. Also provides other construction requirements for embankments, dams and diversion ditches.

ARM 26.4.643-646 (Applicable) provides for protection of groundwater and groundwater recharge, and provides requirements for monitoring surface and groundwater.

ARM 26.4.650 (Applicable) provides for post-mining rehabilitation of sedimentation ponds, diversion, impoundments and treatment facilities before abandonment of the permit area.

ARM 26.4.702 (Applicable) requires that during the redistributing and stockpiling of soil (for reclamation):

1. regraded areas must be deep-tilled, sub-soiled, or otherwise treated to eliminate any possible slippage potential, to relieve compaction, and to promote root penetration and permeability of the underlying layer; this preparation must be done on the contour whenever possible and to a minimum depth of 12 inches;
2. redistribution must be done in a manner that achieves approximate uniform thicknesses consistent with soil resource availability and appropriate for the post-mining vegetation, land uses, contours, and surface water drainage systems; and
3. redistributed soil mist be reconditioned by sub-soiling or other appropriate methods.

ARM 26.4.703 (Applicable) When using materials other than, or along with, soil for final surfacing in reclamation, the operator must demonstrate that the material (1) is at least as capable as the soil of supporting the approved vegetation and subsequent land use, and (2) the medium must be the best available in the area to support vegetation. Such substitutes must be used in a manner consistent with the requirements for redistribution of soil in arm 26.4.701 and 702.

Are 26.4.711 (Applicable) requires that a diverse, effective, and permanent vegetative cover of the same seasonal variety native to the area of land to be affected shall be established except on road surfaces and below the low-water line of permanent impoundments. Vegetative cover is considered of the same seasonal variety if it consists of a mixture of species of equal or superior utility when compared with the natural (or pre-existing) vegetation during each season of the year. (See also ARM 26.4.716 below regarding substitution of introduced species for native species.)

ARM 26.4.713 (Applicable) provides that seeding and planting of disturbed areas must be conducted during the first appropriate period for favorable planting after final seedbed preparation but may not be more than 90 days after soil has been replaced.

ARM 26.4.714 (Applicable) requires use of mulch or cover crop or both until an adequate permanent cover can be established. Use of mulching and temporary cover may be suspended under certain conditions.

ARM 26.4.716 (Applicable) establishes the required method of revegetation, and provides that introduced species may be substituted for native species as part of an approved plan.

ARM 26.4.718 (Applicable) requires the use of soil amendments and other means such as irrigation, management, fencing, or other measures, if necessary to establish a diverse and permanent vegetative cover.

ARM 26.4.720 (Applicable) requires annual state inspection of seeded areas.

ARM 26.4.721 (Applicable) requires rills and gullies forming in areas that have been regraded or resoiled must be filled, graded or otherwise stabilized and the area reseeded or replanted under certain circumstances.

ARM 26.4.723 (Applicable) requires periodic monitoring and data review of vegetation, soils, wildlife and other items at the site by the operator as prescribed or approved by the state.

ARM 26.4.724 (Applicable) provides revegetation comparison standards.

ARM 26.4.725 (Applicable) establishes commencement of the minimum period of responsibility for reestablishing vegetation.

ARM 26.4.726 (Applicable) establishes vegetation production, cover, diversity, density and utility requirements for revegetation and reclamation success.

ARM 26.4.728 (Applicable) sets forth requirements for the composition of vegetation on reclaimed areas.

ARM 26.4.730-731 (Applicable) requires season of use standards and analysis of toxicity if such toxicity is suspected due to the effects of disturbance caused by the reclamation technique.

## 7. OTHER LAWS (NON-EXCLUSIVE LIST)

CERCLA defines as ARARs only federal environmental and state environmental and siting laws. Remedial design, implementation, and operation and maintenance must nevertheless comply with all other applicable laws, both state and federal, if the remediation work is done by parties other than the federal government or its contractors.

The following "other laws" are included here to provide a reminder of other legally applicable requirements for actions being conducted at the Great Divide Sand Tailings Site. They do not purport to be an exhaustive list of such legal requirements, but are included because they set out related concerns that must be addressed and, in some cases, may require some advance planning. They are not included as ARARs because they are not "environmental or facility siting laws." As applicable laws other than ARARs, they are not subject to ARARs waiver provisions.

Section 121(e) of CERCLA exempts removal or remedial actions conducted entirely on-site from federal, state, or local permits. This exemption is not limited to environmental or facility siting laws, but applies to other permit requirements as well.

### a. Other Federal Laws

#### i. <u>Occupational Safety and Health Regulations</u>

The federal Occupational Safety and Health Act regulations found at 29 CFR § 1910 are applicable to worker protection during conduct of RI/FS or remedial activities.

### b. Other Montana Laws

#### i. <u>Water Rights</u>

Section 85-2-101, MCA, declares that all waters within the state are the state's property, and may be appropriated for beneficial uses. The wise use of water resources is encouraged for the maximum benefit to the people and with minimum degradation of natural aquatic ecosystems.

Parts 3 and 4 of Title 85, MCA, set out requirements for obtaining water rights and appropriating and utilizing water. All requirements of these parts are laws, which must be complied with in any action using or affecting waters of the state. Some of the specific requirements are set forth below.

Section 85-2-302, MCA, specifies that a person may not appropriate water or commence construction of diversion, impoundment, withdrawal or distribution works therefore except by applying for and receiving a permit from the Montana Department of Natural Resources and Conservation. While the permit itself may not be required under federal law, appropriate notification and submission of an application should be performed and a permit should be applied for in order to establish a priority date in the prior appropriation system.

### ii. Occupational Health Act, §§ 50-70-101 et seq., MCA.

ARM 17.74.101 addresses occupational noise. In accordance with this section, no worker shall be exposed to noise levels in excess of the levels specified in this regulation. This regulation is applicable only to limited categories of workers and for most workers the similar federal standard in 29 CFR § 1910.95 applies.

ARM 17.74.102 addressed occupational air contaminants. The purpose of this rule is to establish maximum threshold limit values for air contaminants under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effects. In accordance with this rule, no worker shall be exposed to air contaminant levels in excess of the threshold limit values listed in the regulation. This regulation is applicable only to limited categories of workers and for most workers the similar federal standard in 29 CFR § 1910.1000 applies.

### iii. Montana Safety Act

Sections 50-71-201,202 and 203, MCA, state that every employer must provide and maintain a safe place of employment, provide and require use of safety devices and safeguards, and ensure that operations and processes are reasonably adequate to render the place of employment safe. The employer must also do every other thing reasonably necessary to protect the life and safety of its employees. Employees are prohibited from refusing to use or interfering with the use of safety devices.

### iv. Employee and Community Hazardous Chemical Information Act

Sections 50-78-201, 202, and 204, MCA, state that each employer must post notice of employee rights, maintain at the work place a list of chemical names of each chemical in the work place, and indicate the work area where the chemical is stored or used. Employees must be informed of the chemicals at the work place and trained in the proper handling of the chemicals.

# APPENDIX F

# GREAT DIVIDE SAND TAILINGS SITE COST TABLES

## Table F-1

## Alternative 2 - Institutional Controls

| Item | | Description | Quantity | Unit | Unit Price | Total Price |
|---|---|---|---|---|---|---|
| | | | | | | |
| **1** | | **Administration** | | | | |
| | **1.1** | **Mobilization, Bonding, Insurance (10%)** | **1** | **LS** | **$ 1,100.00** | **$ 1,100.00** |
| **2** | | **Institutional Controls** | | | | |
| | **2.1** | **Access Control** | **1** | **LS** | **$ 11,000.00** | **$ 11,000.00** |
| | | *Install Fence* | *2500* | *LF* | *$ 4.40* | *$ 11,000.00* |
| | | | | | | |
| | | SUBTOTAL: | | | | $ 12,100.00 |
| | | Contingency (15%): | | | | $ 1,815.00 |
| | | **TOTAL CAPITAL COSTS:** | | | | **$ 13,915.00** |

## Table F-2

### Alternative 3a - Maintenance

| Item | Description | Quantity | Unit | Unit Price | Total Price |
|---|---|---|---|---|---|
| 1 | **Administration** | | | | |
| 1.1 | **Mobilization, Bonding, Insurance (10%)** | **1** | **LS** | **$ 1,512.50** | **$ 1,512.50** |
| 2 | **Maintenance** | | | | |
| 2.1 | **Drainage Repair** | | | | |
| | *Regrading* | *1500* | *SY* | *$ 0.55* | *$ 825.00* |
| | *Riprap Head Cut Area* | *200* | *CY* | *$ 38.50* | *$ 7,700.00* |
| | *Clean & Repair Existing Lower Slope Ditch* | *1000* | *LF* | *$ 5.50* | *$ 5,500.00* |
| | | | | | **$ 14,025.00** |
| 2.2 | **Revegetation** | | | | |
| | *Fertilize and Seed* | *0.5* | *AC* | *$ 1,100.00* | *$ 550.00* |
| | *Mulch* | *0.5* | *AC* | *$ 1,100.00* | *$ 550.00* |
| | | | | | **$ 1,100.00** |
| | SUBTOTAL: | | | | $ 16,637.50 |
| | Contingency (15%): | | | | $ 2,495.63 |
| | **TOTAL CAPITAL COSTS:** | | | | **$ 19,133.13** |

## Table F-3

## Alternative 3b - Maintenance with New Surface Water Control Ditches

| Item | Description | Quantity | Unit | Unit Price | Total Price |
|---|---|---|---|---|---|
| **1** | **Administration** | | | | |
| **1.1** | **Mobilization, Bonding, Insurance (10%)** | **1** | **LS** | **$ 4,977.50** | **$ 4,977.50** |
| **2** | **Site Preparation** | | | | |
| **2.1** | **Road Improvements** | | | | |
| | *Main Access Road* | *1.00* | *MI* | *$ 825.00* | *$ 825.00* |
| | *Construction Access Roads* | *1.00* | *MI* | *$ 825.00* | *$ 825.00* |
| | | | | | **$ 1,650.00** |
| **3** | **Maintenance** | | | | |
| **3.1** | **Drainage Repair** | | | | |
| | *Regrading* | *1,500* | *SY* | *$ 1.10* | *$ 1,650.00* |
| | *Riprap Head Cut Area* | *200* | *CY* | *$ 38.50* | *$ 7,700.00* |
| | | | | | **$ 9,350.00** |
| **3.2** | **Revegetation** | | | | |
| | *Fertilize and Seed* | *1.5* | *AC* | *$ 1,100.00* | *$ 1,650.00* |
| | *Mulch* | *1.5* | *AC* | *$ 1,100.00* | *$ 1,650.00* |
| | | | | | **$ 3,300.00** |
| **4** | **Drainage Control** | | | | |
| **4.1** | **Upper Run-On Control Ditch - Type 1 Riprap Lined** | | | | |
| | *Construct Upper Ditch* | *700* | *LF* | *$ 6.60* | *$ 4,620.00* |
| | *8" Angular Riprap* | *300* | *CY* | *$ 38.50* | *$ 11,550.00* |
| | | | | | **$ 16,170.00** |
| **4.2** | **Middle Run-Off Control Ditch - Type 2 Riprap Lined** | | | | |
| | *Construct Middle Ditch* | *300* | *LF* | *$ 6.60* | *$ 1,980.00* |
| | *Poly Lining* | *400* | *SY* | *$ 4.40* | *$ 1,760.00* |
| | *8" Angular Riprap* | *100* | *CY* | *$ 38.50* | *$ 3,850.00* |
| | | | | | **$ 7,590.00** |
| **4.3** | **Lower Run-Off Control Ditch - Type 2 Riprap Lined** | | | | |
| | *Construct Lower Ditch* | *400* | *LF* | *$ 6.60* | *$ 2,640.00* |
| | *8" Angular Riprap* | *150* | *CY* | *$ 38.50* | *$ 5,775.00* |
| | *24" CMP Culvert* | *50* | *LF* | *$ 66.00* | *$ 3,300.00* |
| | | | | | **$ 11,715.00** |
| | SUBTOTAL: | | | | $ 54,752.50 |
| | Contingency (15%): | | | | $ 8,212.88 |
| | **TOTAL CAPITAL COSTS:** | | | | **$ 62,965.38** |

## Table F-4

### Alternative 4a - In-Place Containment with Cover Soil Cap

| Item | Description | Quantity | Unit | Unit Price | Total Price |
|---|---|---|---|---|---|
| **1** | **Administration** | | | | |
| **1.1** | **Mobilization, Bonding, Insurance (10%)** | **1** | **LS** | **$ 49,142.50** | **$ 49,142.50** |
| **2** | **Site Preparation** | | | | |
| **2.1** | **Road Improvements** | | | | |
| | *Main Access Road* | *1.0* | *MI* | *$ 825.00* | *$ 825.00* |
| | *Construction Access Roads* | *1.0* | *MI* | *$ 825.00* | *$ 825.00* |
| | | | | **$ 1,650.00** | **$ 1,650.00** |
| **3** | **Reclamation** | | | | |
| **3.1** | **Borrow Area** | | | | |
| | *Strip, Stockpile and Replace Borrow Area Topsoil* | *2,400* | *CY* | *$ 5.50* | *$ 13,200.00* |
| | *Excavate/Stockpile Borrow Area Cover Soil* | *17,000* | *CY* | *$ 5.50* | *$ 93,500.00* |
| | | | | | **$ 106,700.00** |
| **3.2** | **Tailings In-Place Containment Cap** | | | | |
| | *Haul, and Place Amended Cover Soil Cap (2-foot)* | *17,000* | *CY* | *$ 8.80* | *$ 149,600.00* |
| | *Haul, and Place Road Mix on Parking Lots (1-foot)* | *1,000* | *CY* | *$ 15.40* | *$ 15,400.00* |
| | | | | | **$ 165,000.00** |
| **3.3** | **Revegetation** | | | | |
| | *Organic Amendment* | *720* | *Dry Ton* | *$ 220.00* | *$ 158,400.00* |
| | *Fertilize and Seed* | *11* | *AC* | *$ 1,100.00* | *$ 12,100.00* |
| | *Mulch* | *11* | *AC* | *$ 1,100.00* | *$ 12,100.00* |
| | | | | | **$ 182,600.00** |
| **4** | **Drainage Control** | | | | |
| **4.1** | **Upper Run-On Control Ditch - Type 1 Riprap Lined** | | | | |
| | *Construct Upper Ditch* | *700* | *LF* | *$ 6.60* | *$ 4,620.00* |
| | *8" Angular Riprap* | *300* | *CY* | *$ 38.50* | *$ 11,550.00* |
| | | | | | **$ 16,170.00** |
| **4.2** | **Middle Run-Off Control Ditch - Type 2 Riprap Lined** | | | | |
| | *Construct Middle Ditch* | *300* | *LF* | *$ 6.60* | *$ 1,980.00* |
| | *Poly Lining* | *400* | *SY* | *$ 4.40* | *$ 1,760.00* |
| | *8" Angular Riprap* | *100* | *CY* | *$ 38.50* | *$ 3,850.00* |
| | | | | | **$ 7,590.00** |
| **4.3** | **Lower Run-Off Control Ditch - Type 2 Riprap Lined** | | | | |
| | *Construct Lower Ditch* | *400* | *LF* | *$ 6.60* | *$ 2,640.00* |
| | *8" Angular Riprap* | *150* | *CY* | *$ 38.50* | *$ 5,775.00* |
| | *24" CMP Culvert* | *50* | *LF* | *$ 66.00* | *$ 3,300.00* |
| | | | | | **$ 11,715.00** |
| | SUBTOTAL: | | | | $ 540,567.50 |
| | Contingency (15%): | | | | $ 81,085.13 |
| | **TOTAL CAPITAL COSTS:** | | | | **$ 621,652.63** |

## Table F-5

## Alternative 4b - Consolidation and In-Place Containment with Cover Soil Cap

| Item | Description | Quantity | Unit | Unit Price | Total Price |
|---|---|---|---|---|---|
| 1 | **Administration** | | | | |
| 1.1 | **Mobilization, Bonding, Insurance (10%)** | 1 | LS | $ 57,051.50 | $ 57,051.50 |
| 2 | **Site Preparation** | | | | |
| 2.1 | **Road Improvements** | | | | |
| | *Main Access Road* | *1.00* | *MI* | *$ 825.00* | *$ 825.00* |
| | *Construction Access Roads* | *1.00* | *MI* | *$ 825.00* | *$ 825.00* |
| | | | | | **$ 1,650.00** |
| 3 | **Reclamation** | | | | |
| 3.1 | **Borrow Area** | | | | |
| | *Strip, Stockpile and Replace Borrow Area Topsoil* | *2,400* | *CY* | *$ 5.50* | *$ 13,200.00* |
| | *Excavate/Stockpile Borrow Area Cover Soil* | *13,000* | *CY* | *$ 5.50* | *$ 71,500.00* |
| | | | | | **$ 84,700.00** |
| 3.2 | **Tailings Partial Removal & Containment** | | | | |
| | *Excavate, Haul, and Place Surficial Tailings in Consolidation Area* | *12,000* | *CY* | *$ 7.70* | *$ 92,400.00* |
| | *Haul, and Place Amended Cover Soil Cap (2-foot)* | *9,000* | *CY* | *$ 8.80* | *$ 79,200.00* |
| | *Haul, and Place Amended Cover Soil Over Excavated Area (1-foot)* | *4,000* | *CY* | *$ 8.80* | *$ 35,200.00* |
| | *Haul, and Place Road Mix on Parking Lots (1-foot)* | *1,000* | *CY* | *$ 15.40* | *$ 15,400.00* |
| | | | | | **$ 222,200.00** |
| 3.3 | **Revegetation** | | | | |
| | *Organic Amendment* | *720* | *Dry Ton* | *$ 220.00* | *$ 158,400.00* |
| | *Fertilize and Seed* | *11* | *AC* | *$ 1,100.00* | *$ 12,100.00* |
| | *Mulch* | *11* | *AC* | *$ 1,100.00* | *$ 12,100.00* |
| | | | | | **$ 182,600.00** |
| 4 | **Drainage Control** | | | | |
| 4.1 | **Upper Run-On Control Ditch - Type 1 Riprap Lined** | | | | |
| | *Construct Upper Ditch* | *700* | *LF* | *$ 6.60* | *$ 4,620.00* |
| | *8" Angular Riprap* | *300* | *CY* | *$ 38.50* | *$ 11,550.00* |
| | | | | | **$ 16,170.00** |
| 4.2 | **Middle Run-Off Control Ditch - Type 2 Riprap Lined** | | | | |
| | *Construct Middle Ditch* | *300* | *LF* | *$ 6.60* | *$ 1,980.00* |
| | *8" Angular Riprap* | *100* | *CY* | *$ 38.50* | *$ 3,850.00* |
| | | | | | **$ 5,830.00** |
| 4.3 | **Lower Run-Off Control Ditch - Type 2 Riprap Lined** | | | | |
| | *Construct Lower Ditch* | *400* | *LF* | *$ 6.60* | *$ 2,640.00* |
| | *8" Angular Riprap* | *150* | *CY* | *$ 38.50* | *$ 5,775.00* |
| | *24" CMP Culvert* | *50* | *LF* | *$ 66.00* | *$ 3,300.00* |
| | | | | | **$ 11,715.00** |

## Table F-5 (cont.)

### Alternative 4b - Consolidation and In-Place Containment with Cover Soil Cap

| Item | Description | Quantity | Unit | Unit Price | Total Price |
|---|---|---|---|---|---|
| **5** | **Utility Relocation & Replacement** | | | | |
| **5.1** | **Slope Lighting** | | | | |
| | *Remove & Reset Light Pole* | *3* | *EA* | *$ 1,210.00* | *$ 3,630.00* |
| | *Replace Underground Cable* | *750* | *LF* | *$ 15.40* | *$ 11,550.00* |
| | | | | | **$ 15,180.00** |
| **5.2** | **Tower Communications Line** | | | | |
| | *Replace Underground Cable* | *550* | *LF* | *$ 11.00* | *$ 6,050.00* |
| | | | | | **$ 6,050.00** |
| **5.3** | **Telephone Line** | | | | |
| | *Install Pedestal at Splice* | *1* | *EA* | *$ 770.00* | *$ 770.00* |
| | *Replace Underground Cable* | *600* | *LF* | *$ 11.00* | *$ 6,600.00* |
| | | | | | **$ 7,370.00** |
| **5.4** | **Snow Making System** | | | | |
| | *Replace Water Line* | *450* | *LF* | *$ 24.20* | *$ 10,890.00* |
| | *Replace Underground Cable* | *400* | *LF* | *$ 15.40* | *$ 6,160.00* |
| | | | | | **$ 17,050.00** |
| | SUBTOTAL: | | | | $ 627,566.50 |
| | Contingency (15%): | | | | $ 94,134.98 |
| | **TOTAL CAPITAL COSTS:** | | | | **$ 721,701.48** |

## Table F-6

## Alternative 5a - Consolidation in Off-Site Repository With Cover Soil Cap

| Item | Description | Quantity | Unit | Unit Price | Total Price |
|---|---|---|---|---|---|
| 1 | **Administration** | | | | |
| 1.1 | **Mobilization, Bonding, Insurance (10%)** | 1 | LS | $ 125,075.50 | $ 125,075.50 |
| 2 | **Site Preparation** | | | | |
| 2.1 | **Road Improvements** | | | | |
| | *Main Access Road* | *1.00* | *MI* | *$ 825.00* | *$ 825.00* |
| | *Construction Access Roads* | *1.00* | *MI* | *$ 825.00* | *$ 825.00* |
| | | | | | **$ 1,650.00** |
| 3 | **Reclamation** | | | | |
| 3.1 | **Borrow Area** | | | | |
| | *Strip, Stockpile and Replace Borrow Area Topsoil* | *2,400* | *CY* | *$ 5.50* | *$ 13,200.00* |
| | *Excavate/Stockpile Borrow Area Cover Soil* | *18,200* | *CY* | *$ 5.50* | *$ 100,100.00* |
| | | | | | **$ 113,300.00** |
| 3.2 | **Tailings Removal** | | | | |
| | *Excavate, Haul, and Place Tailings in Repository* | *42,000* | *CY* | *$ 8.80* | *$ 369,600.00* |
| | *Haul, and Place Amended Cover Soil Over Excavated Area (1-foot)* | *8,500* | *CY* | *$ 8.80* | *$ 74,800.00* |
| | *Haul, and Place Road Mix on Parking Lots (1-foot)* | *1,000* | *CY* | *$ 15.40* | *$ 15,400.00* |
| | | | | | **$ 459,800.00** |
| 3.3 | **Repository** | | | | |
| | *Haul, and Place Amended Cover Soil Cap (2-foot)* | *9700* | *CY* | *$ 8.80* | *$ 85,360.00* |
| | | | | | **$ 85,360.00** |
| 3.3 | **Revegetatiou** | | | | |
| | *Organic Amendment* | *2,000* | *Dry Ton* | *$ 220.00* | *$ 440,000.00* |
| | *Fertilize and Seed* | *11* | *AC* | *$ 1,100.00* | *$ 12,100.00* |
| | *Mulch* | *11* | *AC* | *$ 1,100.00* | *$ 12,100.00* |
| | | | | | **$ 464,200.00** |
| 4 | **Drainage Control** | | | | |
| 4.1 | **Upper Ditch - Type 1 Riprap Lined** | | | | |
| | *Construct Upper Ditch* | *700* | *LF* | *$ 6.60* | *$ 4,620.00* |
| | *8" Angular Riprap* | *300* | *CY* | *$ 38.50* | *$ 11,550.00* |
| | | | | | **$ 16,170.00** |
| 4.2 | **Middle Ditch - Type 2 Riprap Lined** | | | | |
| | *Construct Middle Ditch* | *300* | *LF* | *$ 6.60* | *$ 1,980.00* |
| | *8" Angular Riprap* | *100* | *CY* | *$ 38.50* | *$ 3,850.00* |
| | | | | | **$ 5,830.00** |
| 4.3 | **Lower Ditch - Type 2 Riprap Lined** | | | | |
| | *Construct Lower Ditch* | *400* | *LF* | *$ 6.60* | *$ 2,640.00* |
| | *8" Angular Riprap* | *150* | *CY* | *$ 38.50* | *$ 5,775.00* |
| | *24" CMP Culvert* | *50* | *LF* | *$ 66.00* | *$ 3,300.00* |
| | | | | | **$ 11,715.00** |

## Table F-6 (cont.)

## Alternative 5a - Consolidation in Off-Site Repository With Cover Soil Cap

| Item | Description | Quantity | Unit | Unit Price | Total Price |
|---|---|---|---|---|---|
| 5 | **Utility Relocation & Replacement** | | | | |
| 5.1 | **Slope Lighting** | | | | |
| | *Remove & Reset Light Pole* | *3* | *EA* | *$ 1,210.00* | *$ 3,630.00* |
| | *Replace Underground Cable* | *1200* | *LF* | *$ 15.40* | *$ 18,480.00* |
| | | | | | **$ 22,110.00** |
| 5.2 | **Tower Communications Line** | | | | |
| | *Replace Underground Cable* | *1100* | *LF* | *$ 11.00* | *$ 12,100.00* |
| | | | | | **$ 12,100.00** |
| 5.3 | **Telephone Line** | | | | |
| | *Install Pedestal at Splice* | *1* | *EA* | *$ 770.00* | *$ 770.00* |
| | *Replace Underground Cable* | *600* | *LF* | *$ 11 00* | *$ 6,600.00* |
| | | | | | **$ 7,370.00** |
| 5.4 | **Snow Making System** | | | | |
| | *Replace Water Line* | *1000* | *LF* | *$ 24.20* | *$ 24,200.00* |
| | *Replace Underground Cable* | *400* | *LF* | *$ 15.40* | *$ 6,160.00* |
| | | | | | **$ 30,360.00** |
| 5.5 | **2400V Power Feed to Shock Shack** | | | | |
| | *Install Junction Box at Splice* | *1* | *EA* | *$ 1,540.00* | *$ 1,540.00* |
| | *Replace Underground Cable* | *500* | *LF* | *$ 38.50* | *$ 19,250.00* |
| | | | | | **$ 20,790.00** |
| | | | | | |
| | SUBTOTAL: | | | | $ 1,375,830.50 |
| | Contingency (15%): | | | | $ 206,374.58 |
| | **TOTAL CAPITAL COSTS:** | | | | **$ 1,582,205.08** |

## Table F-7

### Alternative 5b - Consolidation in Off-Site Repository With Multi-Layered Cap

| Item | Description | Quantity | Unit | Unit Price | Total Price |
|---|---|---|---|---|---|
| **1** | **Administration** | | | | |
| **1.1** | **Mobilization, Bonding, Insurance (10%)** | **1** | **LS** | **$ 147,350.50** | **$ 147,350.50** |
| 2 | **Site Preparation** | | | | |
| **2.1** | **Road Improvements** | | | | |
| | *Main Access Road* | *1.00* | *MI* | *$ 825.00* | *$ 825.00* |
| | *Construction Access Roads* | *1.00* | *MI* | *$ 825.00* | *$ 825.00* |
| | | | | | **$ 1,650.00** |
| 3 | **Reclamation** | | | | |
| **3.1** | **Borrow Area** | | | | |
| | *Strip, Stockpile and Replace Borrow Area Topsoil* | *2,400* | *CY* | *$ 5.50* | *$ 13,200.00* |
| | *Excavate/Stockpile Borrow Area Cover Soil* | *18,200* | *CY* | *$ 5.50* | *$ 100,100.00* |
| | | | | | **$ 113,300.00** |
| **3.2** | **Tailings Removal** | | | | |
| | *Excavate, Haul, and Place Tailings in Repository* | *42,000* | *CY* | *$ 8.80* | *$ 369,600.00* |
| | *Haul, and Place Amended Cover Soil Over Excavated Area (1-foot)* | *8,500* | *CY* | *$ 8.80* | *$ 74,800.00* |
| | *Haul, and Place Road Mix on Parking Lots (1-foot)* | *1,000* | *CY* | *$ 15.40* | *$ 15,400.00* |
| | | | | | **$ 459,800.00** |
| **3.3** | **Repository** | | | | |
| | *Geotextile Filter Fabric* | *15,000* | *SY* | *$ 3.85* | *$ 57,750.00* |
| | *Geosynthetic Clay Liner* | *15,000* | *SY* | *$ 5.50* | *$ 82,500.00* |
| | *Geonet Drainage Layer* | *15,000* | *SY* | *$ 5.50* | *$ 82,500.00* |
| | *Haul, and Place Amended Cover Soil Cap (2-foot)* | *9,700* | *CY* | *$ 8.80* | *$ 85,360.00* |
| | | | | | **$ 308,110.00** |
| **3.3** | **Revegetation** | | | | |
| | *Organic Amendment* | *2,000* | *Dry Ton* | *$ 220.00* | *$ 440,000.00* |
| | *Fertilize and Seed* | *11* | *AC* | *$ 1,100.00* | *$ 12,100.00* |
| | *Mulch* | *11* | *AC* | *$ 1,100.00* | *$ 12,100.00* |
| | | | | | **$ 464,200.00** |
| 4 | **Drainage Control** | | | | |
| **4.1** | **Upper Ditch - Type 1 Riprap Lined** | | | | |
| | *Construct Upper Ditch* | *700* | *LF* | *$ 6.60* | *$ 4,620.00* |
| | *8" Angular Riprap* | *300* | *CY* | *$ 38.50* | *$ 11,550.00* |
| | | | | | **$ 16,170.00** |
| **4.2** | **Middle Ditch - Type 2 Riprap Lined** | | | | |
| | *Construct Middle Ditch* | *300* | *LF* | *$ 6.60* | *$ 1,980.00* |
| | *8" Angular Riprap* | *100* | *CY* | *$ 38.50* | *$ 3,850.00* |
| | | | | | **$ 5,830.00** |
| **4.3** | **Lower Ditch - Type 2 Riprap Lined** | | | | |
| | *Construct Lower Ditch* | *400* | *LF* | *$ 6.60* | *$ 2,640.00* |
| | *8" Angular Riprap* | *150* | *CY* | *$ 38.50* | *$ 5,775.00* |
| | *24" CMP Culvert* | *50* | *LF* | *$ 66.00* | *$ 3,300.00* |
| | | | | | **$ 11,715.00** |

**Table F-7 (cont.)**

**Alternative 5b - Consolidation in Off-Site Repository With Multi-Layered Cap**

| Item | Description | Quantity | Unit | Unit Price | Total Price |
|---|---|---|---|---|---|
| 5 | **Utility Relocation & Replacement** | | | | |
| 5.1 | **Slope Lighting** | | | | |
| | *Remove & Reset Light Pole* | 3 | EA | $ 1,210.00 | $ 3,630.00 |
| | *Replace Underground Cable* | 1200 | LF | $ 15.40 | $ 18,480.00 |
| | | | | | **$ 22,110.00** |
| 5.2 | **Tower Communications Line** | | | | |
| | *Replace Underground Cable* | 1100 | LF | $ 11.00 | $ 12,100.00 |
| | | | | | **$ 12,100.00** |
| 5.3 | **Telephone Line** | | | | |
| | *Install Pedestal at Splice* | 1 | EA | $ 770.00 | $ 770.00 |
| | *Replace Underground Cable* | 600 | LF | $ 11.00 | $ 6,600.00 |
| | | | | | **$ 7,370.00** |
| 5.4 | **Snow Making System** | | | | |
| | *Replace Water Line* | 1000 | LF | $ 24.20 | $ 24,200.00 |
| | *Replace Underground Cable* | 400 | LF | $ 15.40 | $ 6,160.00 |
| | | | | | **$ 30,360.00** |
| 5.5 | **2400V Power Feed to Shock Shack** | | | | |
| | *Install Junction Box at Splice* | 1 | EA | $ 1,540.00 | $ 1,540.00 |
| | *Replace Underground Cable* | 500 | LF | $ 38.50 | $ 19,250.00 |
| | | | | | **$ 20,790.00** |
| | | | | | |
| | SUBTOTAL: | | | | $ 1,620,855.50 |
| | Contingency (15%): | | | | $ 243,128.33 |
| | **TOTAL CAPITAL COSTS:** | | | | **$ 1,863,983.83** |

## Table F-8

## Alternative 5c - Consolidation in Off-Site Modified RCRA Repository

| Item | Description | Quantity | Unit | Unit Price | Total Price |
|---|---|---|---|---|---|
| 1 | **Administration** | | | | |
| 1.1 | **Mobilization, Bonding, Insurance (10%)** | 1 | LS | $ 174,300.50 | $ 174,300.50 |
| 2 | **Site Preparation** | | | | |
| 2.1 | **Road Improvements** | | | | |
| | *Main Access Road* | 1.00 | MI | $ 825.00 | $ 825.00 |
| | *Construction Access Roads* | 1.00 | MI | $ 825.00 | $ 825.00 |
| | | | | | **$ 1,650.00** |
| 3 | **Reclamation** | | | | |
| 3.1 | **Borrow Area** | | | | |
| | *Strip, Stockpile and Replace Borrow Area Topsoil* | 2,400 | CY | $ 5.50 | $ 13,200.00 |
| | *Excavate/Stockpile Borraw Area Cover Soil* | 18,200 | CY | $ 5.50 | $ 100,100.00 |
| | | | | | **$ 113,300.00** |
| 3.2 | **Tailings Removal** | | | | |
| | *Excavate, Haul, and Place Tailings in Repository* | 42,000 | CY | $ 8.80 | $ 369,600.00 |
| | *Haul, and Place Amended Cover Soil Over Excavated Area (1-foot)* | 8,500 | CY | $ 8.80 | $ 74,800.00 |
| | *Haul, and Place Road Mix on Parking Lots (1-foot)* | 1,000 | CY | $ 15.40 | $ 15,400.00 |
| | | | | | **$ 459,800.00** |
| 3.3 | **Repository** | | | | |
| | **Leachate Collection/Removal System** | | | | |
| | *Grade and Compact Subgrade* | 15000 | SY | $ 1.65 | $ 24,750.00 |
| | *Geotextile Filter Fabric* | 15000 | SY | $ 3.85 | $ 57,750.00 |
| | *Geosynthetic Clay Liner* | 15000 | SY | $ 5.50 | $ 82,500.00 |
| | *Geonet Drainage Layer* | 15000 | SY | $ 5.50 | $ 82,500.00 |
| | *Leachate Collection/Removal System* | 1 | LS | $ 22,000.00 | $ 22,000.00 |
| | | | | | **$ 269,500.00** |
| | **Repository Cap** | | | | |
| | *Geotextile Filter Fabric* | 15,000 | SY | $ 3.85 | $ 57,750.00 |
| | *Geosynthetic Clay Liner* | 15,000 | SY | $ 5.50 | $ 82,500.00 |
| | *Geonet Drainage Layer* | 15,000 | SY | $ 5.50 | $ 82,500.00 |
| | *Haul, and Place Amended Cover Soil Cap (2-foot)* | 9,700 | CY | $ 8.80 | $ 85,360.00 |
| | | | | | **$ 308,110.00** |
| 3.3 | **Revegetation** | | | | |
| | *Organic Amendment* | 2,000 | Dry Ton | $ 220.00 | $ 440,000.00 |
| | *Fertilize and Seed* | 11 | AC | $ 1,100.00 | $ 12,100.00 |
| | *Mulch* | 11 | AC | $ 1,100.00 | $ 12,100.00 |
| | | | | | **$ 464,200.00** |
| 4 | **Drainage Control** | | | | |
| 4.1 | **Upper Ditch - Type 1 Riprap Lined** | | | | |
| | *Construct Upper Ditch* | 700 | LF | $ 6.60 | $ 4,620.00 |
| | *8" Angular Riprap* | 300 | CY | $ 38.50 | $ 11,550.00 |
| | | | | | **$ 16,170.00** |
| 4.2 | **Middle Ditch - Type 2 Riprap Lined** | | | | |
| | *Construct Middle Ditch* | 300 | LF | $ 6.60 | $ 1,980.00 |
| | *8" Angular Riprap* | 100 | CY | $ 38.50 | $ 3,850.00 |
| | | | | | **$ 5,830.00** |
| 4.3 | **Lower Ditch - Type 2 Riprap Lined** | | | | |
| | *Construct Lower Ditch* | 400 | LF | $ 6.60 | $ 2,640.00 |
| | *8" Angular Riprap* | 150 | CY | $ 38.50 | $ 5,775.00 |
| | *24" CMP Culvert* | 50 | LF | $ 66.00 | $ 3,300.00 |
| | | | | | **$ 11,715.00** |

## Table F-8 (cont.)

## Alternative 5c - Consolidation in Off-Site Modified RCRA Repository

| Item | Description | Quantity | Unit | Unit Price | Total Price |
|---|---|---|---|---|---|
| 5 | **Utility Relocation & Replacement** | | | | |
| 5.1 | **Slope Lighting** | | | | |
| | *Remove & Reset Light Pole* | *3* | *EA* | *$ 1,210.00* | *$ 3,630.00* |
| | *Replace Underground Cable* | *1200* | *LF* | *$ 15.40* | *$ 18,480.00* |
| | | | | | **$ 22,110.00** |
| 5.2 | **Tower Communications Line** | | | | |
| | *Replace Underground Cable* | *1100* | *LF* | *$ 11.00* | *$ 12,100.00* |
| | | | | | **$ 12,100.00** |
| 5.3 | **Telephone Line** | | | | |
| | *Install Pedestal at Splice* | *1* | *EA* | *$ 770.00* | *$ 770.00* |
| | *Replace Underground Cable* | *600* | *LF* | *$ 11.00* | *$ 6,600.00* |
| | | | | | **$ 7,370.00** |
| 5.4 | **Snow Making System** | | | | |
| | *Replace Water Line* | *1000* | *LF* | *$ 24.20* | *$ 24,200.00* |
| | *Replace Underground Cable* | *400* | *LF* | *$ 15.40* | *$ 6,160.00* |
| | | | | | **$ 30,360.00** |
| 5.5 | **2400V Power Feed to Shock Shack** | | | | |
| | *Install Junction Box at Splice* | *1* | *EA* | *$ 1,540.00* | *$ 1,540.00* |
| | *Replace Underground Cable* | *500* | *LF* | *$ 38.50* | *$ 19,250.00* |
| | | | | | **$ 20,790.00** |
| | SUBTOTAL: | | | | $ 1,917,305.50 |
| | Contingency (15%): | | | | $ 287,595.83 |
| | TOTAL CAPITAL COSTS: | | | | **$ 2,204,901.33** |

## Table F-9

## Alternative 6 - Consolidation in Off-Site DEQ Repository at Bald Butte

| Item | Description | Quantity | Unit | Unit Price | Total Price |
|---|---|---|---|---|---|
| 1 | **Administration** | | | | |
| 1.1 | **Mobilization, Bonding, Insurance (10%)** | **1** | **LS** | **$ 75,949.50** | **$ 75,949.50** |
| 2 | **Site Preparation** | | | | |
| 2.1 | **Road Improvements** | | | | |
| | *Main Access Road* | *1* | *MI* | *$ 825.00* | *$ 825.00* |
| | *Construction Access Roads* | *1* | *MI* | *$ 825.00* | *$ 825.00* |
| | | | | | **$ 1,650.00** |
| 3 | **Reclamation** | | | | |
| 3.1 | **Tailings Removal** | | | | |
| | *Excavate, Haul, and Place Tailings in Repository* | *42,000* | *CY* | *$ 8.80* | *$ 369,600.00* |
| | *Haul, and Place Amended Cover Soil Over Excavated Area (1-foot)* | *8,500* | *CY* | *$ 8.80* | *$ 74,800.00* |
| | *Haul, and Place Road Mix on Parking Lots (1-foot)* | *1,000* | *CY* | *$ 15.40* | *$ 15,400.00* |
| | | | | | **$ 459,800.00** |
| 3.2 | **Revegetation** | | | | |
| | *Organic Amendment* | *720* | *Dry Ton* | *$ 220.00* | *$ 158,400.00* |
| | *Fertilize and Seed* | *6* | *AC* | *$ 1,100.00* | *$ 6,600.00* |
| | *Mulch* | *6* | *AC* | *$ 1,100.00* | *$ 6,600.00* |
| | | | | | **$ 171,600.00** |
| 4 | **Drainage Control** | | | | |
| 4.1 | **Upper Ditch - Type 1 Riprap Lined** | | | | |
| | *Construct Upper Ditch* | *700* | *LF* | *$ 6.60* | *$ 4,620.00* |
| | *8" Angular Riprap* | *300* | *CY* | *$ 38.50* | *$ 11,550.00* |
| | | | | | **$ 16,170.00** |
| 4.2 | **Middle Ditch - Type 2 Riprap Lined** | | | | |
| | *Construct Middle Ditch* | *300* | *LF* | *$ 6.60* | *$ 1,980.00* |
| | *8" Angular Riprap* | *100* | *CY* | *$ 38.50* | *$ 3,850.00* |
| | | | | | **$ 5,830.00** |
| 4.3 | **Lower Ditch - Type 2 Riprap Lined** | | | | |
| | *Construct Lower Ditch* | *400* | *LF* | *$ 6.60* | *$ 2,640.00* |
| | *8" Angular Riprap* | *150* | *CY* | *$ 38.50* | *$ 5,775.00* |
| | *24" CMP Culvert* | *50* | *LF* | *$ 66.00* | *$ 3,300.00* |
| | | | | | **$ 11,715.00** |

## Table F-9

## Alternative 6 - Consolidation in Off-Site DEQ Repository at Bald Butte

| Item | Description | Quantity | Unit | Unit Price | Total Price |
|---|---|---|---|---|---|
| 5 | **Utility Relocation & Replacement** | | | | |
| 5.1 | **Slope Lighting** | | | | |
| | *Remove & Reset Light Pole* | *3* | *EA* | *$ 1,210.00* | *$ 3,630.00* |
| | *Replace Underground Cable* | *1200* | *LF* | *$ 15.40* | *$ 18,480.00* |
| | | | | | **$ 22,110.00** |
| 5.2 | **Tower Communications Line** | | | | |
| | *Replace Underground Cable* | *1100* | *LF* | *$ 11.00* | *$ 12,100.00* |
| | | | | | **$ 12,100.00** |
| 5.3 | **Telephone Line** | | | | |
| | *Install Pedestal at Splice* | *1* | *EA* | *$ 770.00* | *$ 770.00* |
| | *Replace Underground Cable* | *600* | *LF* | *$ 11.00* | *$ 6,600.00* |
| | | | | | **$ 7,370.00** |
| 5.4 | **Snow Making System** | | | | |
| | *Replace Water Line* | *1000* | *LF* | *$ 24.20* | *$ 24,200.00* |
| | *Replace Underground Cable* | *400* | *LF* | *$ 15.40* | *$ 6,160.00* |
| | | | | | **$ 30,360.00** |
| 5.5 | **2400V Power Feed to Shock Shack** | | | | |
| | *Install Junction Box at Splice* | *1* | *EA* | *$ 1,540.00* | *$ 1,540.00* |
| | *Replace Underground Cable* | *500* | *LF* | *$ 38.50* | *$ 19,250.00* |
| | | | | | **$ 20,790.00** |
| | SUBTOTAL: | | | | $ 835,444.50 |
| | Contingency (15%): | | | | $ 125,316.68 |
| | **TOTAL CAPITAL COSTS:** | | | | **$ 960,761.18** |