FINAL

Phase II - Reclamation Investigation Report
Lilly/Orphan Boy Mine
Powell County, Montana

Prepared for:

Montana Department of Environmental Quality

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Definitions of Mining Terms as Used in this Report

Adit – a horizontal, or nearly horizontal, passage from the surface by which a mine is entered and dewatered.

Decline – a downward sloping underground opening for machine access from level to level or from the surface.

Drift – a horizontal, or nearly horizontal, passage driven along a vein.

Raveling – loosening of rock from the roof and walls.

Seep – a small spring, pool, or wetness originating from the walls or ceiling of mine workings.

Spalling – a chip, fragment, or flake from a piece of stone or ore.

Shaft – a vertical or inclined opening that starts on the surface and goes into the mine; the primary access to the various levels in the mine.

Stope – an underground excavation formed by the extraction of ore.

Stull – round timber used to support the sides, roof, or back working of an underground mine.

Vein – a mineral filling of a fault or other fracture, in tabular or sheet-like form, often with associated replacement of the host rock.

Winze – a vertical or near vertical opening sunk from a working level to connect with a lower level or for exploration below a level.

Acronyms and Abbreviations

ARAR	Applicable or Relevant and Appropriate Requirement
AMD	acid mine drainage
ATV	all terrain vehicle
bgs	below ground surface
COC	contaminant of concern
DEQ	Montana Department of Environmental Quality
DO	dissolved oxygen
DOE	U.S. Department of Energy
DQO	Data Quality Objective
DTW	depth to water
EEE/CA	Expanded Engineering Evaluation and Cost Analysis
EPA	U.S. Environmental Protection Agency
FHC	Frontier Historical Consultants
GIS	geographic information system
gpm	gallon per minute
H&H	H&H Enterprises
HASP	Health and Safety Plan
HDPE	high-density polyethylene
LEL	lower explosive limit
LOB	Lilly/Orphan Boy
µm	micrometer
µmhos/cm	micro mhos per centimeter
MSE	MSE Technology Applications
MWCB	Mine Waste Cleanup Bureau
NaOH	Sodium Hydroxide
NRHP	National Register of Historic Places
ORP	Oxygen reduction potential
psi	pounds per square inch
PVC	polyvinylchloride
QAPP	Quality Assurance Project Plan
QA	quality assurance

QC	quality control
RI	Reclamation Investigation
RWP	Reclamation Work Plan
SAP	Sampling and Analysis Plan
SHPO	Montana State Historic Preservation Office
TerraGraphics	TerraGraphics Environmental Engineering, Inc.
Tetra Tech	Tetra Tech EM, Inc.
USGS	U.S. Geological Survey

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Section 1.0 Introduction

TerraGraphics Environmental Engineering, Inc., (TerraGraphics) received Task Orders No. 12, 18, and 27 from the Montana Department of Environmental Quality, Mine Waste Cleanup Bureau (DEQ/MWCB), under DEQ Contract No. 407041, for activities at the Lilly/Orphan Boy Mine (PA #39-006), located in Powell County, Montana.

Under Task Order 12, TerraGraphics prepared a memorandum, dated February 9, 2010 (TerraGraphics, 2010a), which reviewed the Lilly/Orphan Boy Reclamation Investigation Report (2009 RI) by Tetra Tech EM, Inc., dated March 2009 (Tetra Tech, 2009). The TerraGraphics memorandum identified data gaps in the 2009 RI and recommended additional investigation activities necessary to support the preparation of the Expanded Engineering Evaluation and Cost Analysis (EEE/CA). Also under Task Order 12, TerraGraphics prepared a Phase II Reclamation Work Plan (Phase II RWP), dated September 24, 2010 (TerraGraphics, 2010b), to identify and describe the additional field investigation needed for a Phase II RI and the requirements for preparation of an EEE/CA. The Phase II RWP included a Hydrogeology Investigation Plan, a Mine Investigation Plan, a Sampling and Analysis Plan/Quality Assurance Project Plan (SAP/QAPP), and a Health and Safety Plan (HASP).

Under Task Order 18, TerraGraphics removed one of the suspended platforms from the Lilly shaft and installed five new monitoring wells at the site.

Under Task Order 27, TerraGraphics, with the support of specialized subcontractors, conducted the Phase II RI field work addressed in the Phase II RWP, interpreted the results of the investigations, investigated potential borrow and repository areas, derived potential reclamation actions for the site, and completed this Phase II RI Report.

1.1 Report Organization

This Phase II RI Report has been prepared to document the data collected and summarize the results of hydrogeology and mine investigations performed by TerraGraphics at the site during fall 2010. The contents of each section are described below.

Section 1.0 Introduction – This section presents the summary and purpose of the investigation, project personnel, project schedule, and site background.

Section 2.0 Pre-investigation Activities – This section describes the work items completed in preparation for the field investigation and the purpose of each work item.

Section 3.0 Field Investigation – This section describes the work items completed during the field investigations and the purpose of each work item.

Section 4.0 Sampling – This section describes all the sampling that occurred during this investigation.

Section 5.0 Results and Discussion – This section summarizes and interprets the results obtained during the pre-investigation, the field investigation, and sampling.

Section 6.0 Reclamation Action Alternatives – This section lists potential reclamation action alternatives that may be addressed in the EEE/CA.

Section 6.0 Conclusions and Recommendations – This section presents conclusions drawn from the investigations and recommendations for reclaiming/managing the site.

Supporting field documentation such as field notes, calculations, original maps, and photo logs are included in the Appendices.

1.2 Summary and Purpose of the Phase II Reclamation Investigation

The purpose of the Phase II RI was to complete the necessary field work and data collection such that, during an EEE/CA process, it can be determined whether acid mine drainage (AMD) discharging from the Lilly adit into Telegraph Creek can be mitigated and/or stopped. The tasks performed included the following:

- Characterized the spatial extent of tailings and waste rock material;
- Characterized surface water and mine water quality and flows; and
- Characterized the mine workings to support an evaluation of discharge source control alternatives by performing the following:
    - Verified the validity of a 1950 map of the mine workings by Rankin and supplied by Dave Newman (Rankin Mine Map);
    - Located and described obstructions in the mine workings;
    - Evaluated mine working overburden thickness;
    - Evaluated the geology and rock stability in the tunnel and shaft;
    - Located infiltration zones (seeps) and calculated the recharge rate of groundwater entering the mine workings; and
    - Estimated the effects of reclamation on the groundwater system.

Other activities addressed in this Phase II RI Report include the following:

- Performed a geographic information system (GIS) analysis and property inventory to identify potential borrow sources for cover and topsoil;
- Performed a GIS analysis and property inventory to identify potential repository sites; and
- Briefly described potential reclamation action alternatives for the site.

1.3 Project Personnel

The DEQ/MWCB, TerraGraphics, and Trihydro personnel assigned to complete the work under Task Order No. 27 are listed in Table 1.

Table 1. Project Team

Agency/Firm	Personnel	Project Title	Contact Information	Project Role
Montana Department of Environmental Quality/ Mine Waste Cleanup Bureau	John Koerth	Section Supervisor	406-841-5026	Oversight
	Pebbles Clark	Lilly/Orphan Boy Mine Site Project Manager	406-841-5028	DEQ Project Manager
TerraGraphics Environmental Engineering	Susan Firor	Regional Manager	208-882-7858	Project Manager during Final Reporting
	Tom Bourque	Project Manager	-	Principal in Charge during Field Investigation
	Jeremy Mickey	Hydrogeologist	406-846-9566	Lead Hydrogeologist
Trihydro Corporation	Tom Smith	Project Engineer	406-558-4180	Project Manager, Lead Engineer, Field Manager
	Jamie Mongoven	Project Engineer	406-558-4180	Technical Support

Subcontractors were selected in general accordance with DEQ/MWCB procurement procedures. Interested subcontractors were sent a scope of work and cost estimates were requested. The subcontractor that submitted the lowest cost estimate was selected to perform the work. The cost estimates submitted by subcontractors are included in Appendices C through H of the Phase II RWP (TerraGraphics, 2010b).

The following subcontractors were selected and hired to perform specific tasks:

1. Rain for Rent to supply the water treatment and land application systems;
2. Tom's Crane Service to load and unload the water treatment system and install the pump and piping into and out of the shaft;
3. Blue Range Engineering to conduct mine inspection and shaft rehabilitation to provide access to the mine workings; and
4. Brian Moore to support operation of the water treatment and land application systems.

Pace Analytical was the laboratory selected for analysis of soil, surface water, groundwater, mine water, and seep samples.

DEQ also contracted additional services for this effort:

1. Boland Drilling to drill five borings, install monitoring wells, and provide and operate a backhoe for piezometer installation; and
2. H&H Enterprises for crane services during platform removal.

1.4 Project Schedule

The project schedule is presented in Table 2. The effective dates of Task Order No. 27 are September 21, 2010 through October 31, 2011.

Table 2. Project Schedule

Task Performed and Document Submittal	Completion Dates
Draft Reclamation Work Plan	August 20, 2010
Final Reclamation Work Plan	September 24, 2010
Phase II Reclamation Investigation Field Work	September-November 2010
Draft Phase II Reclamation Investigation Report	February 22, 2011
Draft Final Phase II Reclamation Investigation Report	September 2011
Final Phase II Reclamation Investigation Report	October 2011

Field work elements undertaken for this project are listed chronologically by start date in Table 3. Descriptions provided in this report are organized by function and location. Field notes can be found in Appendix A.

Table 3. Field Work Elements

Activity	Start Date	Finish Date	Performed By	Notes	Subcontract Cost
Site survey	late 2009	late 2009	DJ&A	Not part of current project	
Concrete mix designs for waste rock samples	10/1/2009	12/22/2009	Pioneer Technical Services	Not part of current project	
Test pit excavation	10/16/2009	10/16/2009	Hard Rock Road Building & Utilities	Not part of current project	
Platform removal (east removed & west raised)	9/14/2010	9/15/2010	H&H Enterprises	DEQ Contract and TerraGraphics Task Order 18	
Monitoring well drilling and installation	9/23/2010	9/25/2010	Boland Drilling	DEQ Contract and TerraGraphics Task Order 18	
Install piezometers	9/24/2010	9/25/2010	TerraGraphics		
Set up equipment and land application	9/28/2010	10/1/2010	Rain for Rent	Subcontract to TerraGraphics	$60,529
Complete well installations	9/28/2010	9/28/2010	Boland Drilling	DEQ Contract and TerraGraphics Task Order 18	
Unload pumping equipment	9/29/2010	9/29/2010	Tom's Crane Service	Subcontract to TerraGraphics	$3,375
Well development	9/29/2010	9/29/2010	TerraGraphics		
Surface water sampling - Baseline	9/29/2010	9/29/2010	TerraGraphics		
Groundwater sampling	9/29/2010	9/29/2010	TerraGraphics		

Table 3. Field Work Elements

Activity	Start Date	Finish Date	Performed By	Notes	Subcontract Cost
Install/remove well transducers	9/29/2010	11/22/2010	TerraGraphics		
Set pump and pipes	9/30/2010	9/30/2010	Tom's Crane Service		
Learn system operation from Rain for Rent	9/30/2010	10/3/2010	Brian Moore	Subcontract to TerraGraphics	$12,239
Calibrate system and setting parameters	10/1/2010	10/3/2010	Rain for Rent		
Adjust pump levels	10/1/2010	10/22/2010	Brian Moore		
Replace filters	10/1/2010	10/22/2010	Brian Moore		
Monitor land application	10/1/2010	10/22/2010	Brian Moore		
Surface water flow measurement	10/1/2010	10/1/2010	TerraGraphics		
Surface water sampling - Extended	10/2/2010	10/22/2010	TerraGraphics		
pH adjustment	10/3/2010	10/22/2010	Rain for Rent		
Water quality monitoring	10/3/2010	10/22/2010	Rain for Rent		
Land application	10/3/2010	10/22/2010	Rain for Rent		
Soil sampling	10/4/2010	10/4/2010	TerraGraphics		
Determine that water is no longer pooling outside collapsed Lilly adit	10/4/2010	10/4/2010	TerraGraphics		
Switch to a larger pump in shaft	10/9/2010	10/9/2010	Rain for Rent		
Switch pumps and pipe in shaft	10/9/2010	10/9/2010	Tom's Crane Service		
Well survey	10/10/2010	10/10/2010	TerraGraphics		
Initial inspection and safety assessment	10/12/2010	10/14/2010	Blue Range Engineering	Subcontract to TerraGraphics	$16,287
Install ladders	10/12/2010	10/14/2010	Blue Range Engineering		
Air quality monitoring and ventilation	10/12/2010	11/2/2010	Blue Range Engineering		
Replace faulty transducer in MW-1	10/12/2010	10/12/2010	TerraGraphics		
Lower pump in shaft	10/13/2010	10/13/2010	Tom's Crane Service		
Mine investigation	10/14/2010	10/21/2010	TerraGraphics		
Seep sampling	10/15/2010	10/21/2010	TerraGraphics		
Demobilize from site	11/1/2010	11/2/2010	Rain for Rent		
Demobilize pumping equipment	11/1/2010	11/2/2010	Tom's Crane Service		
Install/remove shaft transducer	11/2/2010	12/2/2010	TerraGraphics		
Surface water sampling - 4th quarter monitoring	12/6/2010	12/6/2010	TerraGraphics		

1.5 Site Background

The existing 2009 RI (Tetra Tech, 2009) and historical data available for the Lilly/Orphan Boy Mine Site were reviewed and are summarized in a Memorandum to DEQ dated February 9, 2010 (TerraGraphics, 2010a). The Phase II RWP provides detailed information regarding the environmental setting and waste characteristics at the Lilly/Orphan Boy Mine Site (TerraGraphics, 2010b). The following sections describe the site's features, history, and previous investigations that have been performed at the site.

1.5.1 Site Description

The Lilly/Orphan Boy Mine Site is an abandoned hard rock mine located within the Elliston Mining District and was a historical producer of lead, zinc, copper, silver, and gold. The site is located approximately 10.5 miles south of Elliston, Montana near the headwaters of Telegraph Creek (Figure 1). The Lilly/Orphan Boy Mine Site is situated at an elevation of approximately 6,800 feet above mean sea level and covers approximately 1½ acres. The site is contaminated from metal mining along Telegraph Creek. Infrastructure at the site includes: a second generation wooden headframe; a steel support frame constructed in 1994; a 250-foot deep, two-compartment shaft; three collapsed adits; and three waste rock piles. The site also contains the remains of hoist machinery, two load outs, and four collapsed buildings (RTI, 2002).

The lower half of the site lies directly in the Telegraph Creek drainage, which flows north to the Little Blackfoot River. The surrounding area consists of relatively steep mountain slopes, moderately sloped hillsides, and mountainous terrain. The climate of the Lilly/Orphan Boy Mine Site area is a modified continental climate similar to that of the Helena Valley. Climate information was obtained from the Western Regional Climate Center located at the Helena, Montana airport. Average monthly temperatures range from a high of 85°F and a low of 53°F in July to a high of 30°F and a low of 10°F in January. Average annual precipitation is 12 inches. Average monthly precipitation exceeds 3 inches during May and June, which are the wettest months of the year. Precipitation is mostly in the form of snow in the winter months, snow and rain in the spring and fall, and rain in the summer.

1.5.2 Site History

The Lilly and adjacent Orphan Boy lodes were likely discovered in the early summer of 1890 by a group of four men with the Grand Republic Mining Company. They presumably had the intent to develop the Lilly and Orphan Boy locations along with a few other lode locations on what is now known as O'Keefe Mountain. In 1891, the Lilly was noted in a report by the Montana Inspector of Mines as a mine "held in high estimation" whose ores were treated at a local arrastra during the year (Frontier Historical Consultants [FHC], 2002).

In late 1893, the Lilly/Orphan Boy and other mines owned by the Grand Republic Mining Company were acquired by Empire State Mining Company of New York. Development work at the Lilly/Orphan Boy mines presumably started soon thereafter, but it wasn't until nearly three years later that the Empire State Mining Company requested and received permission from Montana officials to conduct business in the state (FHC, 2002).

In November 1899, the courts ordered the Lilly/Orphan Boy Mine Site property to be sold at public auction to satisfy a mortgage debt held by the Empire State Mining Company. The president of the company, T. H. Teall, obtained ownership of the Lilly/Orphan Boy Mine Site and received a sheriff's deed in December 1900. Ownership of the mine remained under his name until 1927, when the taxes on the claims became delinquent. Powell County received a tax deed to the property early the following year (FHC, 2002).

A rise in the price of metals soon after the onset of the Great Depression rejuvenated active interest in the Lilly/Orphan Boy Mine Site. A new lease was issued by Powell County to a Butte miner named Ed Linquist around 1934. In 1943, Powell County entered into a new lease agreement on the Lilly/Orphan Boy Mine Site with Dave and Leo Newman, who had been mining at other properties in the Telegraph Creek area for the previous several years. Reports indicate that during the period from 1934 to 1951, the mine produced a total of 1,228 tons of ore that yielded 333 ounces of gold, 12,520 ounces of silver, 2,753 pounds of copper, 85,377 pounds of lead, and 39,899 pounds of zinc (FHC, 2002). The last production of ore from the Lilly/Orphan Boy Mine Site was a 50-ton shipment of ore that occurred in either 1954 or 1955 (Newman, 2008).

1.5.3 Previous Investigations

The hazardous site features were inventoried by Pioneer Technical Services in 1993 and the site was assigned identification PA #39-006 as part of the statewide hazardous materials inventory (DEQ, 1993). In August 1994, MSE Technology Applications (MSE) began an 11-year field demonstration for the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE) at the Lilly/Orphan Boy Mine Site to treat and control the AMD of metals-contaminated water using sulfate-reducing bacteria. The study was concluded in July 2005. As part of the technical study, five monitoring wells were installed on the Lilly/Orphan Boy Mine Site. Two angled wells were constructed near the headframe and main shaft, two injection wells were drilled vertically into the Lilly drift, and one monitoring well was installed down-gradient of the injection wells to monitor treated water prior to its discharge at the adit. Water filling the mine workings (lower shaft and Lilly adit) was presumed to be groundwater by MSE personnel during their investigation (MSE, 2008). MSE also constructed two steel platforms and suspended them from a steel support structure that was erected and anchored around the shaft collar. The platforms were reportedly suspended 125 feet below the shaft collar in each compartment of the shaft. MSE reportedly dumped 60 cubic yards of substrate material composed of manure, straw, and wood chips down the shaft and placed 16 cubic yards of substrate in the Lilly tunnel (drift) through the injection wells. This substrate was the source of the sulfate-reducing bacteria. During each spring runoff, MSE observed that the pH decreased in their portal sample but remained near neutral in the tunnel. "The spring runoff events influenced the water quality more noticeably at the portal than in the tunnel due to oxygenated surface water runoff penetrating through the ground above the portal and then solubilizing historical metal precipitates. Also, spring water quality was lower at the portal due to a greater amount of AMD infiltration from fractures within the tunnel walls" (MSE, 2008).

A RI Report was prepared by Tetra Tech in 2009. The 2009 RI examined the extent of waste on the site's surface, estimated the risks posed by the waste to human health and environment based on a recreational use scenario, and presented data for potential reclamation of the waste rock

piles (Tetra Tech, 2009). The 2009 RI did not address the underground mine workings, the groundwater system, or stopping the AMD from the collapsed Lilly adit.

TerraGraphics prepared a Phase II RWP (TerraGraphics, 2010b) that outlined plans for a Hydrogeology Investigation and a Mine Investigation. The Phase II RWP identified the site characterization work items necessary to support completion of an EEE/CA. The Phase II RWP also included a SAP/QAPP for all suggested sampling, a HASP, and cost estimates from subcontractors to perform portions of the proposed field work.

A historic inventory and assessment was performed by FHC in 2002 (FHC, 2002) in which three previous cultural reports were referenced, one in 1990, one in 1995, and another in 2002. The 1990 report did not recommend the site for listing on the National Register of Historic Places (NRHP), as most of the site features were less than 50 years old. However, in 2002 the site was eligible for listing on the NRHP. Sites that are eligible for inclusion in the NRHP are sites that "… possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:

> "A. That are associated with events that have made a significant contribution to the broad patterns of our history; or
>
> "B. That are associated with the lives of persons significant in our past; or
>
> "C. That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
>
> "D. That have yielded, or may be likely to yield, information important in prehistory or history."

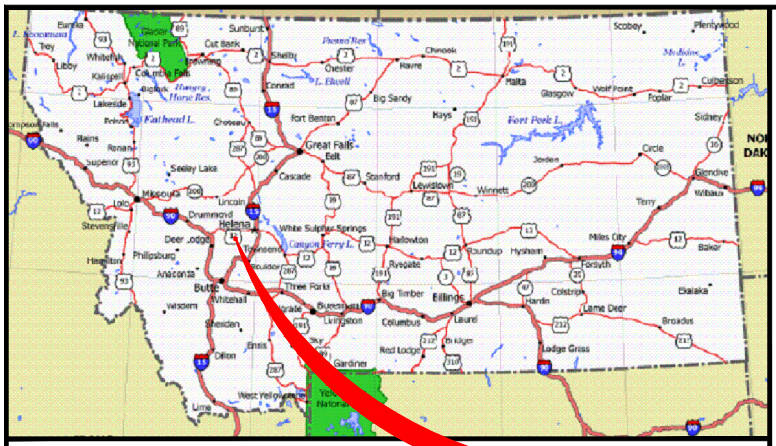
Based on the 2002 assessment, the Lilly/Orphan Boy Mine Site was considered historic and was recommended to be eligible for the NRHP under criteria A and C (FHC, 2002). The Lilly/Orphan Boy Mine produced enough ore to be a major part of the Elliston Mining District and strongly contributes to the local mining history, which satisfies the requirements of criterion A. In addition, sufficient historic features and structures remain at the Lilly/Orphan Boy Mine Site to satisfy the standards set forth under criterion C. DEQ/MWCB has acknowledged the historic significance of the Lilly/Orphan Boy Mine Site and will work with the Montana State Historic Preservation Office (SHPO) to account for historical features should the Lilly/Orphan Boy Mine Site advance to the reclamation stage.

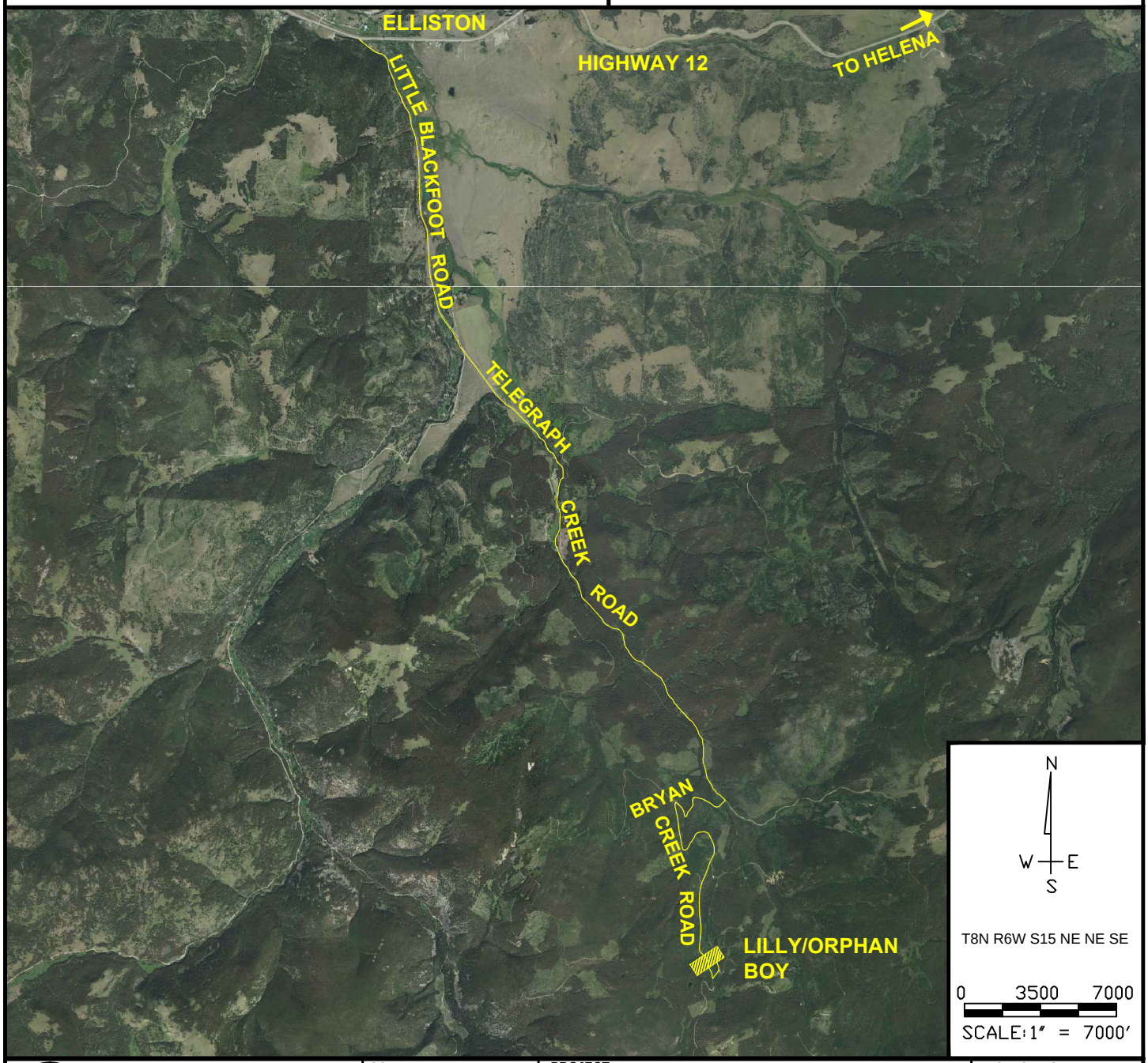
In 1993 Pioneer Technical Services produced a site investigation and hazardous materials inventory report (DEQ, 1993).

In 2002, Renewable Technologies, Inc. submitted an investigation report documenting the past and present land ownership and mine operator history of the site (RTI, 2002). The current owner of the Lilly/Orphan Boy Mine Site is Lindsey Chaquette of Sherwood, OR (Montana Cadastral Mapping, 2010; gis.mt.gov).

In late 2009 DJ&A performed a site-wide topographic survey, and Pioneer Technical Services analyzed site waste rock materials for suitability in concrete mine plugs (Pioneer, 2009). Also in late 2009, test pits were excavated by Hard Rock Road Building and Utilities, Inc. as part of this ongoing investigation.

SITE LOCATION MAP





TerraGraphics Environmental Engineering, Inc.

SCALE: As shown	PROJECT: *LILLY/ORPHAN BOY MINE* *Powell County, Montana*	PROJECT NO: 09210	
DRAWN BY: JM		DATE: 2/17/2011	
PROJECT MANAGER: JM		FIGURE: 1	

Y:\09210 - Lilly-Orphan Boy Mine\E. Deliverables\a. Reports\Ph II RI\Drawings\Figure 1 LOB Site Location Map.dwg

Section 2.0 Pre-investigation Activities

Several activities were required in preparation for the mine investigation. These activities are described in this section and included:

1. Removing MSE platforms from the Lilly shaft;
2. Dewatering the mine; and
3. Inspecting the mine for safety.

2.1 Platform Removal

Two platforms were installed by MSE for a study in 1994 and substrate (manure, straw, and wood chips) was piled on them in an attempt to reduce the acid and metal content of the mine water. The platforms were reportedly installed at the 125-foot level below the collar of the shaft, and then approximately 60 cubic yards of compacted substrate was placed on top of the platforms. The mine workings could not be accessed below the suspended substrate until the platforms were removed.

H&H Enterprises (H&H) arrived at the site on September 14, 2010 to begin removal efforts on the platforms in the shaft using a 60-ton Terex TX560 crane and support vehicle (Figure 2). Before work commenced, H&H and TerraGraphics presented a site orientation and tailgate safety meeting to show the crane crew the mine layout and discuss safety concerns of the site. TerraGraphics personnel were on-site with the three-man H&H crew at all times.

Figure 2. Looking northerly at the 60-ton crane and support truck setup at the shaft.

The crane was set up on the southwestern side of the shaft and within the fence. Four 1-inch diameter cables suspending the platform in the western compartment were connected to the crane and the crane scale showed a weight of 2,500 pounds for the platform and cables. Several

attempts were made to remove the platform but the platform was only raised a few feet. Attempts were made pulling on all four cables (Figure 3), on two cables, and on one cable. The load scale on the crane increased to 22,000 pounds, indicating that the platform was caught on the shaft timbers.

Figure 3. First attempt of crane pulling all four cables of the western platform in the shaft.

The crane crew switched to the eastern platform, this time pulling on only one cable and allowing the platform to rotate. Once the platform was above the water level, light was reflected down the shaft and the crane crew could observe how to proceed with the removal. The eastern platform was placed within the fence southeast of the headframe. The removed platform was constructed of heavy steel and thick rubber seals. The rubber seals were placed to keep the substrate material suspended on the platform (Figure 4). Substrate was not observed on the platform when it was removed from the shaft.

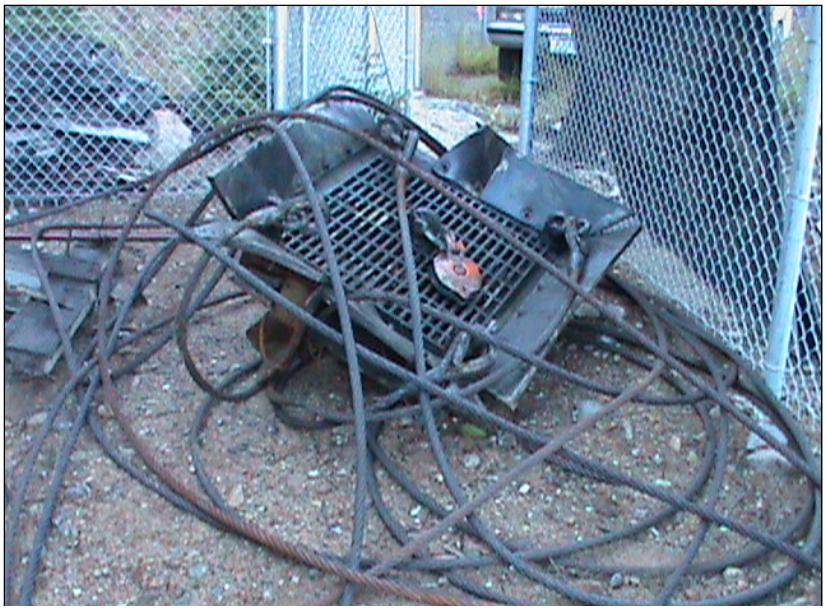


Figure 4. Platform and cables removed from the eastern compartment of the shaft.

Attempts to remove the western platform continued on September 15, 2010. The platform was raised approximately 12 feet in the shaft, from a depth of approximately 98 feet up to 86 feet below the shaft collar, by pulling on one cable before the cable snapped. Efforts continued on other cables, but the platform was wedged in the timbers and the load on the crane scale exceeded approximately 27,000 pounds, indicating potential damage to the crane if pulling continued and another line snapped. The platform was still under water and could not be observed. The remaining three cables were suspended from the steel support structure and the H&H crew demobilized from the site (Figure 5).

Figure 5. Hanging cables from the western compartment after the western platform could not be removed. Looking north.

2.2 Mine Dewatering and Water Handling

At the onset of this investigation, mine water filled the workings to a level of 74.3 feet below the grate at the top of the shaft. The Rain for Rent portable pH adjustment system described in the Phase II RWP along with land application on the Lilly claim site was the preferred alternative for handling and disposal of the mine water (see TerraGraphics, 2010c). The following sections describe the setup of the system on the site, system startup, and operations. Photos of the system setup and operation are provided in Appendix B.

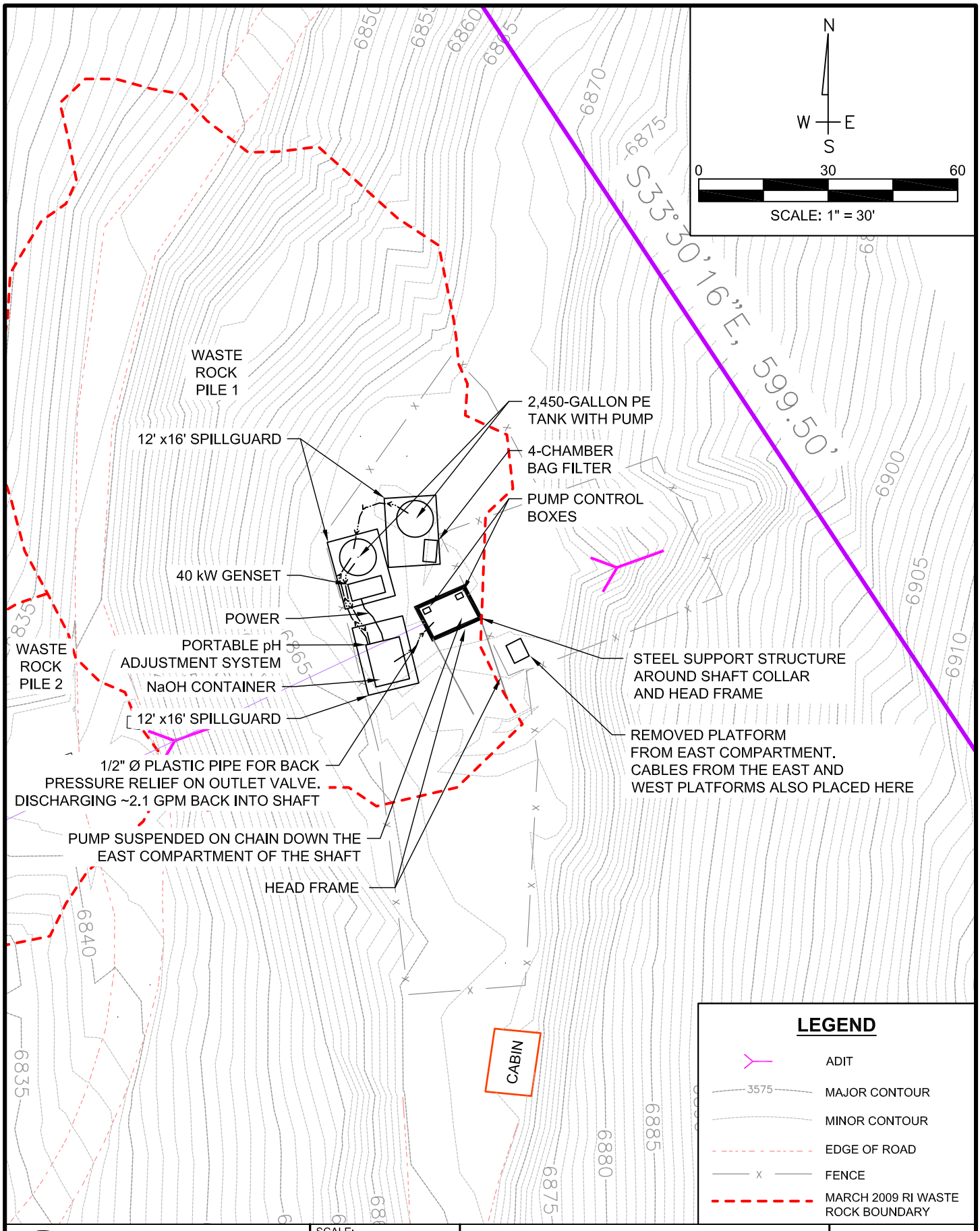
2.2.1 Dewatering and Treatment System Setup

Rain for Rent supplied and installed the pH adjustment system and land application equipment. The system was installed from September 28 to October 1, 2010. The equipment used on the project included the following, listed in the order necessary for transfer of water from the shaft to land application:

- Main dewatering pump, including:
    - One 10-horsepower submersible pump suspended on a chain down the mine shaft with lay flat hose. This pumping equipment was in service from October 1 to October 9, 2010;

  - A high-head pump and aluminum pipe was installed on October 9, 2010 and used until November 2, 2010; and
  - Master power control box.
- Quadruple chamber bag filter system and filter bags.
- Two 2,450-gallon polyethylene tanks, including:
  - One tank with a 4-horsepower pump installed for transferring water,
  - One tank with a 5-horsepower pump installed for transferring water, and
  - Slave power control box.
- One portable pH adjustment system, including:
  - An injection pump to inject sodium hydroxide into the water and adjust pH;
  - A 450-gallon polyethylene additive tank and 325 gallons of 10 percent sodium hydroxide;
  - Two pH and turbidity probes, monitoring, and data logging equipment; and
  - A magnetic flow meter.
- One 40-kilowatt generator.
- Three 12-foot by 16-foot portable containment berms to contain the items above.
- 500 feet of 4-inch diameter high-density polyethylene (HDPE) pipe.
- 1,600 feet of 2-inch diameter polyethylene pipe cut into four 400-foot lengths.
- Forty ¾-inch wobbler sprinklers (10 installed per line by 2-inch brass saddles).

Various other lengths of hoses and pipe, valves, adapters, tees, connectors, rope, power cables, and an air vent were also used. The pH adjustment system was set up within the fenced area on the north and west sides of the shaft and the land application system was set up to the north and west of the shaft as shown in Figure 6 and Figure 7.



TerraGraphics Environmental Engineering, Inc.

SCALE:	1"=30'
DRAWN BY:	C. HEWETT
ENGINEER:	T. SMITH

LILLY/ORPHAN BOY MINE
WATER TREATMENT SYSTEM
LAYOUT AROUND SHAFT

PROJECT NO:	11001-3-3-18
COORDINATE SYSTEM	NAD83, MSP, INT. FT.
DATE:	9/20/2011
FIGURE:	6

N
W E
S
0 80 160
SCALE: 1" = 80'

LOB-SW07
HISTORICAL SEASONAL SPRING IN THIS AREA
DAN NEWMAN ACCESS ROAD
#3 – SET 2 1/2" ALUM. CAP
PROPERTY BOUNDARY
ORPHAN BOY MS 4939
LOB-SW03
7–DJA 1" RPC
WASTE ROCK PILE 1
19–DJA 1" RPC
S33°30'16"E, 599.50'
TELEGRAPH CREEK
BRYAN CREEK RC
LOB-SW06
LOB-MW4
LOB-MW2
18–DJA 1" RPC
S22°04"E, 1500.00'
6–DJA 1" RPC
LOB-SW04
MW-INJECTION 1
MW-INJECTION 2
WASTE ROCK PILE 3 WEST
WASTE ROCK PILE 3 EAST
WASTE ROCK PILE 2
MW-SHAFT
MW-DRIFT
1–DJA 2" ALUM. CAP
LOB-MW1
LOB-MW3
LILLY ADIT
LOB-3 (MSE)
LOB-MW5
BUILDING RUINS
LOB-SW02
LOB-SW01
5–DJA 2" ALUM. CAP
HOLE DUG BY DAVE NEWMAN'S COUSIN TO PIPE WATER TO HIS CLAIM. HOLE IS ~ 3' X 3' X 2' DEEP AND CONTAINS 2" BLACK PE PIPE. ACTS AS A SPRING WHEN ADIT IS DISCHARGING.
#4 – SET 2 1/2" ALUM. CAP
LILLY MS 4938
BUILDING RUINS
ALCESTER MS 4936
S56°23'13"W, 1499.95'
LOB-SW05

LEGEND

ADIT	DITCH
CULVERT	FENCE
EXISTING WELL	MARCH 2009 RI WASTE ROCK BOUNDARY
INSTALLED WELL	
SURFACE WATER SAMPLE LOCATION	2" PE PIPE SPRINKLER LINE
SWAMP	2" PE PIPE W/ 3/4" WOBBLER SPRINKLERS SPACED EVERY 20' (10 SPRINKLERS PER LINE)
3575 MAJOR CONTOUR	
MINOR CONTOUR	
EDGE OF ROAD	4" MAIN SPRINKLER LINE

TerraGraphics Environmental Engineering, Inc.

PROJECT NO.:	11001-3-3-18
SCALE:	1"=80'
DRAWN BY:	C. HEWETT
ENGINEER:	T. SMITH

LILLY/ORPHAN BOY MINE
WATER TREATMENT SYSTEM
SITE LAYOUT OF LAND APPLICATION LINES

COORDINATE SYSTEM:	NAD83, MSP, INT. FT.
DATE:	9/20/2011
FIGURE:	7

Tom's Crane Service was subcontracted to unload the equipment from the delivery truck. Prior to installation of the system, TerraGraphics led a site walk with the Rain for Rent crew to identify the property boundaries marked during the 2009 DJ&A survey. The southwest end of the site, near Telegraph Creek, was observed to be marshy and wet and was determined to be unsuitable for land application. Since the shaft is located near the northeastern boundary of the site, it was determined that the main 4-inch HDPE line could be dragged into place from the shaft area to the northwest, down Waste Rock Pile 1, and to the main access road near and along the northern property boundary. The 2-inch diameter polyethylene pipes were cut into four 400-foot lengths and dragged into place. Three pipes were placed to the south and one to the north.

Placement areas were selected such that the water would not spray over or near the underground workings or within 25 feet of Telegraph Creek. One line was placed in the trees on a benched area north of Waste Rock Pile 1, whereas the other three lines were placed west of the main access road located between Waste Rock Piles 2 and 3. One land application line was placed west of Telegraph Creek to sprinkle water on another benched area. Figure 7 shows the layout of the land application lines. The lines were dragged into place with an all terrain vehicle (ATV). The pieces of pipe were then welded together, as needed, using a portable heat fusion machine and generator. Holes were drilled at the top of the pipe, brass saddles placed over each hole, and the wobbler head sprinklers installed.

Tom's Crane Service unloaded the contents of the second delivery truck onto flatbed trailers for the Rain for Rent pickups to take up to the shaft area for placement. Tom's Crane Service then moved up to the shaft area for final placement of the equipment around the shaft.

The 10 percent sodium hydroxide (NaOH) solution was delivered in a 325-gallon container by freight courier to Elliston, Montana. Tom's Crane Service met the freight courier in Elliston and delivered the container up to the shaft area to be loaded into the additive tank inside the portable pH adjustment system container. The tank was placed on top of the container so that NaOH could be transferred to the additive tank by gravity. The layout of the pH adjustment system is shown in Figure 6.

Brian Moore was hired as a subcontractor to operate the pH adjustment system, adjust the pump levels, replace water filters, manage the land application system, complete the pumping log, provide site security, and fuel equipment as needed. Brain Moore arrived on site shortly before the arrival of the second truckload to help setup and learn the operation of the system from Rain for Rent personnel.

2.2.2 Dewatering and Treatment System Start Up

The system was set up so the flow of water from within the shaft to the land application system was as follows:

1. Water from the shaft was pumped through the main pump into the bag filter system.
2. The filtered water then entered the first 2,450-gallon tank to settle any passed solids.
3. The pump in the first 2,450-gallon tank transferred water to the second 2,450-gallon tank.
4. The pump in the second 2,450-gallon tank transferred water to the portable pH adjustment system where the pH and turbidity were tested with water quality probes and monitored.

   a. If the pH was less than 5, the injection pump injected NaOH into the line and transferred the water back to the second 2,450-gallon tank for mixing.
   b. If the pH was greater than 9, the water was transferred back to the second tank to mix with the incoming water from the first tank.
   c. If the pH was between 5 and 9, the water was released to the 4-inch HDPE main pipe for distribution to the 2-inch land application lines.

5. The treated water flowed through the 4-inch HDPE main pipe to the distribution system where ball valves were used to direct the water to selected 2-inch pipe with wobbler sprinklers.
6. Each 400-foot section of 2-inch poly pipe contained 10 ¾-inch wobbler sprinklers spaced 20 feet apart at the end of each line to apply the water in selected areas within the Lilly claim.
7. The land application lines were alternated on a daily basis, or as needed, by manually opening and closing the ball valves of the selected lines.

Once the system was installed, it was tested and calibrated from October 1 to October 3, 2010. During system start up, the land application lines were flushed and cleared of debris and cuttings from installing the brass saddles and sprinkler heads. The northern land application line (Figure 7) was used during start up to monitor that the water was discharging and the system was operating as specified. The wiring of the pumps was inspected to verify that the pump impellors were spinning in the correct direction. The NaOH injection rate was set on the injection pump. The pH and turbidity probes were also calibrated. Once these items were completed, the overall operation of the system was observed.

On October 2, 2010, the pH adjustment system kept re-circulating and would not release water to the land application lines. Rain for Rent returned to the site on October 3, 2010 and checked the system programming and settings. The outlet valve pressure was adjusted and a back pressure release hose was installed. Brian Moore was also provided with additional training. The back pressure release hose was composed of ½-inch diameter plastic hose discharging at approximately 2 gallons per minute (gpm) back into the west compartment of the shaft, allowing the release valve to operate properly. Once the system started to re-circulate water and adjust the pH to within a range of 5 and 9, the main pump, the pump in the first tank, and the injection pump were stopped to allow the system to equalize. This prevented the water from continuing to load the system and overflow the two tanks. If the injection pump was not stopped, the pH would exceed 9 and water would not discharge to the land application lines.

The water quality monitoring and discharge of water to the land application lines were automated by a programmable logic controller in the pH adjustment system, but the pumps were not automated. Therefore, the system could not be operational on a 24-hour basis. The water levels needed to be closely monitored to effectively operate the system. Manual operation of the system also allowed for the adjustment of the main pump in the shaft as needed.

During the start up and calibration phase, the water level in the shaft was lowered from a baseline depth of 74.3 feet to 78.2 feet as measured from the expanded metal grate cover at the northeast corner of the shaft. All water depth measurements were obtained from this location as the grate cover was kept in place to allow safe operations to occur at and around the shaft. Note that the depth of the mine workings was measured from the shaft collar, and the distance

between the shaft collar and the expanded metal grate was not measured. Therefore, the water depth measurements are offset from the mine workings depths by this unmeasured distance, which is approximately 1 foot.

2.2.3 Dewatering and Treatment System Operation

Once issues identified during system startup were addressed, the system operated well between the specified target pumping and treatment range of 100 to 150 gpm. Approximately 210 gallons of 10 percent NaOH were used to adjust the pH of the mine water. The system was monitored during operation and maintained.

Rain for Rent initially supplied a submersible pump that could handle a head up to approximately 100 feet. The pump was connected to the bag filter system with lay flat hose. Once the water in the mine shaft was pumped down to a depth of approximately 100 feet, a pump and hose that could handle the increased head were needed. On October 9, 2010, the pump was changed out to install a new higher head capacity pump, purchased for this project, along with 4-inch diameter aluminum discharge pipe. The new pump and pipe were used for the remainder of the field investigation and operated well. The only problem was lowering the pump and rigid pipe down the shaft. The pump needed to be lowered frequently, and the changes in dip and direction of the shaft caused the pump to hang up on the shaft timbers as it was lowered. The pump was lowered either with a chain hoist or with the aid of Tom's Crane Service whereby the pump and pipe could be guided down to depth, as needed.

As the top of the water column in the shaft contained floating debris, the filter bags had to be changed each time the water level dropped to the pump level. The bag filter system had pressure gauges on each chamber to monitor pressure differentials or overall pressure increases that developed as the filter bags became full and water flow decreased. When the pressure was observed to increase to 25 pounds per square inch (psi), or have a differential reading between gauges of 25 psi, the filter bags were changed. Four different bag filter sizes were used: 10-micron, 50-micron, 100-micron, and 200-micron. The bags were tested and the 200-micron filter bags worked best as they required less frequent system shut downs for replacement, allowed water production to be maintained, and provided adequate filtration.

As the water level was lowered in the shaft through working levels of the mine, the solids content (also known as muck) increased significantly in the mine water. Several bag filters were used until the water level was lowered below the working level. As the pump was lowered to a depth at or near working levels, the muck content in the mine water was not as noticeable. The muck turned the mine water color to a brownish yellow, the same color as the muck shown in the photos included in Figure 20, Figure 23, and Figure 24 in Section 3.3.4. As the back pressure release line showed muck in the discharge, the line was moved from discharging into the west compartment of the shaft to discharging over the edge of Waste Rock Pile 1 (Figure 6). When the discharge cleared up, the line was moved back to discharge into the west compartment of the shaft.

The land application lines operated well without problem. The biggest challenge was visually checking the land application system, which involved traveling from the treatment system down to the discharge lines to verify that water was not pooling or that runoff was not being created from the ground becoming saturated. Brian Moore used his ATV to efficiently monitor the lower land application lines.

A spring was observed at the intersection of the main access road through the site and the Dan Newman access road that runs to the northeast. This intersection is located approximately 50 feet north of the site and is shown on Figure 7. This spring typically flows during the spring and early summer but was dry at the start of the field investigation. During land application, a possible hydraulic connection between this spring and the ground in the area of the north land application line was detected. The nearest application line was over 80 feet away from the spring. The spring was first observed to begin flowing the week of October 18, 2010, while the north land application line was in use. Soon after the north application line was turned off the spring flows tapered off for about a week, then ceased. The remainder of the mine water was land applied using only the other three lines.

Another spring is located just north of the weir installed by MSE below the collapsed Lilly adit and is shown on Figure 7. This spring is reported by Dave Newman to be the result of a hole excavated by his cousin (Dan Newman) where he installed a 2-inch diameter pipe to bring water to his claim located to the north of the Lilly claim. The hole is approximately 3 feet wide by 3 feet long and appears to be 2 feet deep. This hole acts as a spring when the Lilly adit discharges. No other springs were observed on-site.

2.2.4 Dewatering Log

A copy of the dewatering log that Brian Moore produced is included in Appendix C. Information in the log includes date, time, pumping rate in gpm, total flow in gallons, depth to water in the shaft, and notes of Brian's observations. This log also shows estimated recharge rates estimated by computing the pumping volumes spanning times when similar water surface elevations were observed in the shaft. Notes on the log included filter changes, pumping start and stop times, refueling, and when the pump needed to be lowered in the shaft. Notes were not logged on which land application line was used nor the period of time a line was in service. The notes also did not indicate the pH values shown on the digital screen in the portable pH adjustment system container. The data monitoring and logging equipment within the container was operational; however, the recording of the pH data was later found to not be operational. The lack of recorded pH data was discovered after the equipment was demobilized from the site. Rain for Rent technical support personnel were able to recover turbidity data; however, the dates of recordings appear to be off by several days. Additional field notes with observations of the dewatering and treatment system startup and operation are included in Appendix A.

2.2.5 Mine Water Sampling

Mine water samples were obtained periodically from the bag filter system valves. The valves provided water that was filtered by the bag system as well as a safe and consistent sampling location. Eight samples were collected during the field investigation. The last water sample, which was collected on October 26, 2010, after the end of pumping operations from the shaft, was not filtered.

Measuring the depth to water with the electric tape was difficult due to the change in dip of the shaft as shown in Figure 9. The deepest reading taken while pumping showed a depth of 146.85 feet on October 21, 2010.

2.2.6 Dewatering and Treatment System Shut Down and Demobilization

The use of the dewatering and treatment system concluded on October 22, 2010, as the pump had lost suction. Freezing rain, snow, and temperatures below freezing beginning on October 23, 2010, froze and split the cast iron valve at the bag filter system outlet on October 29, 2010. The wobbler sprinklers were observed to be free spinning even with a layer of snow over several of them.

Rain for Rent and Tom's Crane Service arrived on site on November 1, 2010, to begin decommissioning the system and demobilizing from the site. Demobilization concluded on November 2, 2010. At that time the water level was measured at 110.85 feet and a transducer was installed in the shaft to monitor recovery of the water level in the shaft. However, transducer data from the mine shaft were later found to be vastly different from hand-measured water levels and were not used for analysis.

2.3 Mine Safety Assessment

From October 12 to October 14, 2010, Blue Range Engineering performed the following tasks to ensure the mine was safe to enter:

- Evaluated air quality and provided air ventilation of the workings;
- Provided monitoring and ventilation during all underground activities;
- Assessed the shaft for safe access;
- Constructed and installed ladders;
- Determined depths of accessible workings once dewatered;
- Inspected the Lilly tunnel (drift), the remaining platform in the shaft, and other workings to determine if they were safe to enter; and
- Identified and removed obstructions.

Blue Range Engineering personnel installed a winch and cable, fan, and 60 feet of vent bag for ventilation in the shaft. They also measured the air quality in the shaft using an oxygen, hydrogen sulfide, and lower explosive limit (LEL) meter prior to installing ladders to a depth of approximately 100 feet. Air quality in the mine remained good during the course of investigations. A plastic-coated steel cable ran the entire length of the accessible shaft and was connected at the surface to a horn that investigators in the shaft could use to signal the surface personnel if they wanted to go up, go up rapidly, go down, or stop. A person was always at the surface operating the winch to which the person in the shaft was connected by a harness and a steel cable for additional safety purposes. The ladders in combination with the harness and winch were the primary means of egress from the mine workings. Blue Range Engineering personnel remained available from October 12 to November 2, 2011, to escort investigators into the mine and continue safety assessments as needed.

Section 3.0 Field Investigation

TerraGraphics completed field investigation activities to collect the data necessary to characterize elements of the site in accordance with the Phase II RWP (TerraGraphics, 2010b). Data were collected in support of the Phase II RWP including data specifically delineated in the Hydrogeology Investigation Plan.

The objectives of the Field Investigation were to:

- Determine the hydrogeologic connection of the underground mine workings with the bedrock aquifer;
- Compare groundwater quality in the bedrock aquifer with water in the shaft and mine workings;
- Map the locations of seeps and estimate the flow at these infiltration zones within the mine workings;
- Estimate the impacts of surface water infiltration into the mine workings; and
- Characterize the mine workings to support a detailed evaluation of discharge source control alternatives in an EEE/CA.

The work items listed below are components of the Hydrogeology Investigation that were performed to achieve the objectives of the Phase II RWP:

- Conduct a subsurface investigation of the local aquifer by installing shallow piezometers in the surface soils and monitoring wells into the bedrock to evaluate the existing aquifer characteristics;
- Gather analytical and hydrogeologic data for the evaluation of groundwater quality and flow direction at the site;
- Monitor the groundwater levels with transducers in the new wells and shaft during mine dewatering operations to observe the hydraulic connection between the mine workings and the bedrock aquifer;
- Visually identify and sample water flowing into the workings at different locations to identify the sources and evaluate water quality entering the system;
- Gather physical baseline information about the influence of surface water in an effort to evaluate the contribution of surface water and/or shallow groundwater to the mine workings;
- Gather analytical and physical data to characterize the mine water chemistry in the underground mine workings; and
- Gather physical data to characterize the locations, dimensions, and condition of components of the underground mine workings.

3.1 Field Investigation Methods

This section describes the methods that were used by TerraGraphics during completion of the Phase II RI at the Lilly/Orphan Boy Mine Site in fall 2010. The field activities performed at the Lilly/Orphan Boy Mine Site consisted of the following:

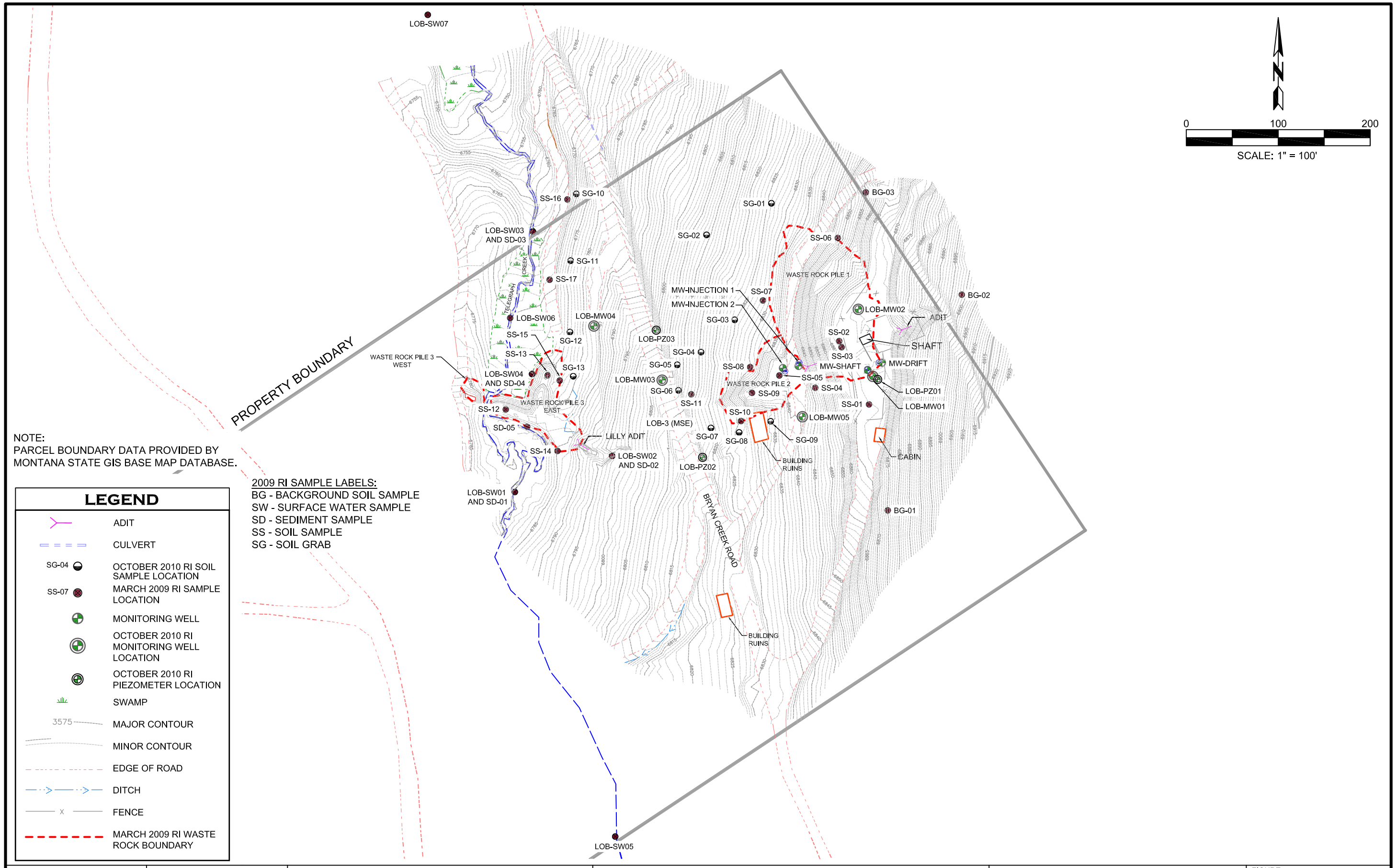
- Drilled five borings at the Lilly/Orphan Boy Mine Site to investigate and describe the soil and bedrock at the drilling locations;
- Installed monitoring wells in the borings to evaluate groundwater gradient and quality;
- Installed pressure transducers in each of the five new monitoring wells to monitor water levels of the local aquifer during dewatering; these results were used to examine the relative extent of groundwater connectivity between the bedrock aquifer and the underground workings;
- Installed a pressure transducer in the shaft following dewatering to monitor recovering water levels in the shaft to evaluate the infiltration rate of groundwater to the workings;
- Installed shallow piezometers within the colluvium/weathered bedrock to further investigate surface water infiltration and the connectivity between infiltrating surface water and the underground workings;
- Completed a tape survey of accessible mine workings to estimate volumes and record dimensions of the workings;
- Inspected the geology in the shaft and accessible areas of the mine; and
- Located and mapped seep areas within the drift and collected seep samples.

3.1.1 Soil Borings

Five pilot borings were drilled and monitoring wells were installed between September 23 and September 25, 2010. The borings/monitoring wells were placed at pre-determined locations throughout the Lilly/Orphan Boy Mine Site along existing roads that could be accessed by the drilling rig and support vehicles. The boring/monitoring well locations are shown on Figure 8.

The borings ranged from 6 to 10 inches in diameter and were advanced using an air hammer drill operated by Boland Drilling. TerraGraphics personnel monitored the drilling and logged the samples and cuttings to describe the lithologies encountered. This information was recorded on soil boring/well logs (Appendix D) and in the field book (Appendix A). Soil and rock samples were collected from the borehole cuttings at 5-foot intervals or at visible lithology changes, then placed and sealed in plastic chip trays.

The monitoring well logs, shown in Appendix D, report and illustrate the drilling equipment and methods used, depths to soil and bedrock unit interfaces, groundwater elevations, sampling information, soil and rock descriptions, and monitoring well construction details.



NOTE:
PARCEL BOUNDARY DATA PROVIDED BY MONTANA STATE GIS BASE MAP DATABASE.

2009 RI SAMPLE LABELS:
BG - BACKGROUND SOIL SAMPLE
SW - SURFACE WATER SAMPLE
SD - SEDIMENT SAMPLE
SS - SOIL SAMPLE
SG - SOIL GRAB

LEGEND

- ADIT
- CULVERT
- SG-04 — OCTOBER 2010 RI SOIL SAMPLE LOCATION
- SS-07 — MARCH 2009 RI SAMPLE LOCATION
- MONITORING WELL
- OCTOBER 2010 RI MONITORING WELL LOCATION
- OCTOBER 2010 RI PIEZOMETER LOCATION
- SWAMP
- 3575 — MAJOR CONTOUR
- MINOR CONTOUR
- EDGE OF ROAD
- DITCH
- FENCE
- MARCH 2009 RI WASTE ROCK BOUNDARY

DRAWN: DJK	PROJECT NO.: 10103	TerraGraphics Environmental Engineering, Inc.	CONSOLIDATED SAMPLING LOCATIONS
PROJECT MANAGER: T. SMITH	SCALE: AS SHOWN		SITE MAP
CHECKED: JWM	APPROVED: JWM		LILLY/ORPHAN BOY ABANDONED MINE SITE
	DATE: 2/4/2011		FIGURE: 8
			DATE: 2/4/2011

3.1.2 Monitoring Well Installation

Five polyvinyl chloride (PVC)-cased monitoring wells were installed in accordance with State of Montana requirements during the field investigation at the Lilly/Orphan Boy Mine Site. TerraGraphics personnel monitored installation of the groundwater monitoring wells and recorded key information on well logs and in the field book (Appendix A). The monitoring well completion details are shown in Table 4.

Four of the monitoring wells were completed as 2-inch diameter wells and one was completed as a 6-inch diameter well (LOB-MW02). The five new monitoring wells were used to determine local aquifer characteristics such as groundwater table elevations, groundwater flow direction, how the local aquifer contributes to the water level in the mine workings, and the effect of the mine dewatering on the groundwater system. Groundwater samples collected from the wells were analyzed to measure chemical and physical parameters for the purposes of: (1) obtaining current baseline information regarding groundwater chemistry, and (2) comparing to corresponding values obtained from the mine water.

Table 4. Monitoring Well and Piezometer Completion Details

Well Identification	Completion Date	Well Diameter (inches)	Well Depth (feet)	Screen Length (feet)	Top of Casing Elevation (feet)
LOB-MW01	9/24/2010	2	122	20	6868.55
LOB-MW02	9/24/2010	6	113	20	6867.50
LOB-MW03	9/25/2010	2	30	20	6804.48
LOB-MW04	9/25/2010	2	25	20	6782.63
LOB-MW05	9/24/2010	2	55	20	6840.14
LOB-PZ01	9/24/2010	1	6	3	6869.69
LOB-PZ02	9/24/2010	1	7	4	6817.91
LOB-PZ03	9/25/2010	1	7.5	4	6800.24

3.1.2.1 Monitoring Well Development and Surveying

To ensure proper hydraulic connectivity with the local aquifer, TerraGraphics personnel developed the five new monitoring wells on September 29, 2010, in accordance with the methods described in Section 2.1.2 of the SAP/QAPP (in TerraGraphics, 2010b). Groundwater pumped to the surface during well development was disposed of onsite and was not allowed to flow directly into Telegraph Creek.

Once the monitoring wells were installed, the PVC casing of each monitoring well was marked on the north side with indelible ink to indicate the groundwater measuring reference point for top of casing. The top of casing elevations were surveyed by TerraGraphics on October 10, 2010, with a total station and referenced to the on-site control points installed by DJ&A during their 2009 site survey.

3.1.2.2 Well Depth and Static Water Level Measurement

Depth to groundwater was measured in the five new monitoring wells following the procedures described in Section 3.2.4 of the Hydrogeology Investigation Plan completed as part of the Phase II RWP (TerraGraphics, 2010b). Water level measurements were recorded in the field book and on the groundwater sampling form to a precision of 0.01 foot (see Appendix A) and are presented in Section 5.3.

3.1.2.3 Transducer Installation

Transducers were programmed and deployed in each of the five new monitoring wells (LOB-MW01 through LOB-MW05) on September 29, 2010, prior to dewatering the mine. The transducers were installed to a depth just above the base of the well screen in each monitoring well to be able to capture and record the full effects of the dewatering on the local bedrock aquifer. The transducers were programmed to record water levels every 10 minutes.

The transducers were checked to verify they were working on October 11, 2010, and the transducer in LOB-MW01 was only recording temperature. A replacement transducer was ordered and the malfunctioning transducer was replaced on October 12, 2010.

Once the mine dewatering and treatment system was dismantled and removed from the site on November 2, 2010, an additional transducer was installed in the shaft to record the post-pumping recovery of the mine water until December 2, 2010. After the transducers were recovered from the five new wells and shaft, the data from each transducer were downloaded, compensated for elevation, and graphed for evaluation (see Appendix E).

3.2 Piezometer Installation

TerraGraphics installed three shallow piezometers within the colluvium/weathered bedrock to further investigate surface water infiltration and the potential connectivity between shallow groundwater and the underground workings. Three test pits were excavated with a backhoe and 1-inch diameter piezometers were installed on September 24 and 25, 2010. The piezometers were placed at pre-determined locations throughout the Lilly/Orphan Boy Mine Site along existing roads that could be accessed by the backhoe. One piezometer (LOB-PZ01) was nested with the monitoring well LOB-MW01 to investigate and monitor the depth of groundwater within the colluvium/weathered bedrock area near the headframe and evaluate the potential surface water interactions occurring around the shaft entrance. The piezometer locations are shown on Figure 8.

The three new piezometers were installed from the bedrock contact to approximately 3 feet above ground surface. TerraGraphics personnel monitored the excavation and logged the test pits to describe the lithology and any groundwater units encountered. This information was recorded in the field book (see Appendix A). PVC screen (20-slot) was placed from the bottom of each piezometer to a depth of approximately 6 inches below ground surface (bgs). The base of each piezometer was capped with a 1-inch PVC slip cap. The piezometer completion details are shown in Table 4.

The PVC casing of each piezometer was marked on the north side with indelible ink to indicate the groundwater measuring reference point for top of casing. The top of casing elevations were

surveyed by TerraGraphics on October 10, 2010, with a total station and referenced to the on-site control points installed by DJ&A during their 2009 site survey.

3.3 Waste Rock Piles

Test pits were excavated in the waste rock piles on site to evaluate the feasibility of utilizing the waste rock as a cemented mine backfill. Backfilling the mine with cemented waste rock is a potential reclamation option. Samples collected from the excavated test pits were submitted to Pioneer Technical Services for sieve analysis and geotechnical design analysis of a cement grout mix for backfill material.

3.4 Subsurface Mine Investigation

Once Blue Range Engineering personnel determined that the mine could be entered safely (see Section 2.3), data were obtained from the dewatered mine workings through a combination of visual observation and physical sample collection. This section describes the procedures used to investigate the physical and hydrogeologic conditions present within the mine workings. The purposes of the subsurface activities were to: (1) collect the data necessary to delineate and map the infiltration zones (seeps) within the portions of the mine that were accessible during dewatering, (2) determine the accuracy of the Rankin Mine Map, and (3) measure mine workings dimensions where possible. A copy of the original 1950 Rankin Mine Map is provided in Appendix F.

The subsurface activities completed for the Hydrogeology Investigation portion of the Phase II RI included:

1. Visually located groundwater infiltration zones within the accessible portions of the workings to construct a map of the seeps and evaluate the groundwater input to the mine workings at these locations; and
2. Collected seep samples to characterize the quality and flow rates of groundwater flowing into the workings.

The results of these subsurface activities were sketched on the Rankin Mine Map and recorded in the field book (Appendix A). Seep samples were collected and analyzed using the same protocols as for groundwater samples (described in Section 4.2) with the exception that field parameters were not measured inside the mine. The seeps are discussed in Section 3.4.3.

3.4.1 General Mine Geology

The Lilly Orphan Boy mine is located in the Elliston mining district in the Boulder Mountains of western Montana. Rocks from Pre-Cambrian to Late Cretaceous age are exposed in the area. The sedimentary section was folded and faulted during the Laramide orogeny. Subsequently, these rocks were overlain by thousands of feet of lava deposited from late Cretaceous to Tertiary time.

"The Boulder batholith was intruded into the sediments and late Cretaceous lavas during the stages or shortly after the Laramide orogeny, probably in the Paleocene time. This igneous derangement has been more definitely described as a three phase tectonic disturbance which

started with an Upper Cretaceous Andesite series followed by a Paleocene granitic intrusion and ended with the extrusion of an Eocene rhyolite series." (Aikin, 1950).

The Lilly/Orphan Boy mine exploited a mineralized vein within a massive quartz monzonite. The mineralized vein is generally uniform and well defined with a strike of north 40° east (N40^{o}E) and dips 80° north. Quartz monzonite has a similar composition to granite, but contains less quartz. The massive quartz monzonite deposit is related to the Boulder batholith. Aikin postulated that the Boulder batholith consolidated at depth and was fractured along the outer periphery. Fractures and fissures along the margins of the batholiths served as conduits for the deep-seated ascending silica-rich igneous rocks such as feldspars and quartz, and later mineral-bearing solutions. Evidence of these silica-rich rocks that formed the vein in the quartz monzonite was observed at several locations in the mine in the form of thick tourmalitic-quartz bodies. The tourmalitic-quartz typically occurs either in the foot- or hanging-wall of a fault or fracture and is associated with the mineralized portions of the vein containing pyrite and gold-bearing arsenopyrite. Within the vein the tourmaline and quartz are black. Outside the vein, the quartz is milky or white. Aikin characterized the vein of the Lilly mine as a "tourmalitic, lead-silver, fissure vein of the granitic phase." Low grade gold and copper were also reported to be encountered. Aikin reported "The mineralized zone is continuous" and the "pay streak generally appears in two stringers which become narrow, expand, and then become narrow again." "Extensive fissuring and faulting has taken place parallel to the fissure vein and generally along the southern footwall." "Several post-mineralization offset faults cut across the vein at right angles with a maximum observed offset of 5 feet. A shallow low-angle fault occurs within 100 feet of the Lilly adit entrance cutting off the vein 2 feet above the haulage track. Displacement along this fault was considerable before merging into the ore zone again" (Aikin, 1950).

3.4.2 Mine Development

Work to advance the Lilly drift was started in 1934 by E. Lindquist and Lester Lindquist. They sold the property to the Newman Brothers in 1941 (Rankin, 1950). The Newman Brothers were the last miners to operate the mine. The ground was reported by Aikin to be "well contained, and timbering has been more of a precaution rather than an absolute necessity. Standard drift sets along the haulage way and well placed stulls in the stopes have proven sufficient" (Aikin, 1950).

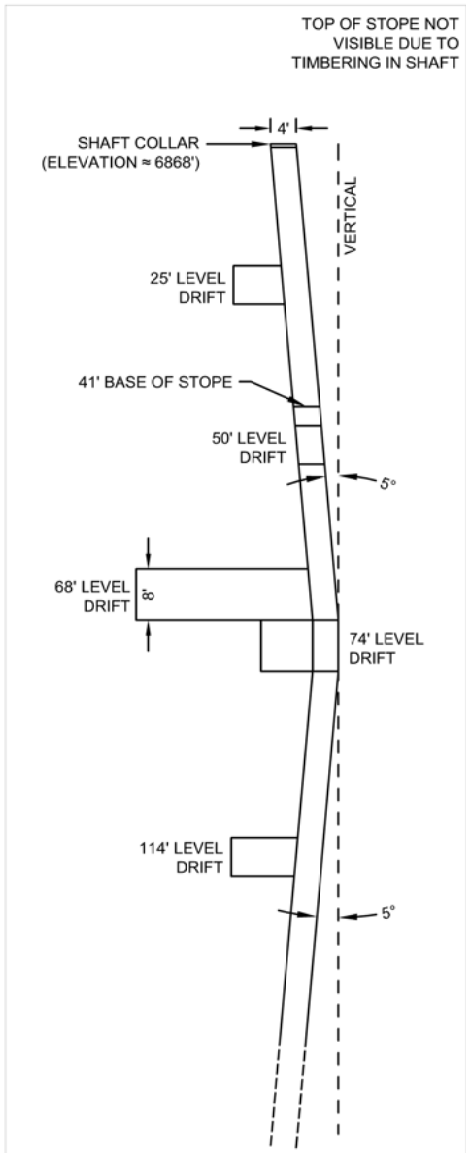
The Newman Brothers Properties report (Rankin, 1950) provided information that the shaft was driven at an incline of 5 degrees from vertical. The shaft consisted of a single hoisting compartment and manway in good condition from the collar down to the Lilly drift (74-foot level). The portion of the shaft below the Lilly drift was also anticipated to be in good condition based on information provided in that report (Rankin, 1950).

3.4.3 Mine Inspection and Seep Sampling

Upon assurance from Blue Range Engineering that the mine was safe to enter, TerraGraphics engineers, Tom Smith and Jamie Mongoven, entered the mine to perform the underground investigation of the mine workings. TerraGraphics engineers conducted the mine inspection and mapping activities from October 14 through 21, 2010, beginning with a tape survey of accessible mine workings to estimate volumes and record the mine dimensions. Results of the tape survey were recorded in the log book and on a copy of the Rankin Mine Map. The shaft was entered through the east compartment. The west compartment of the shaft was not used in this

investigation. Because of safety concerns, no testing of the rock or timber stability, which typically involves barring to find loose rock or hitting of timbers to evaluate soundness, was performed in the observed mine workings. Likewise, power washing of the workings to remove muck and loose rock from the rock walls was not performed due to safety concerns. As a result, rock quality and mine stability were characterized from the observed amount of rock raveling and the standing state of the support timbers. The floors of the levels that had been under water (74-foot and 114-foot levels) were covered with a layer of muck that prevented observation of the floor and lower portion of the walls. Thus, the observations documented in this report regard the dewatered state of the accessible portions of the mine. The observed portions of the Lilly/Orphan Boy mine are shown on Figure 9. The observations from this inspection were superimposed onto the Rankin Mine Map (Appendix F) in three representations: Figure 9 shows the observed mine workings and infrastructure; Figure 10 shows the observed geologic features; and Figure 11 shows the locations and referenced photographs of seeps in the drift at the 74-foot level. Table 5 describes the locations where seep samples were collected.

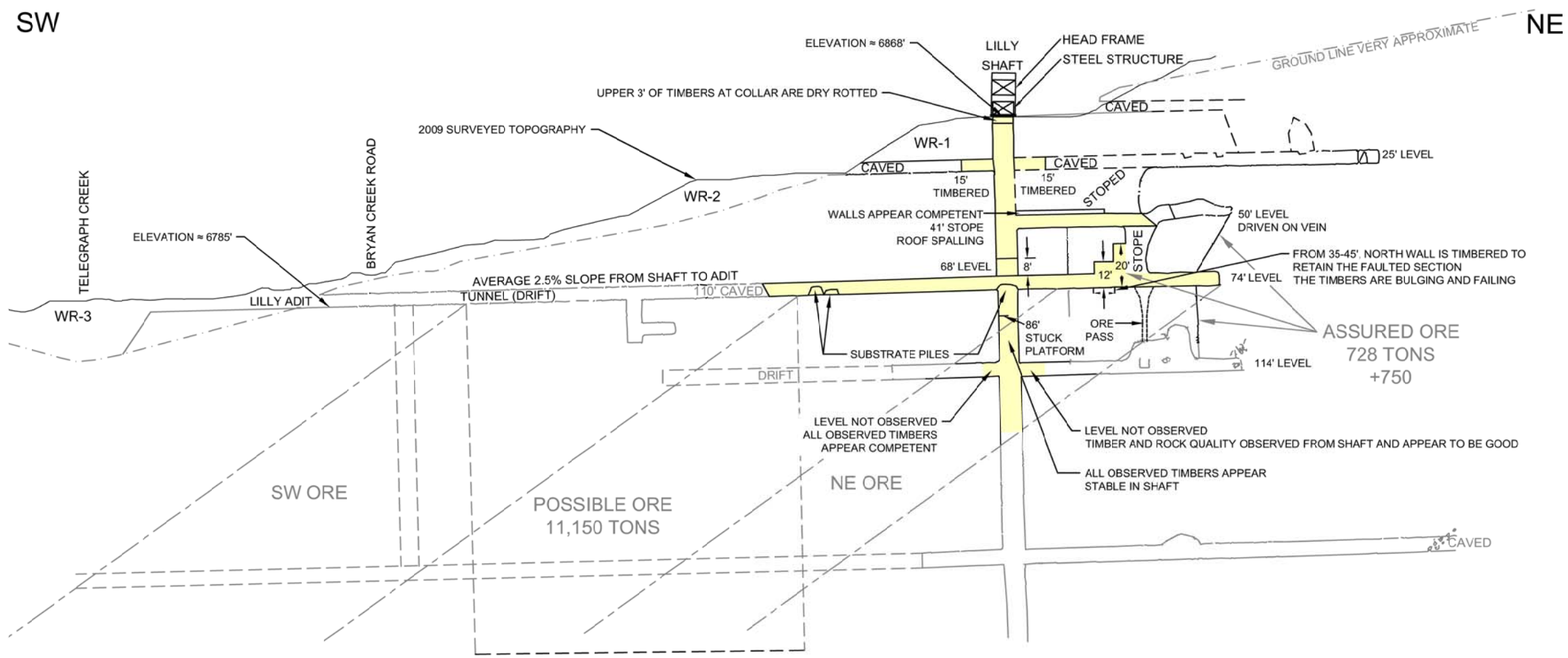
The shaft is rectangular and divided into two compartments. Each compartment is 4-feet by 4-feet wide. The east compartment appears to have been used for hoisting ore as this compartment contains guiderails along the length of the shaft for a skip hoist (used to keep the hoist centered in the compartment as it was raised or lowered) and the west compartment appears to have been used as the manway. The compartments are separated by bracing timbers. The observable section of the shaft, from the collar down to an approximate depth of 130 feet, is completely timbered for support and rock control. The remaining, unobserved portion of the shaft is expected to be timbered in a similar manner because, according to Dave Newman, that portion of the mine was developed by the same group of miners that developed the upper portion of the shaft. Square sets were observed at approximately 5-foot intervals, with round backing timbers placed vertically side-by-side between the square sets. The timbers were observed by Blue Range Engineering to generally be in good condition, except at the collar where the upper approximately 3 feet of timbers were affected by dry rot.



LILLY SHAFT
LOOKING WESTERLY

0 30 60

SCALE: 1" = 30'



PROFILE OF THE UNDERGROUND WORKINGS
LOOKING NORTHWESTERLY

STOPES GENERALLY NOT INSPECTED
BETWEEN LEVELS DUE TO SAFETY CONCERNS

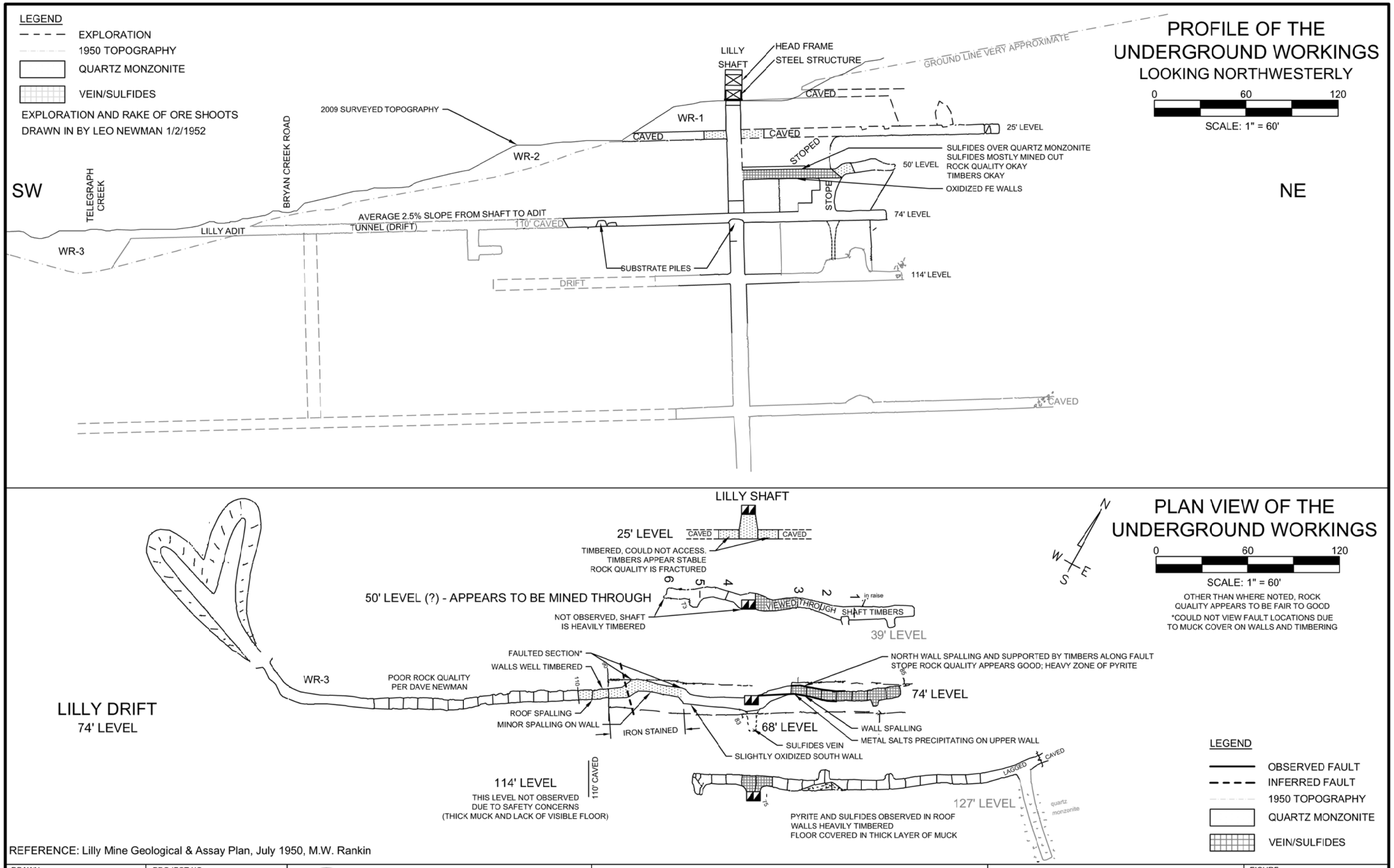
LEGEND

- EXPLORATION
- RAKE OF ORE SHOOTS
- 1950 TOPOGRAPHY
- OBSERVED AREAS OF UNDERGROUND WORKINGS

EXPLORATION AND RAKE OF ORE SHOOTS DRAWN IN BY LEO NEWMAN 1/2/1952

REFERENCE: Lilly Mine Geological & Assay Plan, July 1950, M.W. Rankin

DRAWN: C. HEWETT	PROJECT NO.: 11001-3-3-18	TerraGraphics Environmental Engineering, Inc.	MINE WORKINGS	LILLY/ORPHAN BOY ABANDONED MINE SITE	FIGURE: 9
PROJECT MANAGER: T. SMITH	SCALE: AS NOTED		MAP PROVIDED BY DAVE NEWMAN AND UPDATED BY TOM SMITH MINE INVESTIGATION		DATE: 9/20/2011
CHECKED: ---	APPROVED: ---				
	DATE: --/--/----				



REFERENCE: Lilly Mine Geological & Assay Plan, July 1950, M.W. Rankin

DRAWN: C. HEWETT	PROJECT NO.: 11001-3-3-18	TerraGraphics Environmental Engineering, Inc.	GEOLOGY	LILLY/ORPHAN BOY ABANDONED MINE SITE	FIGURE: 10
PROJECT MANAGER: T. SMITH	SCALE: AS NOTED		MAP PROVIDED BY DAVE NEWMAN AND UPDATED BY TOM SMITH AND JAMIE MONGOVEN MINE INVESTIGATION		DATE: 9/20/2011
CHECKED: ---	APPROVED: ---				
	DATE: --/--/----				

PROFILE OF THE UNDERGROUND WORKINGS
LOOKING NORTHWESTERLY

LEGEND

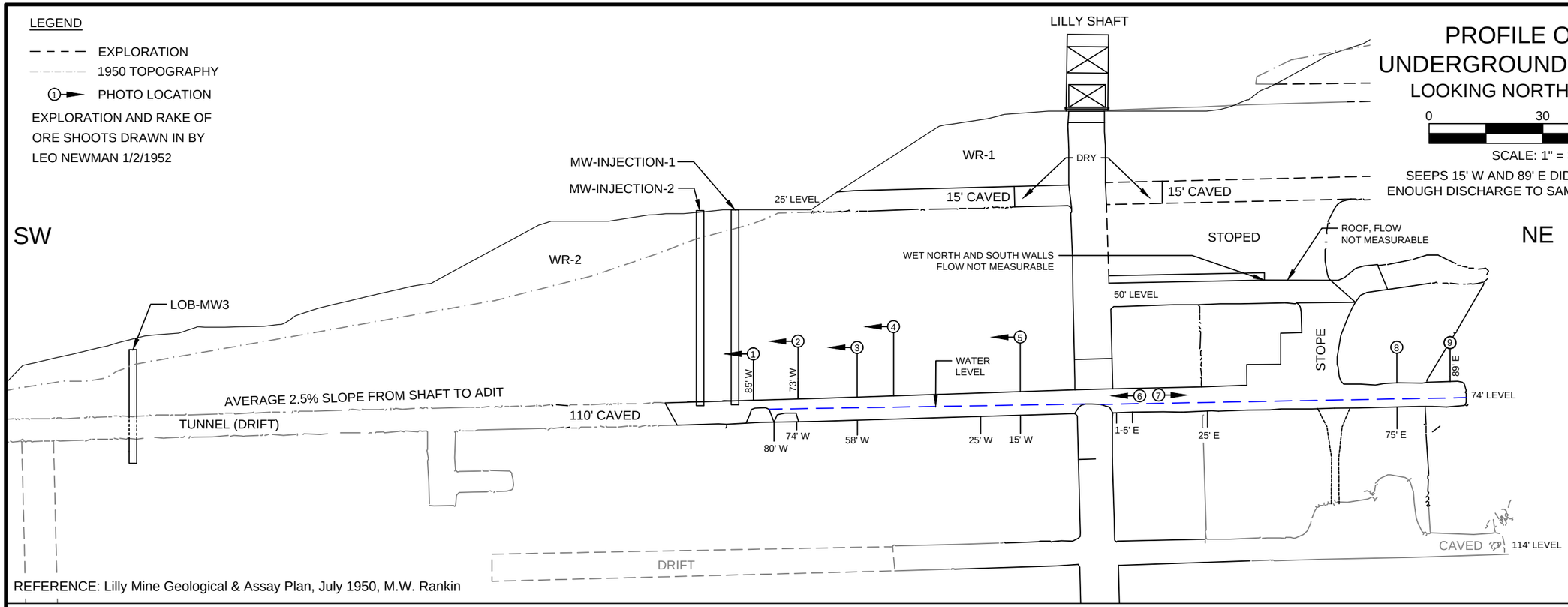
- EXPLORATION
- 1950 TOPOGRAPHY
- PHOTO LOCATION

EXPLORATION AND RAKE OF ORE SHOOTS DRAWN IN BY LEO NEWMAN 1/2/1952

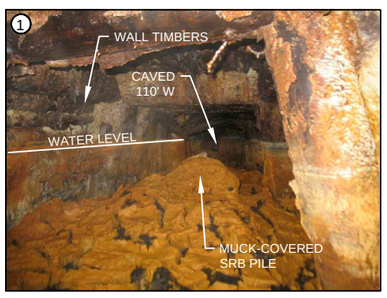
0 30 60

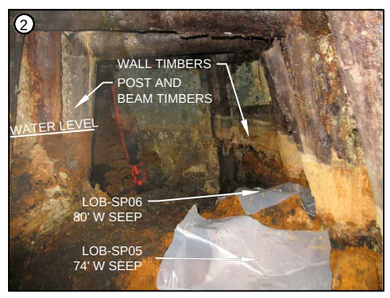
SCALE: 1" = 30'

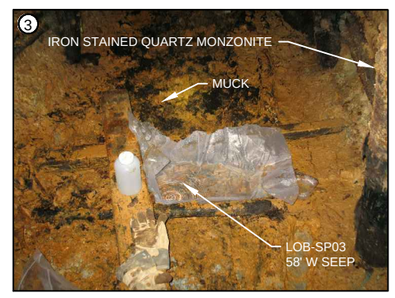
SEEPS 15' W AND 89' E DID NOT GENERATE ENOUGH DISCHARGE TO SAMPLE FOR ANALYSIS

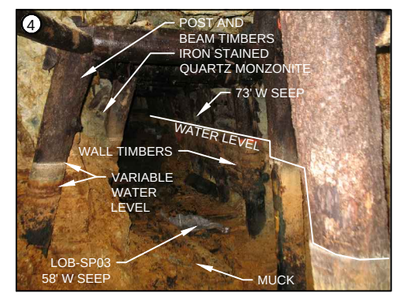


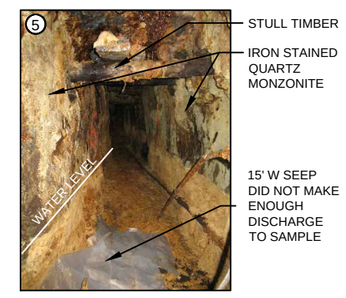
REFERENCE: Lilly Mine Geological & Assay Plan, July 1950, M.W. Rankin

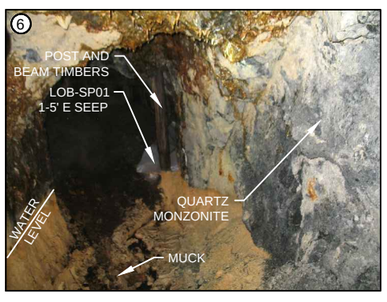


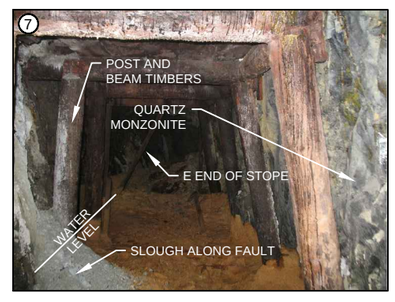


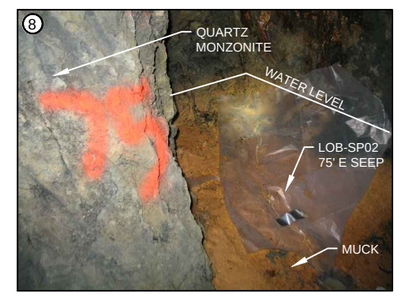


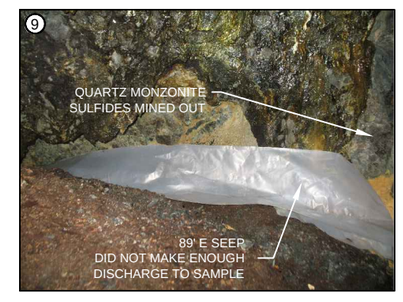












DRAWN: C. HEWETT	PROJECT NO.: 11001-3-3-18	TerraGraphics Environmental Engineering, Inc.	74' DRIFT SEEP SAMPLING STATIONS MAP
PROJECT MANAGER: S. FIROR	SCALE: AS NOTED		MAP PROVIDED BY DAVE NEWMAN AND UPDATED BY TOM SMITH AND JAMIE MONGOVEN MINE INVESTIGATION
CHECKED: ---	APPROVED: ---		LILLY/ORPHAN BOY ABANDONED MINE SITE
	DATE: --/--/----		FIGURE: 11
			DATE: 9/6/2011

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Table 5. Seep Sample Locations

Sample ID	Seep Location Relative to Shaft	Location Notes
LOB-SP06	80' W	Roof & top of N wall seep
LOB-SP05	74' W	Roof seep, N side
LOB-SP03	58' W	Middle of roof seep
LOB-SP04	25' W	Middle of roof seep
--	15' W	Middle of roof seep
LOB-SP01	1-5' E	Roof seep, N side
LOB-SP02	75' E	S wall, seep in the cut
--	89' E	N wall, seep in the cut

The following sections discuss observations made during the October 2010 mine investigation. Each section addresses the various features of the mine in the order they were encountered descending into the shaft from the surface. Figure 9 shows the approximate extent of the mine that was observed. Rock quality and stability assessments were based on observations of the exposed areas of the mine workings. Due to safety concerns, the walls were not probed or picked for loose rock and the timbers were not disturbed. In general, the rock quality and stability is good where still visible. A few locations, as noted on Figure 9 and Figure 10, showed signs of raveling/spalling or collapse. Timbering in the observed areas of the mine appeared to be in good shape with minor deterioration. Based on discussions with Dave Newman, the collapses in some areas of the mine occurred after the mine stopped operation. The collapses are due to poor rock quality, as noted on Figure 9 and Figure 10.

3.4.3.1 25-Foot Level

The 25-foot level is accessed on the south side of the shaft and extends approximately 8 feet to the south. The level has experienced caving on both sides. The non-caved portion extends approximately 15 feet to the east and 15 feet to the west but is filled with jointed round timber sets installed to prevent further caving of this level. The level appeared to be dry and the bedrock composed of fractured quartz monzonite. The rock quality appeared to be poor and the timbers appeared to be stable. No seeps were observed (Figure 12).

Figure 12. View looking south into the 25-foot level from the shaft. The jointed round timber sets on the left and right were installed to prevent further caving of this level.

A difference was observed between the mine maps provided in the Aikin thesis (Aikin Mine Map) and the Rankin Mine Map provided by Dave Newman (see copies of original maps in Appendix F). The Aikin Mine Map does not show this level and indicates that the stope extends to the surface, whereas the Rankin Mine Map shows this level as being stoped. During discussions with Dan Newman, who stated he used to work this mine with his cousin Dave Newman from time to time, it was determined that the back wall of the 25-foot level was always wet and discharged water. Based on this information, it is possible that the map Mr. Aikin included in his thesis was not accurate because he was not able to observe this level of the mine.

3.4.3.2 41-Foot Level

The 41-foot level was not accessible due to the timber backing but could be partially viewed to the east from the shaft. Looking between the timbers, it appeared that this level was part of the stope shown on Figure 9, where stull timbers span the stope for support. The stull timbers appeared to be stable and the rock quality fair to good. Rock and muck were observed on the floor (Figure 13). The rock in the walls appeared to be iron-stained quartz monzonite with black tourmaline banding so it is likely that the ore was completely removed in this stope. The Rankin Mine Map shows this stope extending approximately 47 feet to the east of the shaft and extending above the 25-foot level. The top of the stope and eastern extent were not observed due to the shaft timbers blocking access and view. A few small seep areas were observed. The seep areas were slightly wet and did not appear to be producing measureable discharge. Seep sample stations were not installed.

Figure 13. View looking east from the shaft through the timbers into the 41-foot level and into the stope.

3.4.3.3 50-Foot Level

The 50-foot level was accessed on the east side of the shaft. The drift dimensions were approximately 4 feet wide by 5 feet high. This drift contained an old wheelbarrow and wood box at the entrance. Post and beam timber sets were observed for the first 40 feet of the drift. At a distance of approximately 42 feet from the shaft, a stope was encountered that extends above and below the level and contains several stull timbers for support. The stull timbers appeared stable. According to the Rankin Mine Map, this stope is a continuation of the stope described in the 25-foot level section and extends down to the 74-foot level. However, the extent of the stope was not confirmed during this investigation. A plank spanning the stope, and supported by stull timbers (Figure 14), was not crossed due to safety concerns; therefore, the stope was the last portion of the drift at the 50-foot level that could be observed. The drift was estimated to extend to an overall length of approximately 75 feet. The drift appeared to have been driven on the vein and the rock quality appeared to range from fair to good. The vein was likely oxidized due to the high iron content observed in the walls. Approximately 30 to 40 feet from the shaft, water-deposited minerals were observed on the walls of the drift in six areas. These areas were only slightly wet and the discharge could not be measured. As a result, no seep sampling stations were set up on this level.

This level may correspond to the level labeled as the 39-foot level on the Rankin Mine Map.

Figure 14. View looking east at the stope in the 50-foot level. Note the stull timbers, post and beam timbers, and plank bridge.

3.4.3.4 68-Foot Level

The 68-foot level is accessed on the south side of the shaft and extends approximately 25 feet to the south of the shaft. The drift was approximately 4 feet wide by 6 feet high measured between the timber sets. The overall opening was 5 feet wide and 8 feet high up to the bedrock, with blocks and shims between the timber sets and bedrock. A pile of substrate installed by MSE (2008) partially blocked access to this level (Figure 15). The floor entry from the shaft into this level consisted of timbers that form the roof of the 74-foot level. The timber supports in this section of the mine are square sets. Remnant pieces of timber were scattered on the floor of this level. The bedrock was iron-stained quartz monzonite with black tourmaline banding. The timbers appeared to be stable and the rock quality appeared to range from fair to good. Three small drip areas were observed in the roof, but they were not discharging measureable flow, so seep sampling stations were not installed.

This level appears to be the dashed line extending south of the shaft on the 74-foot level plan view on the Rankin Mine Map (Figure 9).

Figure 15. View looking south into the 68-foot level from the shaft. Note the substrate pile in the lower left corner of photo.

3.4.3.5 74-Foot Level – The Lilly Drift

The 74-foot level, also known as the Lilly drift or Lilly tunnel, was accessed to the south of the shaft by climbing over a substrate pile. The drift extends approximately 110 feet to the west from the west edge of the shaft, to where the level has caved, and approximately 92 feet to the east from the east edge of the shaft. It is clear from the Rankin and Aikin Mine Maps and from evidence on the ground that this level originally extended to the Lilly adit where it intersected the ground surface. The west portion of the level was approximately 5 feet wide by 7 feet high. The east portion of the 74-foot level averaged 5 feet wide and 8 feet high. The stoped section varies in height and width to follow the sulfide ore in the vein out to the faults running almost parallel with the northern and southern walls of the level. Figure 10 shows the faults and Figure 9 shows the estimated heights observed in the stope. What appears to be an ore pass from the 74-foot level down to a lower level was observed along the southern wall of the stoped area. This was not marked on the Rankin Mine Map. A ladder was observed on the west side but the area was not explored due to safety concerns. Of the overall reported 450-foot length of this drift (Rankin, 1950), approximately 212 feet were observed during the 2010 investigation.

The rock observed in the walls of the Lilly drift was composed primarily of dark yellowish brown and gray quartz monzonite with iron staining. Black tourmaline banding was observed in the quartz monzonite around the landing of the shaft and extended to the east until the brown and dark gray sulfides were encountered in the vicinity of the stope. The sulfides became dark gray and black in color and extended eastward for the last 40 feet of the drift. White or light gray metal salts were observed forming in the roof and upper wall portions on the stope, approximately 25 to 40 feet east of the shaft (Figure 16 and Figure 17). Exposed unoxidized pyrite veins were also observed in the stope. The mining had stopped at the pyrite. This section was slightly wet but was not producing measureable discharge, so a seep sample station was not

installed. The wet areas were oxidized and yellowish brown to dark brown in color. The development of the stope evidently followed the sulfides and extended to the normal faults along the northern and southern walls. The faults were observed mainly along the southern wall and extending up into the stope.

As shown on the Aikin Mine Map (Appendix F), the drift was driven from the Lilly adit eastward to a point where the sulfide vein was cut off near the floor by a fault (section A-A'). East of the shaft the drift was driven along the vein. During the 2010 investigation, the entire drift could not be observed due to the 4 to 6 inches of accumulated muck and iron coating on the walls by the retained mine pool; however, the upper portions of the walls and some of the roof rock could be observed. The roof appeared to consist of quartz monzonite, consistent with the geological mapping reported by Aikin.

The overburden thins west of the shaft from approximately 67 feet (i.e., the drift floor at 74 feet minus a 7-foot roof height equals approximately 67 feet of overburden) at the west end of the shaft down to 17 feet at monitoring well LOB-MW03 and then 0 feet at the collapsed Lilly adit (Figure 9). As the overburden thins, the rock quality is expected to degrade from exposure to the atmosphere. The rock quality in the drift ranges from fair to good except where the caving occurred on the west end and along the faulting in the stoped area to the east of the shaft. Minor raveling was also observed in the offset faulted section located between approximately 40 and 60 feet west of the shaft (Figure 18).

Figure 16. View upward into the stope from a location in the 74-foot level east of the shaft. Note the stull timbers, white metal salts, and slightly wet dark brown areas in the upper right corner.

Figure 17. View looking up in the stope approximately 30 feet east of the shaft at the 74-foot level at the location of a fault (right arrow) along the southern wall.
Note the white metal salts and dark brown pyrite indicated with left and center arrows.

Figure 18. View looking west at the faulted and offset section of the drift at the 74-foot level at a location approximately 40 feet west of the shaft.
Note the post and beam timbering and minor raveling on the south wall near the center of the photo. The exposed rock is quartz monzonite with black tourmaline banding.

Plan views of the 74-foot level drift provided by Aikin and on the Rankin Mine Map (Appendix F) appear to provide reasonably accurate representations of this level of the mine.

3.4.3.5.1 Timbers in the 74-Foot Level

The configuration of timbering installed in the 74-foot drift varied by location. From the shaft to 40 feet west, stull timbering was used. West of the faulted section of the drift, approximately 40 feet west of the shaft, post and beam timbering was used. From the faulted section westward to the caved area, backing timbers were placed between the timber sets that covered the bottom two-thirds of the walls.

From the shaft to 15 feet east, stull timbering was used to support the mine. From this point eastward, post and beam timber sets with backing boards were used to a point in the drift approximately 40 feet east of the shaft. Stull timbering was observed to have been installed from the 40-foot point to the eastern extent of the level. On the north wall of the stope, approximately 35 feet east of the shaft, the backing timbers installed between the timber sets retaining the faulted section were bulging and appeared to be failing (Figure 19). Additional timbering was also observed along the fault on the north wall, approximately 80 to 90 feet east of the shaft.

Figure 19. View looking east at the timbers retaining the faulted section located approximately 35 feet east of the shaft in the 74-foot level.

3.4.3.5.2 Mine Pool in the 74-Foot Level

Based on water marks observed on the walls within the 74-foot level, the mine pool level varied along the drift. East of the shaft, the pool appeared to reach a level approximately 20 to 24 inches above the floor. Heading west of the shaft, the water level marks were observed to be approximately 20 inches above the floor for the first 40 feet of drift, to the point where the faulted and offset section of the drift was encountered. From that point to the west, the pool then increased in depth relative the floor of the drift. At a point approximately 58 feet west of the shaft, the water mark was approximately 44 inches above the floor and then increased to a height

of 48 inches at a point 73 feet west of the shaft (the location of the eastern end of the first substrate stockpile). Continuing west along the drift to point approximately 85 feet west of the shaft (i.e., the west end of the first substrate stockpile), the water mark was about 54 inches above the floor. At the caved portion of the drift, about 110 feet west of the shaft, the water mark indicating the pool depth was approximately 60 inches above the floor of the drift (Figure 20). Figure 11 shows the approximate water line within the 74-foot level and the mine pool level is also marked on the photographs.

3.4.3.5.3 MSE Wells and Substrate Piles within the 74-Foot Level

MSE drilled and installed two monitoring wells (MW-Injection 1 and MW-Injection 2) that were reported to have penetrated this drift. Although the wells were reported to have been used to inject substrate into the level (MSE, 2008), observations made during this investigation indicate the wells did not directly penetrate the drift.

Figure 20. View looking west at the caved portion of the 74-foot level approximately 110 feet west of the shaft.
Note the muck covered substrate pile in the foreground. Substrate piles were reported to have been placed through injection wells but neither drill holes nor injection wells were observed in the roof of the drift.

The distance from the wells to the shaft was scaled from the site topographic map and used as a guide to estimate where the wells could be encountered within the workings (approximately 73 feet west for MW-Injection 1 and 91 feet for MW-Injection 2). Although substrate piles were observed in the drift at these approximate distances, it appeared the substrate was brought in using a wheelbarrow and piled. The substrate piles appeared to be too large to have been injected through a well and did not have a conical shape as would be expected if the piles were placed by injection methods. Most significantly, no evidence of drill holes or PVC pipe was observed in the roof or the walls of the drift.

Calculations performed to estimate the depth of the MW-Injection 1 and MW-Injection 2 wells relative to the floor elevation of the Lilly drift show that both injection wells were drilled to a depth sufficient to encounter the 74-foot level drift (Appendix G). Substrate material was observed on a bailer used to sample the wells and the wells where observed to go dry when the water level in the mine was lowered below the 74-foot level during dewatering for this investigation. Thus, although the wells do not appear to directly penetrate the drift, available evidence indicates both wells are hydraulically connected to the 74-foot level.

A well log and descriptions included in the 1995 memorandum by Jim Potts of MSE show that well LOB-3 was installed into the 74-foot level drift. This well is located approximately 208 feet southwest of the shaft and into the uphill road cut of the Forest Service access road into the site. The memorandum indicates the roof of the drift was encountered at a depth of approximately 17 feet and the floor was encountered at approximately 26 feet. At the time of drilling, the level was open at the location where it was intersected by LOB-3. Water was measured to be 1 to 1½ feet below the roof of the drift (MSE, 1995). This well would have been located beyond (west of) the collapsed area in the drift, and could not be observed during this investigation.

3.4.3.6 The West Platform at 86-Feet

The platform MSE had installed in the west shaft compartment could not be observed until the mine was dewatered and workings accessed. The top of this platform was encountered to be slightly rotated and resting on timbers at 86 feet below the collar of the shaft. Further inspection revealed that this platform was constructed differently from the east platform that had been successfully removed from the shaft. The top deck was the same but the west platform included a skid constructed of heavy steel that extended approximately 6 feet below the deck (Figure 21).

The purpose of the skid was to center the platform. If the platform rotated or tilted as it was lowered, the center skid would contact the timbers and push it back to center. Observation from below the platform in the mine provided insight into why the platform could not be removed by the crane. Section 2.1 provides additional discussion regarding the efforts that were undertaken to remove the platforms. When effort was exerted with the crane to remove the platform the center skid broke through the bracing timbers separating the compartments. No damage was observed on the square set or backing timbers; however, the bracing timbers were removed from the interval of the shaft between approximately 100 feet and 92 feet below the collar. The support timbers were also damaged by the top deck of the platform from approximately 92 feet up to 86 feet below the collar. One cable was observed to have failed during the removal attempts on this platform.

Figure 21. View of the east compartment of the shaft at a depth of 95 feet looking up at the west platform wedged into the timbers at a depth of 86 feet. Note the skid on the bottom, broken bracing timbers dividing the compartments, the lack of damage to the square set and backing timbers, and the lack of substrate on the platform.

Blue Range Engineering deemed the platform to be stable resting on the timbers and it was left in place. For safety reasons, the cables were cut from the platform and removed, except for the remaining portion of the failed cable which was dropped below the platform and was observed to be resting on the timbers at a depth of approximately 105 feet (Figure 22). The removed cables were placed in the fenced area southeast of the shaft and headframe, next to the east platform that was removed.

Figure 22. View from a depth of 95 feet in the east compartment of the shaft looking down at the water level.
The water level is at approximately 110 feet deep in the shaft. The cut portion of failed cable, on the left, is resting at a depth of 105 feet in the west compartment. The aluminum pipe, chain, and power cable are connected to the dewatering pump. Note the substrate on top of the square set timbers.

3.4.3.7 114-Foot Level

This level is accessed from the north side of the shaft and has timbers across the floor retaining at least a 2-foot thick section of muck. The drift was approximately 5 feet wide and 7 feet high between the timbers. The timbering was observed to have noticeably better construction quality than the upper levels. The timbering consisted of larger square sets than in the upper levels. The walls were fully timbered. This level was not explored due to safety concerns, as it was not known if this level contained winzes, declines, or ore passes that could be covered by the muck. The drift was observed to a distance of approximately 20 feet east and west of the shaft (Figure 23 and Figure 24). The only visible rock was fresh pyrite in the roof at the landing located north of the shaft. This level appeared to be consistent with the levels above insofar as it appeared to have been driven on the same vein.

Looking up the shaft from this level, the shaft was observed to dip toward the north from the collar down to the 74-foot level, then dip back to the south from the 74-foot level to the 114-foot level (Figure 25). A profile of the shaft is shown in Figure 9. This variance in the direction of the shaft explains why difficulties were encountered in lowering the pump beyond a depth of 106 feet below the collar. The pump was most likely getting caught (hanging) on the timbers.

Figure 23. View of the landing to the 114-foot level, looking east. Note the brown muck level on the timbers.

Figure 24. View of the landing to the 114-foot level, looking west. Note the brown muck level on the timbers.

Figure 25. View looking up the shaft from a depth of 95 feet. The change in dip of the shaft, marked by the arrows, is evident. The change in dip made lowering of the pump difficult and impacted removal of the platforms.

3.4.3.8 Unobserved Level

During the last week of mine dewatering, muck colored water was observed and several filter changes were required on October 19, 2010. As was observed by the dewatering of the 114-foot level, the presence of the muck in the water is an indication that another level in the mine is being dewatered. If another level exists, as shown on the Rankin Mine Map, it is likely located between a depth of 130 feet and 145 feet below the shaft collar.

The existence of this level could not be confirmed as additional exploration within the mine could not be undertaken due to weather turning to snow and the need to terminate field operations. Based on the volume and rate of water that was pumped, and assuming the level has working dimensions of 5 feet wide by 7 feet high, the workings could be approximately 150 feet in length if there are no stopes. However, since stopes were observed in the upper levels and were connected, the overall development of the workings at this level could be less. Although direct evidence of this level was not obtained, pumping observations and calculations indicate that it probably exists.

Section 4.0 Sampling

Surface water, groundwater, soil, and seep samples were collected at the Lilly/Orphan Boy Mine Site during the 2010 investigation. All procedures for sampling, decontamination of sampling equipment, and analysis of samples were outlined in the SAP/QAPP (TerraGraphics, 2010b). This section describes the specific samples collected, sample locations, and analyses that were performed.

4.1 Surface Water Sampling and Analysis Methods

The purposes for sampling surface water were to:

- Collect baseline surface water quality data from Telegraph Creek; and
- Monitor the water chemistry in Telegraph Creek during dewatering and land application.

TerraGraphics personnel collected surface water samples from five locations along Telegraph Creek beginning on September 29, 2010, and ending on October 22, 2010. The surface water samples were analyzed for the constituents shown in Table 6.

Surface water samples were collected using the Direct Method and were handled and analyzed according to the procedures and methods identified in Section 2.1.4 of the SAP/QAPP. The surface water sample locations are shown on Figure 8 and described in Table 7.

Field tasks associated with the pre-pumping (baseline) surface water monitoring activities conducted by TerraGraphics on September 29, 2010, included: (1) staking and surveying each sampling station, (2) measuring stream discharge at each station, (3) measuring and recording field physiochemical parameters, and (4) collecting surface water samples for laboratory analysis. Surface water sampling information was recorded on surface water sampling record sheets and in the field book (Appendix A).

Further surface water monitoring was conducted on December 6, 2010, a month after mine dewatering ceased, to investigate the seasonal variation of geochemical constituents. Adit discharge was not sampled.

Table 6. Parameters, Methods, and Reporting Limits for Surface Water Analyses

Parameter	Analyte	Method	Reporting Limit[a]
Physical Properties	pH	A4500-H B	0.1 s.u.
	Conductivity	A2510 B	1µmhos/cm
	Total Dissolved Solids	A2540 C	10 mg/L
	Total Suspended Solids	A2540 D 06	10 mg/L
	Acidity-Total as $CaCO_3$[b]	A2310 B	None
Dissolved Inorganics	Chloride	EPA 300.0	1 mg/L
	Sulfate	EPA 300.0	1 mg/L
Inorganics	Alkalinity, Total as $CaCO_3$	A2320 B	4 mg/L
	Bicarbonate as HCO_3	A2320 B	4 mg/L
	Carbonate as CO_3	A2320 B	4 mg/L
	Chloride	EPA 300.0	1 mg/L
	Sulfate	EPA 300.0	1 mg/L
Metals	Aluminum (Total and Dissolved)	EPA 200.8	0.03 mg/L
	Arsenic (Total and Dissolved)	EPA 200.8	0.003 mg/L
	Cadmium (Total and Dissolved)	EPA 200.8	0.00008 mg/L
	Calcium (Dissolved)	EPA 200.7	1 mg/L
	Copper (Total and Dissolved)	EPA 200.8	0.001 mg/L
	Iron (Total and Dissolved)	EPA 200.7	0.05 mg/L
	Lead (Total and Dissolved)	EPA 200.8	0.0005 mg/L
	Magnesium (Dissolved)	EPA 200.7	1 mg/L
	Manganese (Total and Dissolved)	EPA 200.8	0.005 mg/L
	Potassium (Dissolved)	EPA 200.7	1 mg/L
	Sodium (Dissolved)	EPA 200.7	1 mg/L
	Zinc (Total and Dissolved)	EPA 200.8	0.01 mg/L
	Hardness, Total as $CaCO_3$		

Notes:

a. Reporting Limits are less than or equal to Circular DEQ-7 required reporting values for practical quantitation limit

b. Acidity was analyzed only if pH was less than 4.5

mg/L = milligram per liter

Table 7. Surface Water Sampling Locations

Station Identification (from upstream to downstream)	Surface Water Sample Location
LOB-SW05	Approximately 530 feet upstream of Waste Rock Pile 3 where the property line crosses Telegraph Creek
LOB-SW01[a]	Approximately 70 feet upstream of Waste Rock Pile 3 at the crossing of the property line on Telegraph Creek.
LOB-SW06	Approximately 90 feet downstream of Waste Rock Pile 3
LOB-SW03[a]	Approximately 190 feet downstream of Waste Rock Pile 3 at the crossing of the property line on Telegraph Creek.
LOB-SW07 (new sample location not included in SAP/QAPP)	Approximately 430 feet downstream of Waste Rock Pile 3 at culvert outlet. This site was requested by DEQ as a downstream check on the water quality to monitor during the land application operations.

a. Sample locations first established for Reclamation Investigation (Tetra Tech, 2009).

Discharge measurements were taken at the five surface water sampling sites by TerraGraphics personnel utilizing the area-velocity method (wading technique) in accordance with the SAP/QAPP (TerraGraphics, 2010b). Stream widths and corresponding depths were measured and recorded in the field to determine cross-sectional areas. Stream velocities for each cross-section were measured and recorded using an electronic hand-held flow meter. Stream discharge information was recorded on stream discharge forms and in the field book (Appendix A) and is summarized in Section 5.3.

4.2 Groundwater Sampling and Analysis Methods

The purposes for sampling groundwater were to:

- Characterize the groundwater system at the mine site;
- Compare the quality of groundwater in the bedrock with water in the mine workings; and
- Support future analysis of reclamation alternatives for reducing or stopping discharge from the Lilly adit.

Groundwater data were collected by TerraGraphics field technicians on September 29, 2010, from the five new monitoring wells installed at the Lilly/Orphan Boy Mine Site (see Figure 8). Field tasks included measuring static water levels in each well, field measurement of chemical/physical parameters, and collecting groundwater samples for laboratory analysis. The groundwater samples were analyzed for the constituents shown in Table 8 as specified in the SAP/QAPP (TerraGraphics, 2010b).

Table 8. Parameters, Methods, and Reporting Limits for Mine Water and Groundwater Analyses

Parameter	Analyte	Method	Reporting Limit[a]
Physical Properties	pH	A4500-H B	0.1 s.u.
	Conductivity	A2510 B	1µmhos/cm
	Acidity-Total as $CaCO_3$[b]	A2310 B	None
Dissolved Inorganics	Bicarbonate as HCO_3[c]	A2320 B	4 mg/L
	Carbonate as CO_3[c]	A2320 B	4 mg/L
	Chloride	EPA 300.0	1 mg/L
	Sulfate	EPA 300.0	1 mg/L
Inorganics	Alkalinity, Total as $CaCO_3$	A2320 B	4 mg/L
	Chloride	EPA 300.0	1 mg/L
	Sulfate	EPA 300.0	1 mg/L
Metals	Aluminum (Total)	EPA 200.8	0.03 mg/L
	Arsenic (Total)	EPA 200.8	0.003 mg/L
	Cadmium (Total)	EPA 200.8	0.00008 mg/L
	Copper (Total)	EPA 200.8	0.001 mg/L
	Iron (Total)	EPA 200.7	0.05 mg/L
	Lead (Total)	EPA 200.8	0.0005 mg/L
	Manganese (Total)	EPA 200.8	0.005 mg/L
	Zinc (Total)	EPA 200.8	0.01 mg/L

Notes:

a. Reporting Limits are less than or equal to Circular DEQ-7 required reporting values for practical quantitation limit

b. Acidity was reported only if pH was less than 4.5

c. Only groundwater will be analyzed for these parameters

mg/L = milligram per liter
µmhos/cm = micromhos per centimeter

Samples were collected using the low-flow, minimum drawdown technique in accordance with the sampling plan described in Section 2.1 of the SAP/QAPP (TerraGraphics, 2010b). All sample handling procedures followed the guidelines for handling and documentation described in Section 2.6 of the SAP/QAPP. Groundwater quality assurance/quality control (QA/QC) samples were collected and analyzed as described in Section 2.3 of the SAP/QAPP. Groundwater sampling information was recorded on groundwater sampling record sheets and in the field book (Appendix A). Results are discussed in Section 5.3.

4.3 Mine Water Sampling and Analysis Methods

Mine water samples were collected from shaft water during dewatering as described in Sections 2.2.5 and from seeps during the underground investigation as described in Section 3.4.3. The mine water samples were analyzed for the constituents shown in Table 8. Results are discussed

in Section 5.3.5. Field parameters (temperature, pH, Dissolved Oxygen [DO], conductivity, and oxygen reduction potential [ORP]) were not recorded for mine water during dewatering or seep inspection. A total of 14 samples were collected from the mine water. Some mine water samples were filtered to remove mobilized solids, not in accordance with the SAP/QAPP (TerraGraphics, 2010b), as they were collected downstream from the bag filter as this was the first and closest sampling location available immediately downstream of the pump. The filtering of solids was necessary to prevent damage to the water treatment and land application systems. The filters were 100 and 200 mesh. The pressure in the chambers ranged from 10 to 15 psi during operation. Either of these parameters may impact the concentrations of total metals in the samples. In addition, filtering of the samples compromises the comparison of these samples with samples from other areas (wells, seeps, surface water) that were not filtered. One water sample was collected from shaft water when pumping was not underway.

4.4 Soil Sampling and Analysis Methods

The purpose of soil sampling was to further determine the extent of metals-contaminated soil across the entire site. Thirteen soil samples were collected on October 4, 2010, in general accordance the SAP/QAPP. Samples were collected from 0 to 3 inches bgs at predetermined locations throughout the site. The soil samples were submitted for the analyses listed in Table 9.

Table 9. Parameters, Methods, and Reporting Limits for Soil Analyses

Parameter	Analyte	Method	Reporting Limit[a]
Acid Base Accounting	Acid Potential w/ Sulfur Forms	Sobek Modified	0.005 t/kt
	Acid/Base Potential	Sobek Modified	-5000 t/kt
	Neutralization Potential	Sobek Modified	-5000 t/kt
Conductivity	Saturated Paste Conductivity	ASA10-3	0.01 mmhos/c
Metals- Total	Aluminum	EPA 6010.20	5 mg/kg
	Arsenic	EPA 6010.20	5 mg/kg
	Cadmium	EPA 6010.20	1 mg/kg
	Copper	EPA 6010.20	5 mg/kg
	Iron	EPA 6010.20	5 mg/kg
	Lead	EPA 6010.20	5 mg/kg
	Manganese	EPA 6010.20	5 mg/kg
	Zinc	EPA 6010.20	5 mg/kg

Notes:

a. Reporting Limits are less than or equal to Circular DEQ-7 required reporting values for practical quantitation limit

t/kt = ton per thousand ton

mg/kg = milligram per kilogram

The results of the soil analyses are discussed in Section 5.3.6

Section 5.0 Results and Discussion

This section discusses the results of the Phase II RI activities described in Sections 2, 3, and 4 of this report. The work completed during the Phase II RI was performed in accordance with the Phase II RWP and SAP/QAPP (TerraGraphics, 2010b). Deviations from the RWP are discussed in this section. Deviations during sampling and the effects of these deviations on data quality and usability are discussed in the Data Validation Report provided in Appendix H of this report.

5.1 Pre-investigation Activities

5.1.1 Platform Removal Results

H&H removed the eastern platform that obstructed the shaft. Several attempts were made to remove the western platform, but the platform was only moved several feet vertically up the shaft before it wedged into the shaft timbers. Ultimately, the western platform was raised approximately 30 feet in the shaft before it became wedged in the shaft timbers again. The wedged platform could not be observed at the time because of water in the shaft. The cables that remain connected to the western platform were suspended from the steel support structure and the western compartment platform remains lodged in the shaft.

The eastern platform was removed and placed within the fence southeast of the headframe. The removed platform was constructed of heavy steel and thick rubber seals to keep the substrate material suspended on the platform.

5.1.2 Mine Dewatering and Land Application

The dewatering system was started on October 1, 2010, and shut down on October 22, 2010. A total of 397,000 gallons of water was pumped from the shaft and land applied. Discharge water quality was monitored with Rain for Rent's portable water quality monitoring system and pH was adjusted, as necessary, to achieve project objectives. The pH of the mine water was treated to achieve a range of greater than 5 and less than 9 by adding NaOH. Due to a data logger malfunction, the pH results were not recorded as originally planned; however, the turbidity data were recovered and are included in Appendix I.

A transducer was installed in the shaft on November 2, 2010, after the removal of all dewatering equipment, to monitor the recharge in the shaft. A graph showing the Lilly/Orphan Boy shaft water level recovery measurements is included in Appendix E. The average recharge recovery rate during mine dewatering was calculated to be 5.5 gpm (Appendix C). These calculations and the data from the 2009 RI (Appendix K) indicate that flow into the mine is consistently less than 10 gpm. This relatively slow recharge rate suggests that the bedrock aquifer contributes a minor amount of water to the mine workings under base flow conditions.

5.1.3 Mine Inspection and Safety Assessment

Contract miners from Blue Range Engineering performed the mine safety assessment on behalf of TerraGraphics on October 12 through 14, 2010, after the mine had been dewatered to approximately the 100-foot level. The process of assessing the safety of the mine began with evaluating the air quality and ventilating the workings with a fan. Air quality in the shaft was

determined to be acceptable for entry and the contract miners from Blue Range Engineering installed and stabilized the ladder in the shaft to the 80-foot level. A visual inspection of the shaft timbers showed that they were intact and stable and Blue Range Engineering cleared the shaft for entry on October 13, 2010. After clearing the substrate from the opening of the Lilly drift, Blue Range Engineering personnel visually inspected the tunnel and cleared it for entry to near where the tunnel ceiling was collapsed approximately 110 feet west of the shaft.

During a telephone interview with Larry Hoffman of Blue Range Engineering on April 5, 2011, Mr. Hoffman stated that he did not take any notes or complete any documentation regarding the mine safety assessment. However, Mr. Hoffman explained that they inspected the mine to the 114-foot level and that it was "loaded with slimy sediments (muck) and was not safe to enter." During the interview, Mr. Hoffman further stated that there were "not really" any issues with the mine that he conveyed to TerraGraphics personnel during the safety assessment and that there were "No active flows to speak of" within the workings that he accessed. According to Mr. Hoffman, "Everything is in remarkably good shape and open" (Hoffman, 2011).

5.2 Field Investigation

5.2.1 Soil Borings and Monitoring Well Installation

Five borings (LOB-MW01 through LOB-MW05) were advanced to depths ranging from approximately 25 feet bgs to 122 feet bgs. The monitoring well completion details are discussed in Section 3.1.2 of this report and are shown in Table 4. The well logs showing the lithologic descriptions of the earth materials encountered during drilling are included in Appendix D. The well logs indicate that the wells are screened in weathered quartz monzonite. LOB-MW01 had a few feet of glacial till under the waste rock fill. LOB-MW05 had a mix of fill and glacial till a few feet below the surface.

5.2.1.1 Pressure Transducer Results

Water level changes observed during and after dewatering in monitoring wells LOB-MW01, LOB-MW02, LOB-MW03, and LOB-MW05 indicate some hydraulic connection between the bedrock aquifer and the mine workings, with a decrease in water table elevations in the wells observed during pumping and an increase in water table elevations following the end of dewatering. The monitoring well LOB-MW04 appears to be located outside the cone of depression created around the shaft during dewatering because the pre- and post-pumping levels in this well did not change significantly. The slight rise in water levels observed in LOB-MW04 around October 20, 2010, may be due to the effects of the land application system that was located immediately upgradient of LOB-MW-04. Graphs showing the groundwater elevation data for each monitoring well are included in Appendix E.

5.2.2 Waste Rock Piles

Six test pits were excavated by Hard Rock Road Building and Utilities on October 16, 2009; two test pits per waste rock pile. Waste Rock Pile 1 likely contains waste rock from most of the development but primarily consists of material from the upper portions of the mine. Lead and zinc ore along with pyrite were observed in this pile. Waste Rock Pile 2 contains waste rock from the development of the 25-foot level and Waste Rock Pile 3 contains waste rock from development of the 74-foot level and possibly other levels. Ore has been reported by Dave

Newman to have been stockpiled on the northern leg of this pile (Newman, 2008), which likely adds to the acid discharge into Telegraph Creek that is observed in this area. The waste rock piles are weathering and decomposing.

The observed sulfides within the waste rock piles appeared to have little oxidation. However, the sample materials kept in storage during geotechnical testing may have consumed oxygen, as a vacuum pressure was produced within the sealed 5-gallon bucket sample containers. This could also be attributed to temperature change.

5.2.3 Piezometer Installation

Three shallow piezometers were installed within the colluvium/weathered bedrock to further investigate surface water infiltration and the connectivity of infiltrating surface water with the underground workings. The piezometer locations are shown in Figure 8. The three new piezometers were installed from the bedrock contact to approximately 3 feet above ground surface. The bedrock contact ranged from 6 feet bgs at LOB-PZ01 to 7.5 feet bgs at LOB-PZ03, revealing a relatively thin veneer of soil over bedrock across most of the site. Although the initial plan was to install six piezometers nested with the monitoring wells, soils at the other monitoring well sites were too thin to allow for piezometer installation.

5.2.4 Subsurface Mine Investigation

The subsurface mine investigation resulted in the characterization of the mine workings as shown in Figure 9 and the mine area geology as shown in Figure 10. In addition, seeps that discharge water into the Lilly drift (Figure 11) were measured for flow rates and analyzed for metals concentrations.

5.2.4.1 Seep Sampling and Analysis Results

Flow rates measured at seeps in the Lilly drift are shown in Table 10. The measured seeps were contributing approximately 0.24 gallons of water per day in late fall 2010.

Geochemical results from these seeps are shown in Table 11 and Table 12 and indicate that the seep water, although small in volume, has low pH and high metals concentrations during base flow conditions. Amplified surface water infiltration during spring runoff or heavy precipitation events may increase discharge at the seeps and the influence of this low-quality water on the chemistry of AMD exiting the Lilly adit near Telegraph Creek.

5.2.4.2 Mine Investigation Results

From October 14 through 21, 2010, TerraGraphics engineers conducted the mine inspection and mapping beginning with a tape survey of accessible mine workings in the 74-foot level to estimate volumes and record the dimensions of accessible portions of the mine. The results of the tape survey were recorded in the log book (see Appendix A) and on the Rankin Mine Map shown in Figure 9.

The rocks exposed in the walls of the Lilly drift are composed primarily of competent quartz monzonite with cross-cutting sulfide ore veins. The tunnel is caved-in at a distance of approximately 110 feet west of the shaft opening (Figure 10). The infiltration zones observed in the workings were composed of small seeps emanating from the roof and walls of the tunnel (Figure 11). Discharge from the seeps was minor and it took an appreciable amount of time to

collect enough water from the seeps for laboratory analysis. Based upon the visible oxide staining and moisture content of the wall rock, the maximum level of water in the shaft appears to be approximately 3 feet higher than the floor of the Lilly drift.

The Rankin Mine Map and the Aikin Mine Map reasonably accurately represent the nature and extent of observed mine workings. The shaft and levels observed appear to be relatively stable except where noted. The rock quality generally ranges from fair to good, except where noted along faults and at the west end of the 74-foot level where cover is relatively thin and rock has caved approximately 110 feet west of the shaft.

Table 10. Seep Flow Sampling Summary

LILLY/ORPHAN BOY MINE Seep Infiltration Rates

Tom Smith

Seep Flow Sampling Summary in 74-Foot Level

Seep Location Relative to Shaft[1]	Location Notes	Initial Setup		1st Sample Collection			Approx. Flow		2nd Sample Collection			Approx. Flow	
		Date	Time	Date	Time	Volume	mL/hour	gal/day	Date	Time	Volume	mL/hour	gal/day
80' W	Roof & top of N wall seep	10/15/2010	10:35	10/18/2010	12:54	---	---	---	10/21/2010	11:31	1.25 L	**8.62**	**0.055**
74' W	Roof seep, N side	10/15/2010	10:45	10/18/2010	12:50	---	---	---	10/21/2010	11:29	750 mL	**5.18**	**0.033**
58' W	Middle of roof seep	10/15/2010	10:50	10/18/2010	12:42	2.75 L	**37.23**	**0.236**	10/21/2010	---	---	---	---
25' W	Middle of roof seep	10/15/2010	11:05	10/18/2010	12:40	~ 400 mL	**5.44**	**0.034**	10/21/2010	11:23	1.25 L	**8.66**	**0.055**
15' W[2]	Middle of roof seep	10/15/2010	11:15	10/18/2010	NA	---	---	---	10/21/2010	NA	---	---	---
1-5' E	Roof seep, N side	10/15/2010	11:40	10/18/2010	12:27	750 mL	**10.30**	**0.065**	10/21/2010	---	---	---	---
75' E	S wall, seep in the cut	10/15/2010	11:30	10/18/2010	12:33	750 mL	**10.27**	**0.065**	10/21/2010	11:55	1.5 L	**10.39**	**0.066**
89' E[2]	N wall, seep in the cut	10/15/2010	11:25	10/18/2010	NA	---	---	---	10/21/2010	NA	---	---	---

Range of Flows: **5 to 37 mL/hour**
or **0.033 to 0.236 gal/day**
(0.001 to 0.01 gpm)

W - west

E - east

N - north

S - south

NOTES:

[1] Seep sample Location as measured from the west or east end of shaft.

[2] These seeps did not discharge sufficient quantity for a sample to be obtained.

Table 11. Seep Water Analytical Results - Physiochemical Parameters and Common Anions

Lilly/Orphan Boy Mine Site

Sample ID	Seep Location Relative to Shaft	Collection Date	Physiochemical						Inorganics										Dissolved Inorganics									
			Specific Conductance (µmhos/cm)	pH	Total Dissolved Solids (mg/L)		Total Suspended Solids (mg/L)		Alkalinity, Total as $CaCO_3$ (mg/L)		Bicarbonate as HCO_3 (mg/L)		Carbonate as CO_3 (mg/L)		Chloride (mg/L)		Sulfate (mg/L)		Alkalinity, Total as $CaCO_3$ (mg/L)[a]		Bicarbonate as HCO_3 (mg/L)		Carbonate as CO_3 (mg/L)		Chloride (mg/L)		Sulfate (mg/L)	
					result	flag	result	flag	result	flag	result	flag	result	flag	result	flag	result	flag	result	flag	result	flag	result	flag	result	flag	result	flag
LOB-SP01-A-20101018	1-5' E	10/18/10																										
LOB-SP02-A-20101021	75' E	10/21/10	1960	2.9	2500		347		5	U	5	U	5	U	3	U	2140		5	U	5	U	5	U	3	U	1950	
LOB-SP03-A-20101018	58' W	10/18/10	302	3.5	175		10	U	5	U	5	U	5	U	1	U	119		5	U	5	U	5	U	1	U	144	
LOB-SP04-A-20101021	25' W	10/21/10	2240	2.4	585			IS	5	U	5	U	5	U	1		932											
LOB-SP05-A-20101021	74' W	10/21/10	2550	3		IS		IS		IS		IS		IS	2.9		2830											
LOB-SP06-A-20101021	80' W	10/21/10	2520	3	2830			IS	5	U	5	U	5	U	4		2730		5	U	5	U	5	U	3.2		2380	

Notes:

U - the compound was analyzed for, but not detected; detection limit reported

J- the result is an estimate

IS - insufficient sample volume for analysis

Table 12. Seep Water Analytical Results - Total Metals

Lilly/Orphan Boy Mine Site

Sample ID	Seep Location Relative to Shaft	Collection Date	Aluminum		Arsenic (mg/L)		Cadmium (mg/L)		Copper (mg/L)		Iron (mg/L)		Lead (mg/L)		Manganese		Zinc (mg/L)	
			Total	flag	Total	flag	Total	flag	Total	flag	Total	flag	Total	flag	Total	flag	Total	flag
LOB-SP01-A-20101018	1-5' E	10/18/2010	14.5		207		0.19	J+	1.7		434		1.3		1.1		51.7	
LOB-SP02-A-20101021	75' E	10/21/2010	38.4		110		3.9	J+	1	U	247		0.019		5	U	216	
LOB-SP03-A-20101018	58' W	10/18/2010	2.3		0.96		0.14	J+	0.11		3.7		0.13		2.3		5.9	
LOB-SP04-A-20101021	25' W	10/21/2010	5.2		8.9		0.41		2.7		38.4		1.4		6.5		75.2	
LOB-SP05-A-20101021	74' W	10/21/2010	5.4		0.15		0.53		0.45		5.5		0.041		28.1		49.2	
LOB-SP06-A-20101021	80' W	10/21/2010	141		0.055		1.2		4		14.2		0.0063		30.9		98.5	

Notes:

Acute and Chronic levels are for aquatic life standards as listed in Circular DEQ-7, 2010.

Flag Qualifiers:

U - the compound was analyzed for, but not detected; detection limit reported

J+ = high estimate

5.3 Sampling Results

Samples were collected at the Lilly/Orphan Boy Mine Site during fall 2010. Surface water samples were collected from Telegraph Creek. Groundwater was sampled from monitoring wells, the mine shaft, and seeps in the Lilly drift. Soil was sampled across the site. Sampling was conducted in accordance with the RWP and the associated SAP/QAPP (TerraGraphics, 2010b). This section presents results of the sampling.

5.3.1 Data Quality Objectives and Assessment

Laboratory data validation and verification were reconciled with the Data Quality Objectives (DQOs) identified in the SAP/QAPP (TerraGraphics, 2010b). TerraGraphics personnel conducted QA/QC reviews to evaluate the precision, accuracy, and completeness of the data obtained from both the field and the laboratory. Definitions and QC objectives for these parameters are described in the SAP/QAPP. A summary of findings for all evaluated QA/QC review criteria is provided in the Data Validation Report in Appendix H. The formulas used to calculate these QA/QC parameters are shown in the SAP/QAPP. Based on this assessment, no results were rejected and the data met the target goal of 95 percent completeness for the project.

5.3.2 Surface Water Sampling and Analysis Results

The 2009 RI listed arsenic, lead, and manganese as the contaminants of concern (COCs) for human health under the recreational risk analysis. Total arsenic, cadmium, copper, lead, and zinc were reported at elevated concentrations in surface water at the Lilly/Orphan Boy Mine Site and pose an unacceptable risk to the environment. Further surface water sampling was conducted during this investigation in order to determine whether land application of mine water impacted the water quality in Telegraph Greek.

5.3.2.1 Stream Discharge Results

Discharge measurements were taken at the five surface water sampling sites along Telegraph Creek (Figure 8) on October 1, 2010. Stream widths and corresponding depths were measured and recorded in the field to determine cross-sectional areas. Stream velocities for each cross-section were measured and recorded using an electronic hand-held flow meter. The discharge measurements for each surface water sampling site are summarized in Table 13 and shown on the stream discharge forms in Appendix A.

5.3.2.2 Surface Water Quality Sampling and Analysis Results

Surface water samples were collected by TerraGraphics personnel from five locations along Telegraph Creek (Figure 8) beginning on September 29, 2010, (pre-pumping) and ending on October 22, 2010 (end of mine dewatering) to monitor the water chemistry in Telegraph Creek during dewatering and land application. The surface water laboratory analytical results have been reviewed and flagged with appropriate qualifiers and are shown in Table 14, 15, and 16.

Acute and chronic aquatic life surface water standards for total cadmium, copper, lead, and zinc are hardness-dependent. Hardness-adjusted standards are shown in Appendix J. Surface water standards were exceeded for most total metals throughout the sampling season as shown in Table 15.

Overall, no substantial change in surface water chemistry was observed in Telegraph Creek at the sample locations downstream of the land application system during dewatering of the mine workings (LOB-SW01, LOB-SW03, LOB-SW06, and LOB-SW07). The slight variations in total metals concentrations and pH at each of these downstream surface water sampling locations is similar to the variation observed at the upstream sample location (LOB-SW05) during pumping and between surface water samples collected on September 29, 2010, and December 6, 2010. Therefore, the data show no evidence that land application of mine water caused negative impacts to water quality in Telegraph Creek during dewatering.

Table 13. Surface Water Discharge Measurements.

Sample ID	Sample Location	Date	Discharge (cfs)
LOB-SW01	Approximately 70 feet upstream of Waste Rock Pile 3 on Telegraph Creek	10/1/2010	0.43
LOB-SW03	Approximately 190 feet downstream of Waste Rock Pile 3 on Telegraph Creek	10/1/2010	0.38
LOB-SW05	Approximately 530 feet upstream of Waste Rock Pile 3 where the property line crosses Telegraph Creek	10/1/2010	0.03
LOB-SW06	Approximately 90 feet downstream of Waste Rock Pile 3 on Telegraph Creek	10/1/2010	0.012
LOB-SW07	Approximately 430 feet downstream of Waste Rock Pile 3 on Telegraph Creek	10/1/2010	0.08

cfs = cubic feet per second

Table 14. Surface Water Analytical Results - Field Parameters and Ions

Lilly/Orphan Boy Mine Site

Sample ID	Collection Date	Field Parameters							Physical Properties							Inorganics										Dissolvd Inorganics							
		Specific Conductivity (uS/cm)	pH	Temperature (Degrees F)	DO (mg/L)	DO (% Sat)	ORP (mV)	Turbidity (NTU)	Specific Conductance (µmhos/cm)	pH	Hardness (mg/L)	Total Dissolved Solids (mg/L)		Total Suspended Solids (mg/L)		Alkalinity, Total as $CaCO_3$ (mg/L)		Bicarbonate as HCO_3 (mg/L)		Carbonate as CO_3 (mg/L)		Chloride (mg/L)		Sulfate (mg/L)		Bicarbonate as HCO_3 (mg/L)		Carbonate as CO_3 (mg/L)		Chloride (mg/L)		Sulfate (mg/L)	
												result	flag	result	flag	result	flag	result	flag	result	flag	result	flag	result	flag	result	flag	result	flag	result	flag	result	flag
LOB-SW01-A-20100929	9/29/10	107	7.5	43.54	11.34	92.1	29.9		59	7	16.9	80		9.9	U	13.75	J	13.8		5	U	1	U	13.2		13.7		5	U	1	U	12.9	
LOB-SW01-A-20101206	12/6/10								68.5	7	17.8	17	J	10	U	12.1	J	11.8		5	U	2		16		12.4		5	U	1	U	15	
LOB-SW03-A-20100929	9/29/10	141	7.6	44.84	11.17	92.4	51.5		77.7	6.6	22.9	90		10	U	11	J	11.1		5	U	1	U	22.5		10.9		5	U	1	U	22.1	
LOB-SW03-A-20101013	10/13/10	147	6.85	41.25	12.92	101.5	106.3	4.8	82.5	6.7	21.9	86.3		10	U	11.8	J	11.9		5	U	1.4		23.2		11.7		5	U	1.2		22.5	
LOB-SW03-A-20101015	10/15/10	221	7	43.97	11.1	89.9	87.4	6.8	124	6.5	33.5	122		10	U	9.7	J	9.7		5	U	1.1		43.6		9.7		5	U	1.1		43.5	
LOB-SW03-A-20101017	10/17/10	163	7.15	36.09	9.23	67.5	56.9	4.8	89.6	6.5	23.4	106		9.9	U	10.3	J	10.1		5	U	1.1		28.8		10.5		5	U	1.1		28.2	
LOB-SW03-A-20101018	10/18/10	174	7.51	34.36	5.75	40.5	72.3	5	94.2	6.3	26.1	72		10	U	9.8	J	9.9		5	U	1.0		30.9		9.7		5	U	1.1		31.0	
LOB-SW03-A-20101019	10/19/10	234	6.84	39.47	9.41	72.1	96.5	6.5	128	6.2	35.5	68		10	U	5.3	J	5.2		5	U	2	U	50.9		5.4		5	U	1.0		54.6	
LOB-SW03-A-20101020	10/20/10	213	7.38	34.51	0.21	1.5	97.9	5.1	113	6.4	31.3	109		9.9	U	8	J	8.1		5	U	1.1		45.2		7.9		5	U	1.1		44.2	
LOB-SW03-A-20101021	10/21/10								135	6.3	35.8	103		10	U	5.95	J	5.9		5	U	2	U	54.2		6.0		5	U	1.1		56.4	
LOB-SW03-A-20101022	10/22/10	3	8.02	40.08	2.71	20.9	84.4	6.3	99.5	6.3	28.9	87		10	U	8.9	J	8.8		5	U	1.0		37.4		9.0		5	U	1.0		37.0	
LOB-SW03-A-20101206	12/6/10								67.1	7	18.1	67		17.7		11.65	J	11.3		5	U	1		16		12.0		5	U	1	U	16	
LOB-SW05-A-20100929	9/29/10	101	7.52	44.23	11.25	92.2	56.6		56.4	7.1	16.4	85		9.8	U	15.85	J	16.1		5	U	1	U	9.5		15.6		5	U	1	U	9.3	
LOB-SW05-A-20101007	10/7/10	111	7.83	43.01	11.7	94.2	78.4	3.8	59	6.9	17.6	94		9.7	U	14.65	J	17.3		5	U	1.1		9.4		12		5	U	1.1		11.6	
LOB-SW05-A-20101206	12/6/10								55.8	7.2	17.8	45		27.3	U	17.95	J	17.4		5	U	1		8		17.9		5	U	1	U	8	
LOB-SW06-A-20100929	9/29/10	122	7.54	46.64	11.08	93.9	44		66	7	20.5	94		15.3		12.7	J	12.8		5	U	1	U	16.0		12.6		5	U	1	U	15.5	
LOB-SW06-A-20101206	12/6/10								63.1	7.2	31.9	47		142		11.7	J	11.9		5	U	1	U	16		11.5		5	U	1	U	16	
LOB-SW07-A-20101001	10/1/10								87.2	6.2	24.1	104		5.2	U	11.55	J	11.4		5	U	1	U	24.7		11.7		5	U	1	U	24.4	
LOB-SW07-A-20101007	10/7/10	173	7.32	42.44	11.27	90.2	83.7	4.6	103	6.6	28.6	117		9.8	U	10.65	J	10.6		5	U	1.2		33.6		10.7		5	U	1.3		33.3	
LOB-SW07-A-20101013	10/13/10	166	6.96	41.66	12.75	100.8	100.5	4.5	91.7	6.6	24.9	97.5		10	U	11.4	J	11.2		5	U	1.1		26.2		11.6		5	U	1.1		26.1	
LOB-SW07-A-20101015	10/15/10	215	7.01	41367	11.25	89.1	96.7	5.7	120	6.6	34.7	114		9.7	U	9.75	J	9.9		5	U	1.2		41.6		9.6		5	U	1.2		41.5	
LOB-SW07-A-20101017	10/17/10	193	7.07	36.56	10.43	77	75.8	4.6	109	6.6	30.5	113		9.6	U	9.6	J	9.6		5	U	1.1		35.7		9.6		5	U	1.2		35.5	
LOB-SW07-A-20101018	10/18/10	200	7.32	34.47	7.88	56	84.2	4.5	110	6.2	31.6	77		9.9	U	9	J	9.3		5	U	1.1		38.7		8.7		5	U	1.1		38.0	
LOB-SW07-A-20101019	10/19/10	244	6.91	38.86	8.91	67.7	100.9	5	130	6.4	37.6	100		10	U	7.3	J	7.4		5	U	1.1		53.2		7.2		5	U	1.2		52.6	
LOB-SW07-A-20101020	10/21/10	249	7.13	34.68	0.26	1.8	105.7	7	133	6.4	38.6	51		9.7	U	7.45	J	7.4		5	U	1.1		54.6		7.5		5	U	1.1		54.0	
LOB-SW07-A-20101021	10/21/10	116	7.52	36.08	3.81	27.8	70.6	5.5	119	6.5	33	73		10	U	8.95	J	9.3		5	U	1.1		44.8		8.6		5	U	1.0		43.6	
LOB-SW07-A-20101022	10/22/10								112	6.3	34.1	100		10	U	8.85	J	9.0		5	U	1.0		42.4		8.7		5	U	1.0		42.6	
Surface Water Standards	Acute	--	--	--	--	--	--	--	--	6.5-8.5	--	--		--		--		--		--		--		--		--		--		--		--	
	Chronic	--	--	--	--	--	--	--	--	6.5-8.5	--	--		--		--		--		--		--		--		--		--		--		--	
	Human Health	--	--	--	--	--	--	--	--	6.5-8.5	--	--		--		--		--		--		--		--		--		--		--		--	

Notes:

Acute and Chronic levels are for aquatic life standards as listed in Circular DEQ-7, 2008.

U - the compound was analyzed for, but not detected

J- the result is an estimate

Table 15. Surface Water Analytical Results - Metals
Lilly/Orphan Boy Mine Site

Sample ID	Collection Date	Aluminum (mg/L)				Arsenic (mg/L)				Cadmium (mg/L)*				Copper (mg/L)*				Iron (mg/L)				Lead (mg/L)*				Manganese (mg/L)				Zinc (mg/L)*			
		Total	flag	Dissolved	flag	Total	flag	Dissolved	flag	Total	flag	Dissolved	flag	Total	flag	Dissolved	flag	Total	flag	Dissolved	flag	Total	flag	Dissolved	flag	Total	flag	Dissolved	flag	Total	flag	Dissolved	flag
LOB-SW01-A-20100929	9/29/10	0.092		0.062		0.003	U	0.003	U	0.00008	U	0.00008	U	0.0014		0.001		0.5	J+	0.34		0.0005	U	0.0005	U	0.14		0.16		0.022	J+	0.041	
LOB-SW01-A-20101206	12/6/10	0.12	J+	0.089		0.003	U	0.003	U	0.00008		0.00008		0.0012		0.001	U	0.63		0.33		0.0005	U	0.0005	U	0.19		0.18		0.08	J+	0.048	J+
LOB-SW03-A-20100929	9/29/10	0.22		0.13		0.015		0.012		0.0018		0.0018		0.0036		0.0026		0.71	J+	0.46		0.0021		0.0013		0.46		0.49		0.38		0.38	
LOB-SW03-A-20101013	10/13/10	0.27	J+	0.11	J-	0.024		0.0075		0.0018		0.0015		0.0033		0.0022		1.3		0.3		0.0033		0.0007		0.53		0.38		0.31		0.28	
LOB-SW03-A-20101015	10/15/10	0.28	J+	0.11		0.029		0.0067		0.0033		0.003		0.0032		0.0019		1.3		0.25		0.0028		0.00057		0.68		0.61		0.52		0.5	
LOB-SW03-A-20101017	10/17/10	0.25		0.16		0.015		0.0074		0.003		0.0026		0.0039		0.0033		0.72		0.26		0.0026		0.0011		0.55		0.52		0.44		0.43	
LOB-SW03-A-20101018	10/18/10	0.41		0.17		0.019		0.0054		0.0054	J+	0.0052		0.006		0.004		1.1		0.23		0.004		0.00099		0.66		0.58		0.6		0.68	J+
LOB-SW03-A-20101019	10/19/10	0.56		0.056		0.026		0.003	U	0.0093		0.0097		0.01		0.0059		1.3		0.05	U	0.0065		0.0005	U	1		1.1		1.3		1.2	
LOB-SW03-A-20101020	10/20/10	0.47		0.067		0.027		0.003	U	0.0074		0.007		0.0075		0.0042		1.1		0.063		0.005		0.0005	U	0.82		0.8		0.9		0.79	
LOB-SW03-A-20101021	10/21/10	0.6		0.054		0.032		0.0032		0.011		0.011		0.012		0.0063		1.3		0.05	U	0.0069		0.0005	U	1.1		1.1		1.4		1.3	
LOB-SW03-A-20101022	10/22/10	0.36		0.13		0.019		0.0046		0.0063		0.006		0.0074		0.0046		0.83		0.15		0.0038		0.00075		0.67		0.64		0.72		0.81	
LOB-SW03-A-20101206	12/6/10	0.25	J+	0.054		0.026		0.0046		0.00049		0.00017		0.0015		0.001	U	1.7		0.18		0.0037		0.0005	U	0.54		0.2		0.092	J+	0.063	J+
LOB-SW05-A-20100929	9/29/10	0.085		0.063		0.0035		0.003	U	0.00008	U	0.00008	U	0.0012		0.001	U	0.19	J+	0.14		0.0005	U	0.0005	U	0.085		0.083		0.016	J+	0.031	
LOB-SW05-A-20101007	10/7/10	0.079	J+	0.046	J-	0.0035		0.003	U	0.00008	U	0.00008	U	0.001	U	0.0011		0.2		0.079		0.0005	U	0.0005	U	0.092		0.0072		0.015	J+	0.013	
LOB-SW05-A-20101206	12/6/10	0.2	J+	0.046		0.0094		0.0035		0.00028	U	0.00008	U	0.0019		0.001	U	0.91		0.079		0.0011	U	0.00077		0.15		0.042		0.083	J+	0.032	J+
LOB-SW06-A-20100929	9/29/10	0.099		0.063		0.012		0.009		0.00041		0.0005		0.0015		0.0011		0.65	J+	0.35		0.00069		0.0005	U	0.29		0.28		0.12		0.14	
LOB-SW06-A-20101206	12/6/10	0.29	J+	0.072		0.027		0.0052		0.00046		0.00024		0.0018		0.0033		1.8		0.21		0.0056		0.0005		0.59		0.2		0.084	J+	0.085	J+
LOB-SW07-A-20101001	10/1/10	0.17		0.086		0.014		0.0079		0.0025		0.0022		0.0038		0.0029		0.54	J+	0.23		0.0013		0.00063		0.46		0.35		0.48		0.43	
LOB-SW07-A-20101007	10/7/10	0.16		0.094		0.014		0.007		0.0031		0.0029		0.0038		0.0032		0.47		0.18		0.0013		0.0005	U	0.52		0.45		0.56		0.54	
LOB-SW07-A-20101013	10/13/10	0.19		0.11		0.015		0.0071		0.0029		0.0025		0.0042		0.0032		0.68		0.27		0.0014		0.00053		0.5		0.38		0.47		0.44	
LOB-SW07-A-20101015	10/15/10	0.21	J+	0.11		0.017		0.0071		0.0042		0.0037		0.0046		0.0035		0.68		0.2		0.0015		0.0005	U	0.58		0.54		0.63		0.62	
LOB-SW07-A-20101017	10/17/10	0.21	J+	0.14		0.012		0.0076		0.0041		0.0039		0.0051		0.004		0.47		0.2		0.0013		0.00055		0.56		0.54		0.63		0.63	
LOB-SW07-A-20101018	10/18/10	0.29		0.11		0.014		0.0048		0.0057	J+	0.0054		0.0061		0.0044		0.69		0.15		0.0019		0.00052		0.65		0.64		0.77		0.8	J+
LOB-SW07-A-20101019	10/19/10	0.36		0.03	U	0.021		0.003		0.0082		0.0078		0.0083		0.0036		0.84		0.05	U	0.0029		0.0005	U	0.85		0.82		1.2		1	
LOB-SW07-A-20101020	10/21/10	0.36		0.03	U	0.018		0.003	U	0.0075		0.0073		0.0073		0.0044		0.75		0.059		0.0024		0.0005	U	0.79		0.81		1.1		0.96	
LOB-SW07-A-20101021	10/21/10	0.31		0.1		0.017		0.0052		0.0062		0.0062		0.0069		0.0044		0.73		0.13		0.0027		0.0005	U	0.63		0.65		0.88		0.8	
LOB-SW07-A-20101022	10/22/10	0.28		0.11		0.013		0.0057		0.0059		0.0058		0.0063		0.0044		0.51		0.13		0.0017		0.0005	U	0.63		0.66		0.86		0.84	
Surface Water Standards	Acute	0.75				0.34				see Appendix J				see Appendix J				--				see Appendix J				--				see Appendix J			
	Chronic	0.087				0.15				see Appendix J				see Appendix J				1.0				see Appendix J				--				see Appendix J			
	Human Health	--				0.01				0.005				1.3				0.3 (aesthetic)				0.015				0.05 (aesthetic)				2.0			

Notes:

Acute and Chronic levels are for aquatic life standards as listed in Circular DEQ-7, 2010.

* - these aquatic life standards are hardness dependent.

Flag Qualifiers:

U - the compound was analyzed for, but not detected.

J - estimate

J+ = high estimate

Table 16. Surface Water Analytical Results - Common Cations

Lilly/Orphan Boy Mine Site

Sample ID	Collection Date	Common Cations							
		Calcium Dissolved (mg/L)		Magnesium Dissolved (mg/L)		Potassium Dissolved (mg/L)		Sodium Dissolved (mg/L)	
		result	flag	result	flag	result	flag	result	flag
LOB-SW01-A-20100929	9/29/10	4.9		1.1		1	U	4.1	
LOB-SW01-A-20101206	12/6/10	5.2		1.2		1	U	4.2	
LOB-SW03-A-20100929	9/29/10	6.6		1.5		1.1		4.3	
LOB-SW03-A-20101013	10/13/10	6.3		1.5		1.1		4.3	
LOB-SW03-A-20101015	10/15/10	9.7		2.2		1.3		6.2	
LOB-SW03-A-20101017	10/17/10	6.6		1.6		1.1		4.5	
LOB-SW03-A-20101018	10/18/10	7.4		1.8		1.1		5	
LOB-SW03-A-20101019	10/19/10	9.9		2.6		1.3		6.3	
LOB-SW03-A-20101020	10/20/10	8.7		2.3		1.2		6.1	
LOB-SW03-A-20101021	10/21/10	9.9		2.7		1.3		7	
LOB-SW03-A-20101022	10/22/10	8.2		2		1.2		5.7	
LOB-SW03-A-20101206	12/6/10	5.3		1.2		1	U	4	
LOB-SW05-A-20100929	9/29/10	4.8		1.1		1	U	3.9	
LOB-SW05-A-20101007	10/7/10	5.2		1.1		1.1		4.2	
LOB-SW05-A-20101206	12/6/10	5.3		1.1		1	U	3.5	
LOB-SW06-A-20100929	9/29/10	6.1		1.3		1		4.2	
LOB-SW06-A-20101206	12/6/10	10.5		1.4		1.1		4.6	
LOB-SW07-A-20101001	10/1/10	6.8		1.7		1.1		4	
LOB-SW07-A-20101007	10/7/10	8.2		2		1.2		4.7	
LOB-SW07-A-20101013	10/13/10	7.1		1.8		1.1		4.3	
LOB-SW07-A-20101015	10/15/10	10.1		2.3		1.3		5.8	
LOB-SW07-A-20101017	10/17/10	8.8		2.1		1.2		5	
LOB-SW07-A-20101018	10/18/10	9.1		2.2		1.2		5.2	
LOB-SW07-A-20101019	10/19/10	10.5		2.8		1.2		6.2	
LOB-SW07-A-20101020	10/21/10	10.7		2.9		1.3		6.5	
LOB-SW07-A-20101021	10/21/10	9.2		2.4		1.2		5.8	
LOB-SW07-A-20101022	10/22/10	9.7		2.4		1.2		5.7	

Notes:

U - the compound was analyzed for, but not detected

5.3.3 Groundwater Sampling and Analysis Results

Groundwater samples were collected from the monitoring wells on September 29, 2010, prior to the start of mine dewatering. The sampling effort resulted in the collection and laboratory analysis of five baseline groundwater samples from the bedrock aquifer and three QC samples (i.e., a rinsate blank, field blank, and field duplicate). The analytical results have been reviewed and flagged with appropriate qualifiers and are shown in Table 17 and Table 18.

Per the SAP/QAPP, groundwater samples were analyzed for total metals to allow comparison with the mine water quality (TerraGraphics, 2010b).

The samples were analyzed for total concentrations of aluminum, arsenic, cadmium, copper, iron, lead, manganese, and zinc. Although each well had detectable concentrations for each metal, groundwater quality in the monitoring wells is generally good. pH values ranged from 6.28 to 7.79. Total arsenic was highest in LOB-MW02 (0.083 mg/L) and lowest in LOB-MW04 (0.0032 mg/L) and LOB-MW05 (0.0064 mg/L). Total cadmium was highest in LOB-MW03 (0.11 mg/L) and lowest in LOB-MW05 (0.00015 mg/L). Total copper was highest in LOB-MW01 (0.012 mg/L) and lowest in LOB-MW05 (0.0057 mg/L). Total iron was highest in LOB-MW02 (27 mg/L) and lowest in LOB-MW04 (0.22 mg/L); the total iron concentrations were qualified as estimates, biased high. Total lead was highest in LOB-MW02 (0.056 mg/L) and lowest in LOB-MW04 (0.0014 mg/L). Total manganese was highest in LOB-MW02 (12.5 mg/L) and lowest in LOB-MW04 (0.37 mg/L). Total zinc was highest in LOB-MW03 (15.3 mg/L) and lowest in LOB-MW05 (0.054 mg/L).

Table 17. Groundwater Analytical Results - Field Parameters and Ions

Lilly/Orphan Boy Mine Site

Sample ID	Collection Date		Field Parameters					Physiochemical				Inorganics										Dissolved Inorganics									
		Depth to Water (ft)	Specific Conductance (µmhos/cm)	pH	Temperature (Degrees F)	DO (mg/L)	ORP (mV)	Specific Conductance (µmhos/cm)	pH at 25 Degrees C	Total Dissolved Solids (mg/L)	Total Suspended Solids (TSS)	Bicarbonate as HCO_3 (mg/L)		Carbonate as CO_3 (mg/L)		Alkalinity, Total as CaCO3 (mg/L)		Chloride (mg/L)		Sulfate (mg/L)		Bicarbonate as HCO_3 (mg/L)		Carbonate as CO_3 (mg/L)		Alkalinity, Total as CaCO3 (mg/L)		Chloride (mg/L)		Sulfate (mg/L)	
										Result	Result	Result	Flag	Result	Flag	Result	Flag	Result	Flag	Result	Flag	Result	Flag	Result	Flag	Result	Flag	Result	Flag	Result	Flag
LOB-MW01-A-20100929	9/29/10	66.19	628	7.28	43.79	8.43	-35.7	314	7.4	218	149	92.2		5	U	92.2		3.4		56.4		89.1		5	U	89.1		3.3		56	
LOB-MW02-A-20100929	9/29/10	70.82	2028	6.47	41.8	6.55	45.8	1090	5.7	942	101	5	U	5	U	5	U	15.7		594		5	U	5	U	5	U	15.2		607	
LOB-MW03-A-20100929	9/29/10	8.11	1481	7.2	44.37	11.47	54.6	808	6.4	666	53.9	10.2		5	U	10.2		1.2		438		10		5	U	10		1.2		419	
LOB-MW04-A-20100929	9/29/10	8.31	1698	6.28	43.42	9.23	132	917	6.3	777	33.3	8.9		5	U	8.9		1.2		543		8.5		5	U	8.5		1.2		511	
LOB-MW05-A-20100929	9/29/10	27.36	446	7.79	47.67	9.77	28.2	242	7.2	237	93.3	56.7		5	U	56.7		20.3		24		56.3		5	U	56.3		19.8		23.1	

Notes:

U - the compound was analyzed for, but not detected; detection limit reported

Table 18. Groundwater Analytical Results - Total Metals

Lilly/Orphan Boy Mine Site

Sample ID	Date Collected	Aluminum (mg/L)		Arsenic (mg/L)		Cadmium (mg/L)		Copper (mg/L)		Iron (mg/L)		Lead (mg/L)		Manganese (mg/L)		Zinc (mg/L)	
		Total	flag	Total	flag	Total	flag	Total	flag	Total	flag	Total	flag	Total	flag	Total	flag
LOB-MW01-A-20100929	9/29/10	0.64		0.019		0.00064		0.012		2.3	J+	0.02		1.4		0.47	
LOB-MW02-A-20100929	9/27/10	0.79		0.083		0.0074		0.0059		27	J+	0.056		12.5		11.7	
LOB-MW03-A-20100929	9/29/10	0.61		0.069		0.11		0.011		0.76	J+	0.014		0.49		15.3	
LOB-MW04-A-20100929	9/29/10	0.29		0.0032		0.016		0.0078		0.22	J+	0.0014		0.37		13.3	
LOB-MW05-A-20100929	9/29/10	2.5		0.0064		0.00015		0.0057		2.4	J+	0.01		0.63		0.054	J+

Notes:

J+ = high estimated concentration

5.3.4 Groundwater Elevations and Flow Direction

A water table map (**Error! Reference source not found.**) was developed using the water surface elevations measured on September 30, 2010, to approximate the pre-pumping groundwater flow direction at the site. A water table map is a specific type of potentiometric surface map that shows lines (contours) of equal elevation for the water table. The water table elevations are presented in Table 19. The water table map illustrates that the local water table sloped to the north-northwest on September 30, 2010.

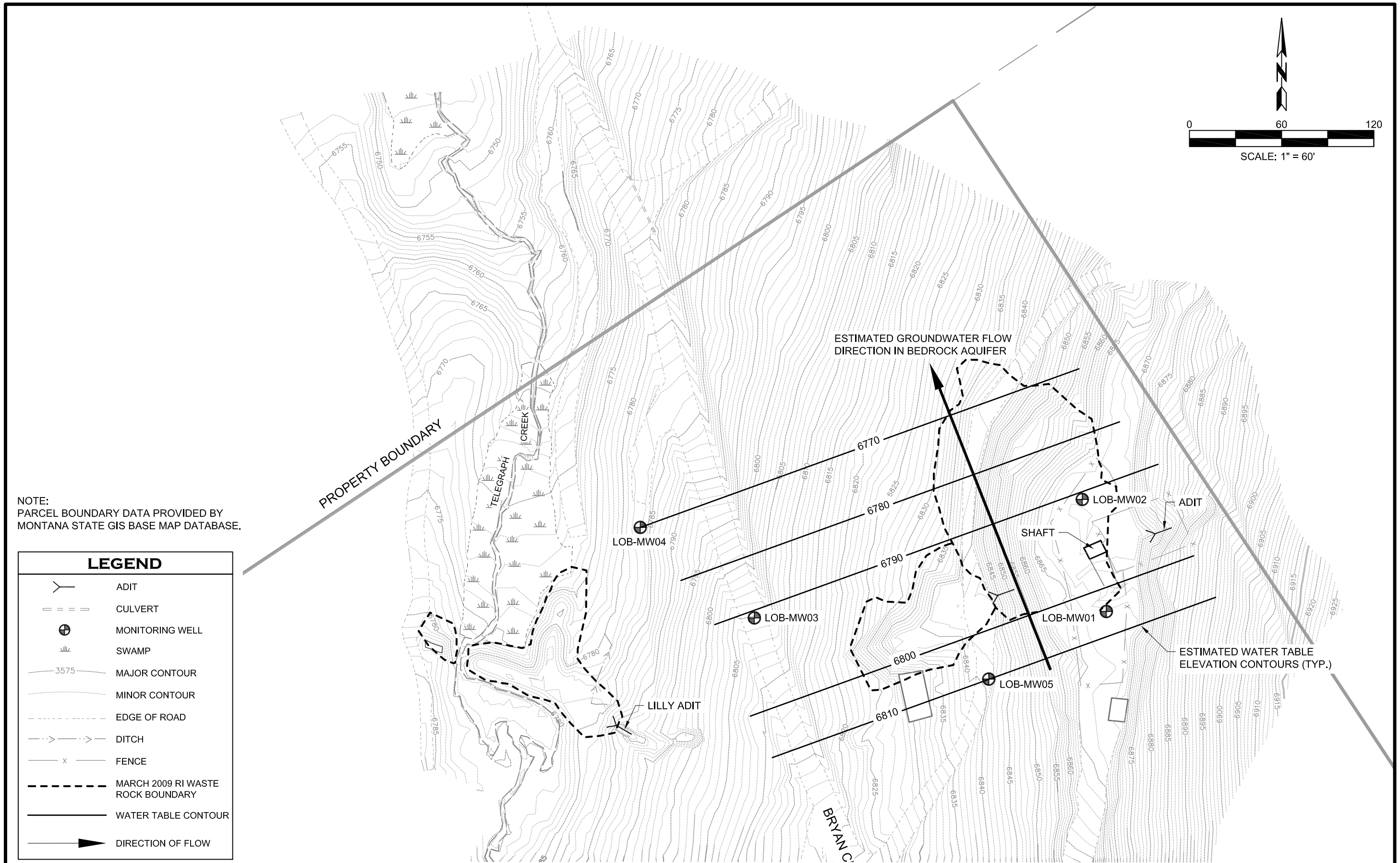
Table 19. Monitoring Well and Piezometer Static Water Levels Collected on 9/29/2010

Well Identification	Well Depth (bgs)	Top of Casing Elevation (ft)	Depth to Groundwater (ft below top of casing on 9/29/2010)	Static Water Level Elevation (ft)
LOB-MW01	122 ft	6868.55	66.19	6802.36
LOB-MW02	113 ft	6867.50	70.82	6796.68
LOB-MW03	30 ft	6804.48	8.11	6796.37
LOB-MW04	25 ft	6782.63	8.31	6774.32
LOB-MW05	55 ft	6840.14	27.36	6812.78
LOB-PZ01	6 ft	6869.69	Dry	--
LOB-PZ02	7 ft	6817.91	Dry	--
LOB-PZ03	7.5 ft	6800.24	small amt of water	--

Three groundwater elevation cross-sections are shown in **Error! Reference source not found.**, 28 and 29, each containing three profiles. The three profiles represent groundwater surface elevations before mine dewatering began (September 30, 2010), immediately after mine dewatering was completed (October 22, 2010), and near the end of the field investigation (December 2, 2010). These profiles show several trends:

- Water in LOB-MW01 and LOB-MW02 responded strongly to dewatering;
- Water in LOB-MW03, LOB-MW04, and LOB-MW05 did not respond or responded slightly to dewatering; and
- Groundwater flow direction remained constant during the duration of the field investigation.

On September 29, 2010, piezometers LOB-PZ01 and LOB-PZ02 were dry and piezometer LOB-PZ03 contained only a small amount of water at its base. These data indicate that the surface soils are relatively well drained and that only the bedrock aquifer is present beneath the site. Water may flow on top of the bedrock laterally or infiltrate where the bedrock is weathered or fractured. Surface water that infiltrates the thin soils and waste rock across the site may enter the drift along fractures to form seeps within the workings.



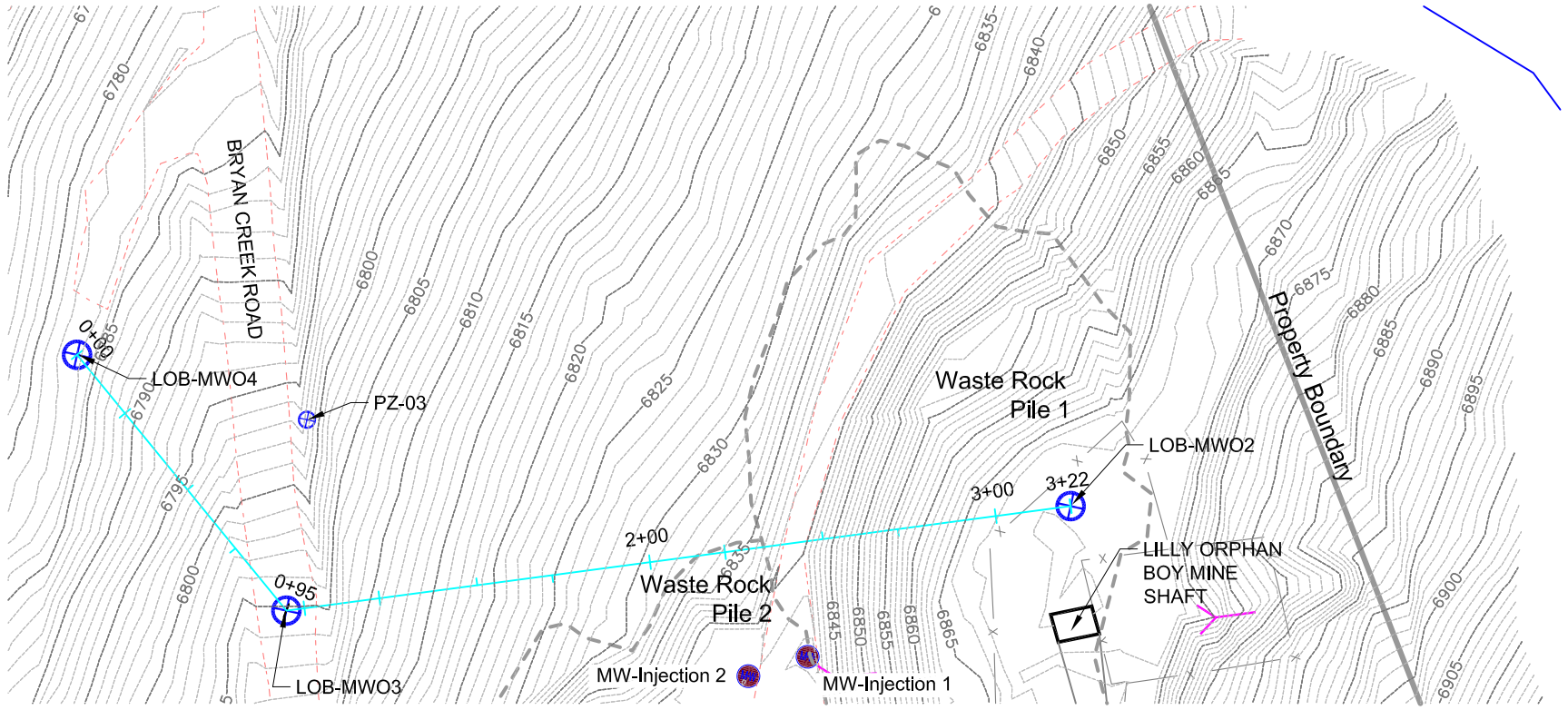
NOTE:
PARCEL BOUNDARY DATA PROVIDED BY
MONTANA STATE GIS BASE MAP DATABASE.

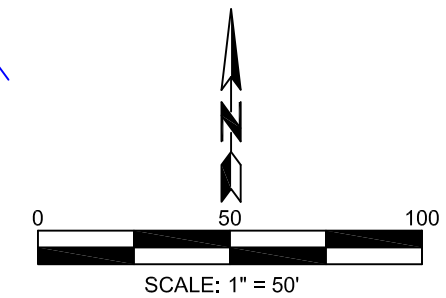
LEGEND

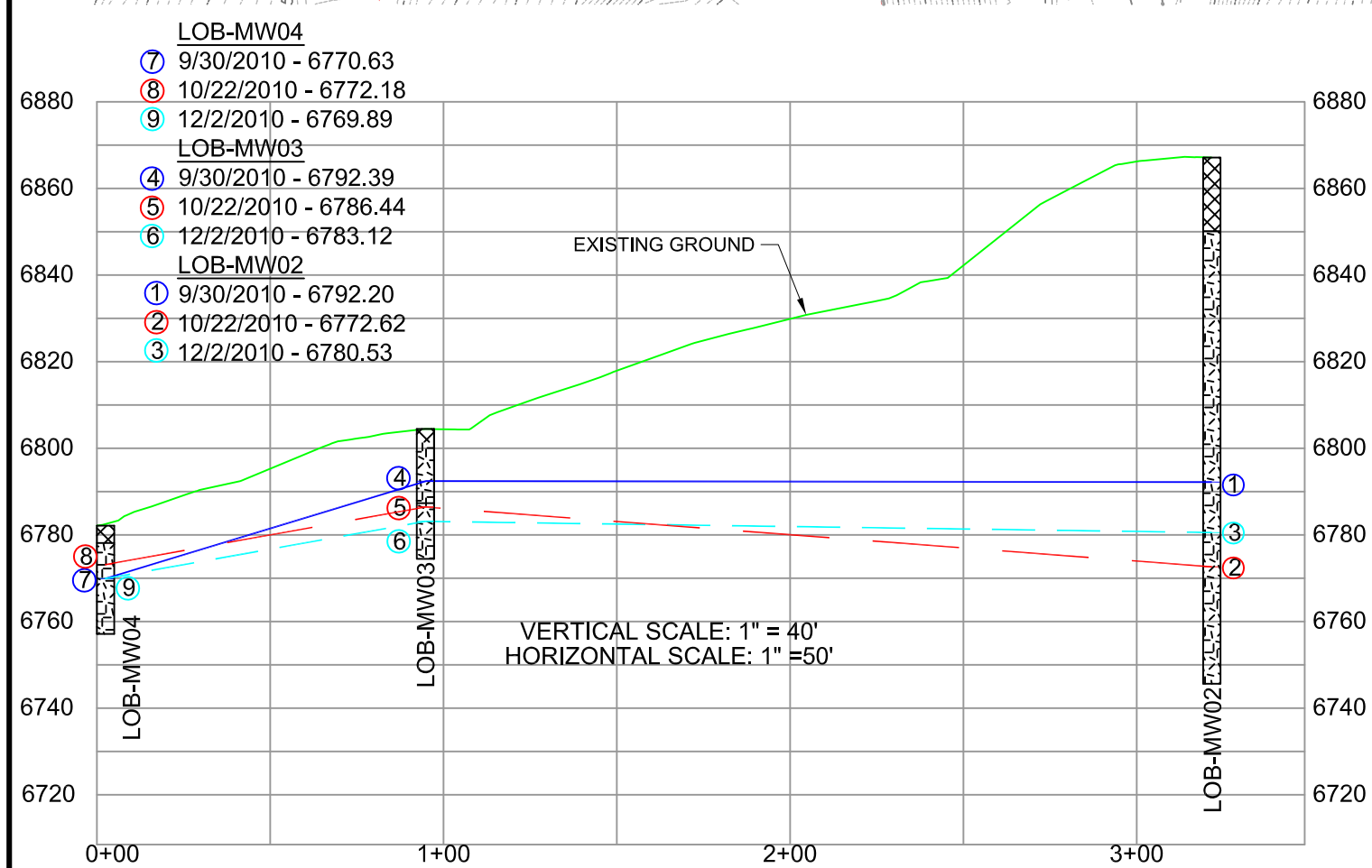
- ADIT
- CULVERT
- MONITORING WELL
- SWAMP
- 3575 MAJOR CONTOUR
- MINOR CONTOUR
- EDGE OF ROAD
- DITCH
- FENCE
- MARCH 2009 RI WASTE ROCK BOUNDARY
- WATER TABLE CONTOUR
- DIRECTION OF FLOW

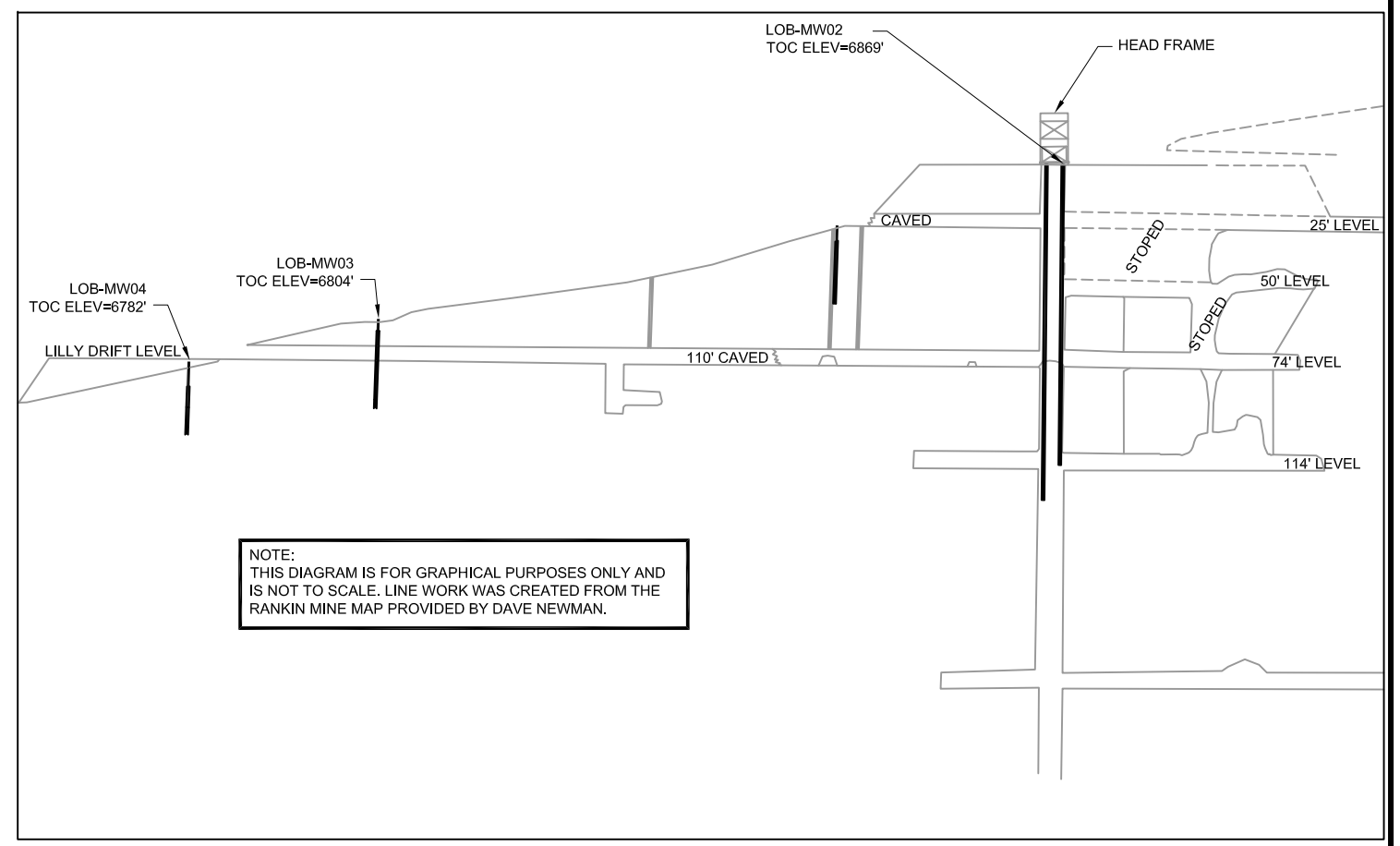
DRAWN: DJK	PROJECT NO.: 10103	TerraGraphics Environmental Engineering, Inc.	WATER TABLE MAP
PROJECT MANAGER JWM	SCALE: 1" = 60'		SEPTEMBER 30, 2010
CHECKED: JWM	APPROVED: JWM		LILLY/ORPHAN BOY ABANDONED MINE SITE
	DATE: 2/4/2011		FIGURE: 26
			DATE: 2/4/2011

Y:\09210 - Lilly-Orphan Boy Mine\E. Deliverables\a. Reports\Ph II RI\Drawings\FIGURE 7 WATER TABLE MAP.dwg









TerraGraphics Environmental Engineering, Inc.

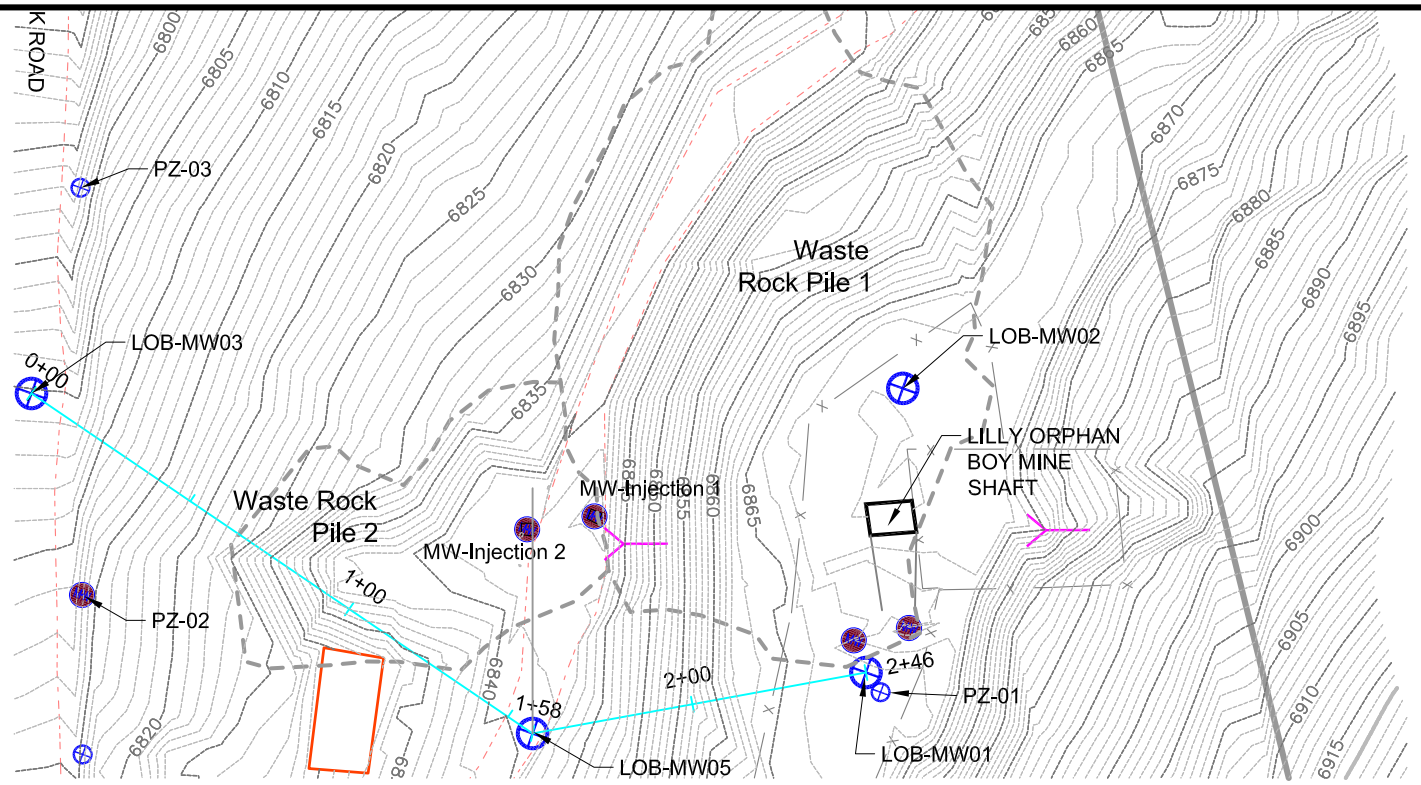
DRAWN: D.KLIMA			
PROJECT MANAGER: T. SMITH	SCALE: AS SHOWN		
CHECKED: S. FIROR	APPROVED: J.MICKEY		
DATE: 3/8/2011	DATE: 3/82011		

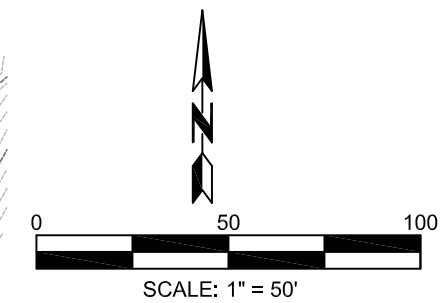
FIGURE 27. GROUNDWATER PLAN AND PROFILES

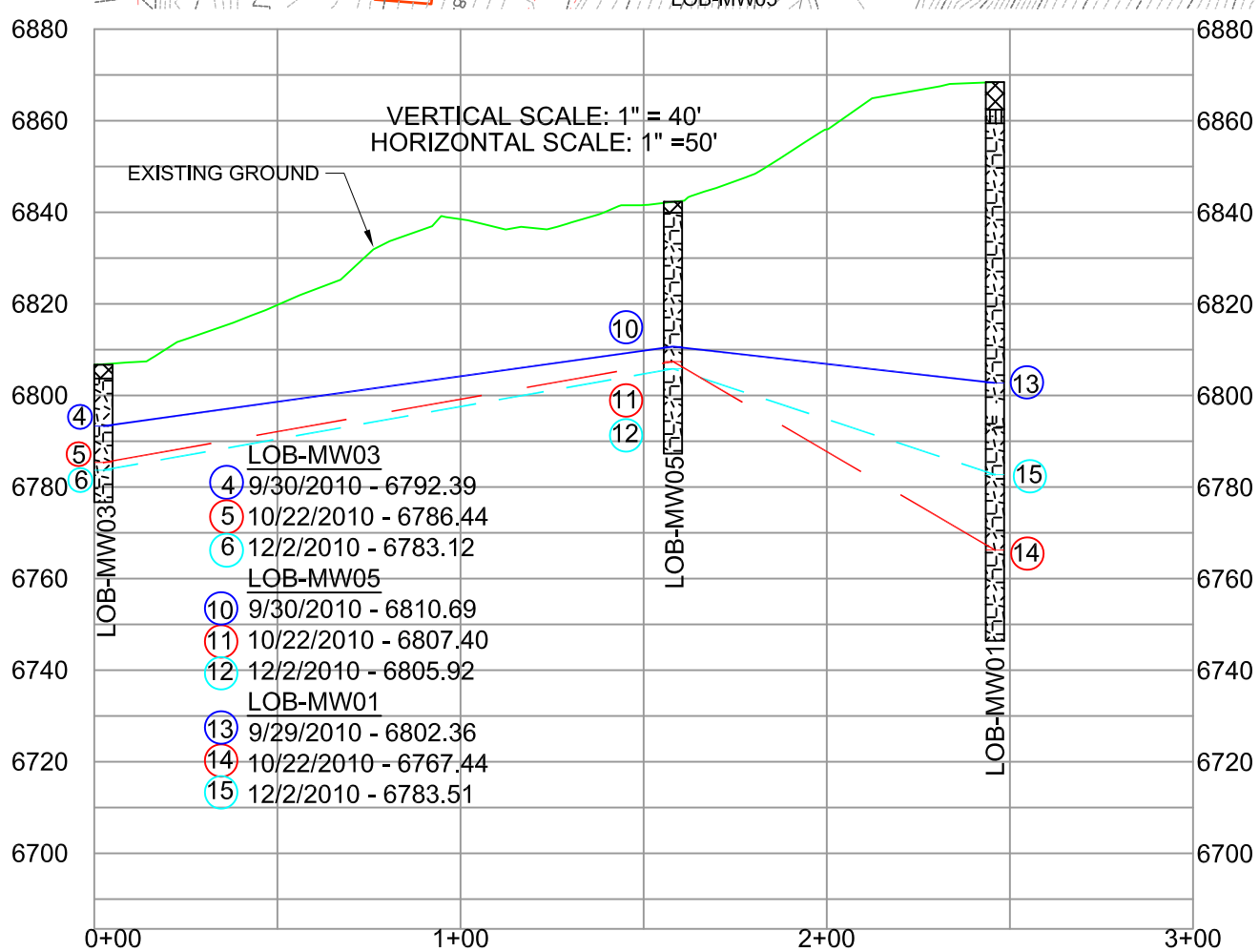
CROSS-SECTION BETWEEN MONITORING WELLS

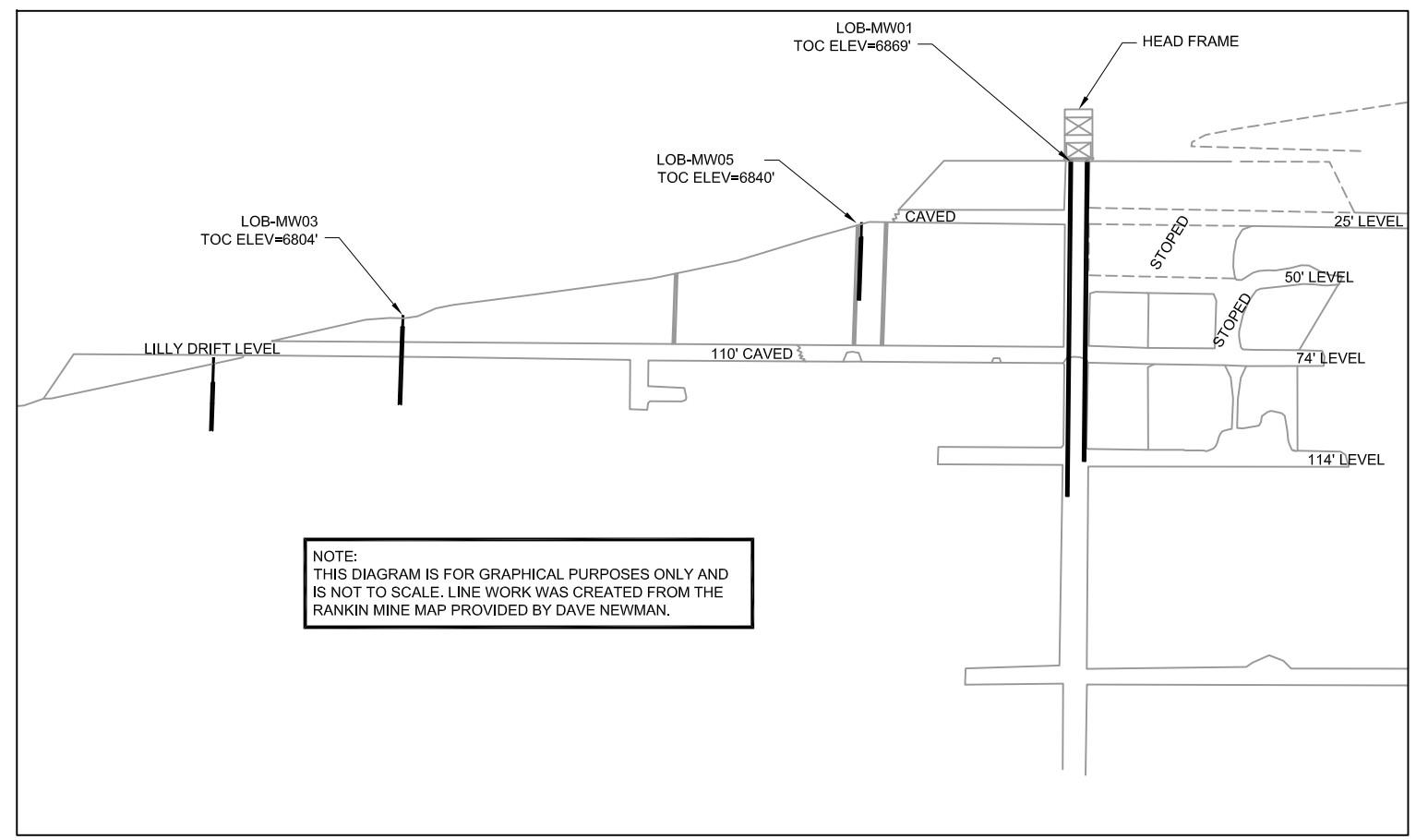
LILLY/ORPHAN BOY ABANDONED MINE SITE

SHEET INDEX: P.1
PROJECT NO.: 10103
DATE: 9/4/2011









TerraGraphics Environmental Engineering, Inc.

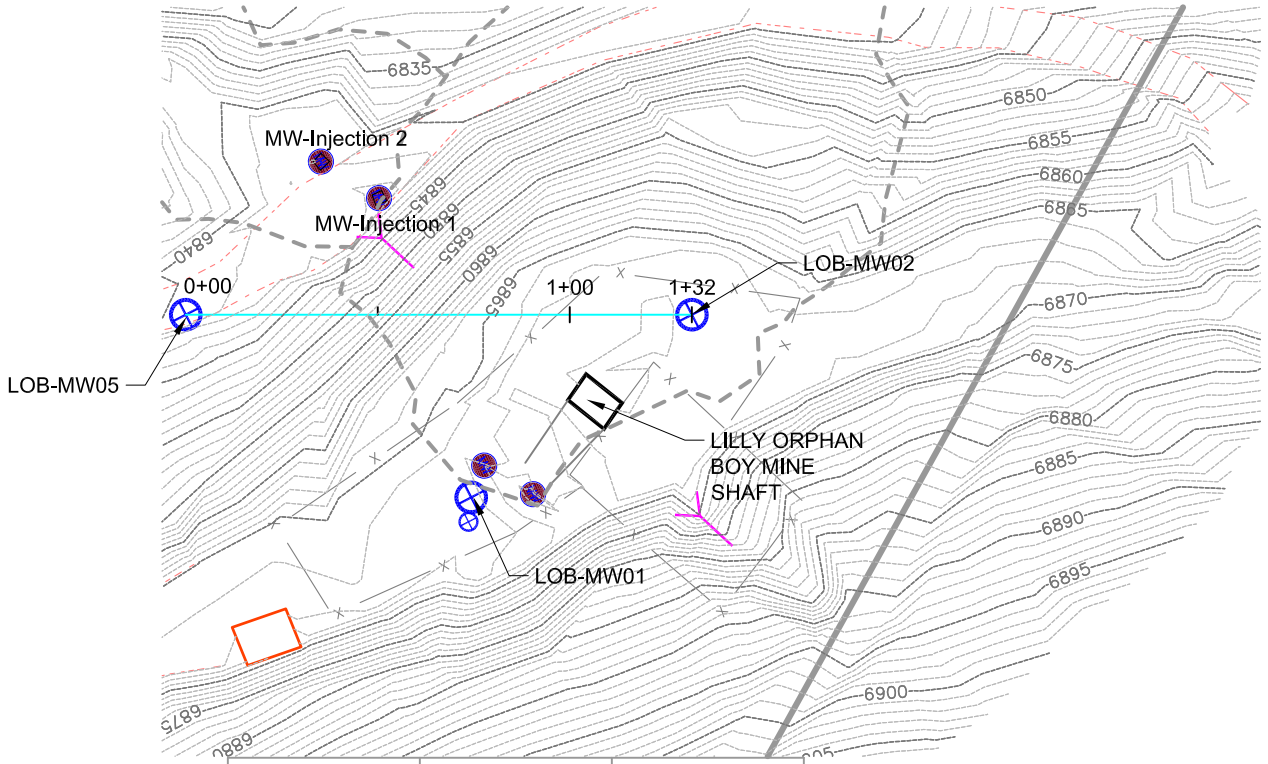
DRAWN: D.KLIMA			
PROJECT MANAGER: T. SMITH	SCALE: AS SHOWN		
CHECKED: S. FIROR	APPROVED: J.MICKEY		
DATE: 3/8/2011	DATE: 3/8/2011		

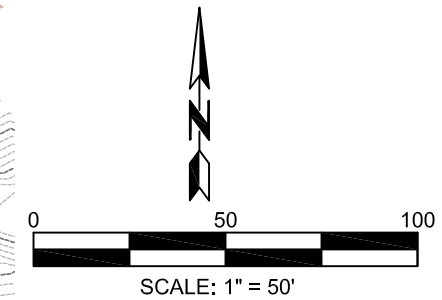
FIGURE 28. GROUNDWATER PLAN AND PROFILES

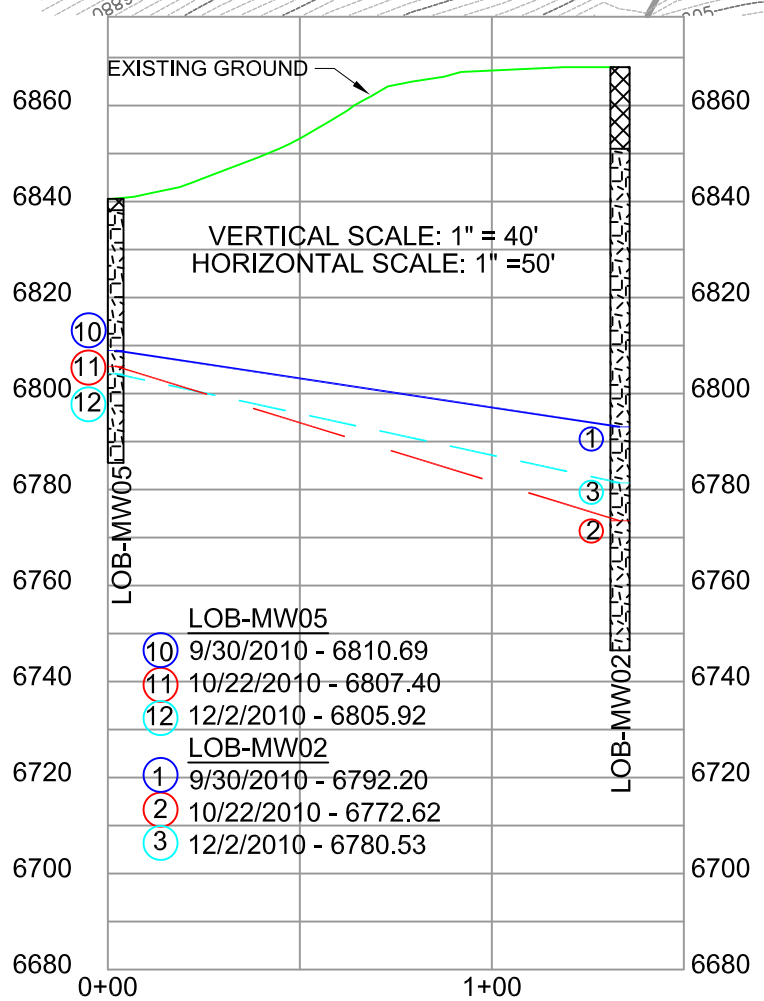
CROSS-SECTION BETWEEN MONITORING WELLS

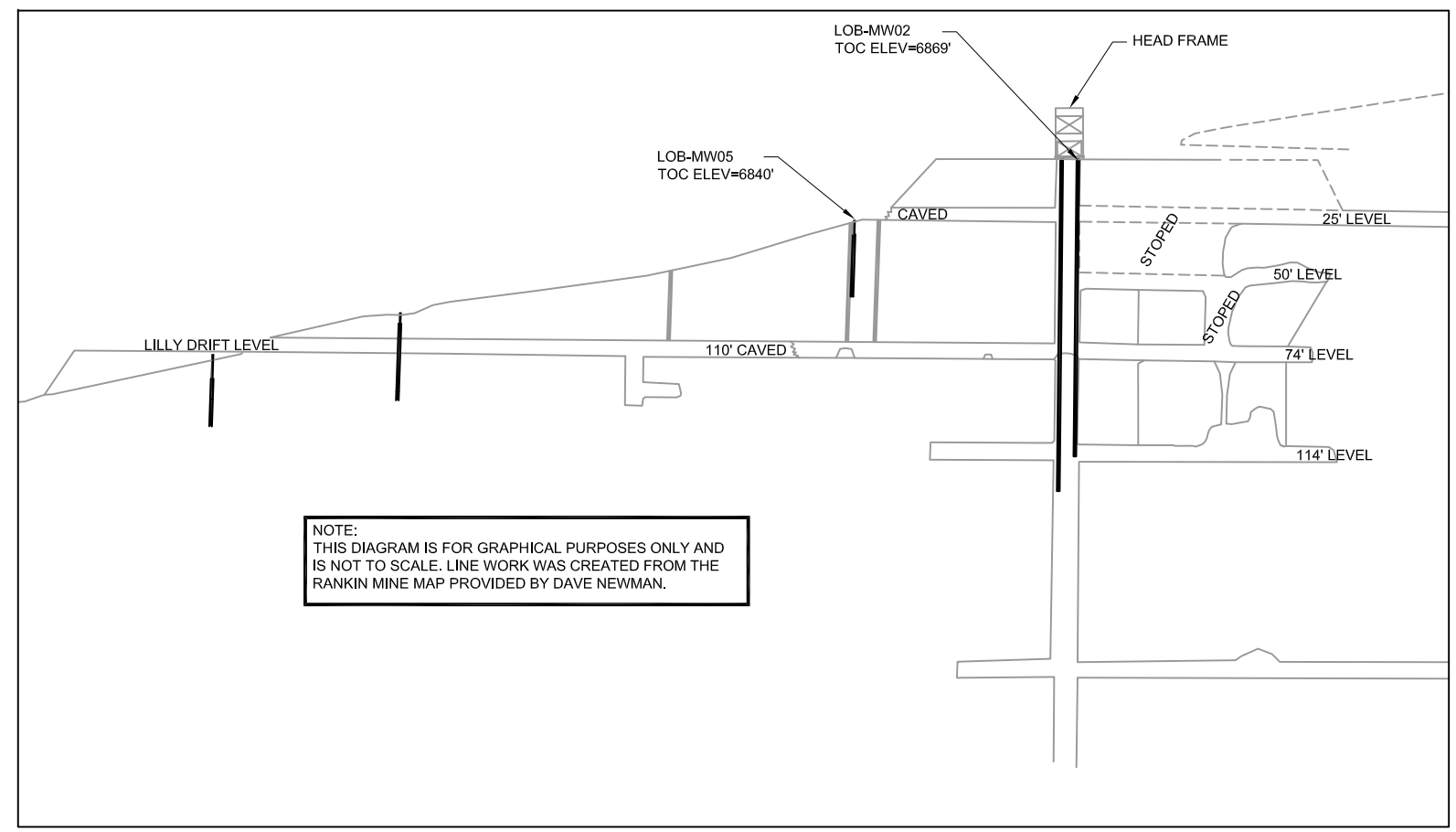
LILLY/ORPHAN BOY ABANDONED MINE SITE

SHEET INDEX: P.2
PROJECT NO.: 10103
DATE: 9/20/2011









NOTE:
THIS DIAGRAM IS FOR GRAPHICAL PURPOSES ONLY AND IS NOT TO SCALE. LINE WORK WAS CREATED FROM THE RANKIN MINE MAP PROVIDED BY DAVE NEWMAN.

TerraGraphics Environmental Engineering, Inc.

DRAWN: D.KLIMA			
PROJECT MANAGER: T. SMITH	SCALE: AS SHOWN	FIGURE 29. GROUNDWATER PLAN AND PROFILES	LILLY/ORPHAN BOY ABANDONED MINE SITE
CHECKED: S. FIROR	APPROVED: J.MICKEY	CROSS-SECTION BETWEEN MONITORING WELLS	
DATE: 3/8/2011	DATE: 3/8/2011		

SHEET INDEX: P.3
PROJECT NO.: 10103
DATE: 9/20/2011

5.3.5 Mine Water Sampling Results

Water samples were collected from the mine shaft on eight occasions while dewatering was underway from October 13 through 26, 2010, and were analyzed for total concentrations of aluminum, arsenic, cadmium, copper, iron, lead, manganese, and zinc. Results are shown in Table 20 and Table 21. All total metals concentrations, with the exception of cadmium, increased from October 13 to October 15, 2010. This was the greatest percent change over the period of record. Concentrations then decreased on October 18, 2010 and increased on October 19, 2010. After the pump was turned off (October 26, 2010 sample), total metals concentrations continued to decrease with the exception of cadmium, which increased.

Table 20. Mine Shaft Water Analytical Results - Physiochemical Parameters and Common Anions

Lilly/Orphan Boy Mine Site

Sample ID	Collection Date	Sample Depth	Physiochemical						Iorganics										Dissolved Inorganics									
			Specific Conductance (µmhos/cm)	pH at 25 Degrees C	Total Dissolved Solids (mg/L)		Total Suspended Solids (mg/L)		Bicarbonate as HCO_3 (mg/L)		Carbonate as CO_3 (mg/L)		Alkalinity, Total as $CaCO_3$ (mg/L)		Chloride (mg/L)		Sulfate (mg/L)		Bicarbonate as HCO_3 (mg/L)		Carbonate as CO_3 (mg/L)		Alkalinity, Total as $CaCO_3$ (mg/L)		Chloride (mg/L)		Sulfate (mg/L)	
					result	flag	result	flag	result	flag	result	flag	result	flag	result	flag	result	flag	result	flag	result	flag	result	flag	result	flag	result	flag
LOB-SH01-A-20101013	10/13/10	102.5	795	3.3	535		59.8		5	U	5	U	5	U	5	U	352		5.0	U	5.0	U	5.0	U	1.1		3.3	
LOB-SH01-A-20101016	10/15/10	Not Measured[a]	757	3.6	59.1		1470		5	U	5	U	5	U	5	U	427		5.0	U	5.0	U	5.0	U	1.2		477	
LOB-SH01-A-20101018	10/18/10	117.5	889	5.0	560		1460		5	U	5	U	5	U	5	U	558		5.0	U	5.0	U	5.0	U	5.0	U	243	
LOB-SH01-A-20101019	10/19/10	127.2	713	3.6	480		239		5	U	5	U	5	U	5	U	381		5.0	U	5.0	U	5.0	U	5.0	U	385	
LOB-SH01-A-20101020	10/20/10	Not Measured[a]	551	5.8	254		39.2		8.8		5	U	8.8		10	U[b]	299		14.0		5.0	U	14.0		5.0	U	289	
LOB-SH01-A-20101021	10/21/10	146.9	479	5.9	401		38.8		19		5	U	19		5	U	260		27.6		5.0	U	27.6		5.0	U	253	
LOB-SH01-A-20101022	10/22/10	Not Measured[a]	485	6.0	397		25.8		12.8		5	U	12.8		5	U	239		29.5		5.0	U	29.5		5.0	U	241	
LOB-SH01-A-20101026	10/26/10	Not Measured[a]	401	5.9	314		32		5	U	5	U	5	U	3	U	205		12.1		5.0	U	12.1		2.0	U	199	

Notes:

[a] Depth difficult to measure accurately due to dip in shaft

U - the compound was analyzed for, but not detected; detection limit reported

[b]Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference

Table 21. Mine Shaft Water Analytical Results - Total Metals

Lilly/Orphan Boy Mine Site

Sample ID	Collection Date	Sample Depth (ft)	Aluminum		Arsenic (mg/L)		Cadmium		Copper (mg/L)*		Iron (mg/L)		Lead (mg/L)*		Manganese		Zinc (mg/L)*	
			Total	flag	Total	flag	Total	flag	Total	flag	Total	flag	Total	flag	Total	flag	Total	flag
LOB-SH01-A-20101013	10/13/2010	102.5	4.3	J+	2.2	J	0.19	J	0.08	J	41.7	J	0.096	J	7.7	J	19.1	J
LOB-SH01-A-20101016	10/15/2010	Not Measured[a]	31.8	J+	73.8	J	0.1	J	0.67	J	154	J	6.5	J	10.9	J	25.6	J
LOB-SH01-A-20101018	10/18/2010	117.5	1.3	J	10.8	J	0.026	J+	0.025	J	75.3	J	0.24	J	9.8	J	12.4	J
LOB-SH01-A-20101019	10/19/2010	127.2	6.9	J	30.3	J	0.065	J	0.14	J	92.2	J	2.1	J	9.7	J	15.2	J
LOB-SH01-A-20101020	10/20/2010	Not Measured[a]	0.42	J	5.9	J	0.093	J	0.011	J	58.8	J	0.084	J	7.5	J	12.4	J
LOB-SH01-A-20101021	10/21/2010	146.9	0.38	J	5	J	0.14	J	0.03	J	41.8	J	0.15	J	6.9	J	10.8	J
LOB-SH01-A-20101022	10/22/2010	Not Measured[a]	0.92	J	5.3	J	0.16	J	0.11	J	39.2	J	0.32	J	6.7	J	10.6	J
LOB-SH01-A-20101026	10/26/2010	Not Measured[a]	0.54	J	4.2	J	0.23	J	0.068	J	30.4	J	0.25	J	5.8	J	8.9	J

Notes:

[a] Depth difficult to measure accurately due to dip in shaft

Flag Qualifiers:

J+ = high estimate

J = the result is an estimate

5.3.6 Soil Sampling and Analysis Results

The soil sampling effort conducted on October 4, 2010, resulted in the collection and laboratory analysis of 13 soil samples and 3 quality control samples (i.e., a field duplicate, field blank, and rinsate blank). The soil sample locations are shown on Figure 8. The laboratory analytical results for the soil samples collected during this investigation have been reviewed and flagged with appropriate qualifiers and are shown in Table 22.

The only concentrations measured in the soil samples collected on October 4, 2010, that exceeded the Recreational Clean-up Guidelines established for the site were for total arsenic from sample locations SG02, SG03, SG06, SG10, and SG13. Total cadmium, copper, lead, manganese, and zinc concentrations in all of the soil samples collected during this investigation were significantly below their respective Recreational Clean-up Guidelines. Soil sample SG10 was collected outside the subject property immediately north of the property boundary. Acid/Base Accounting results indicate that the soils surrounding the waste rock piles also have the potential to generate acid and create an environment hostile to plant growth.

Table 22. Soil Sampling Analytical Results

Lilly/Orphan Boy Mine Site

LabID	Sample Depth (inches)	Aluminum (mg/kg)		Arsenic (mg/kg)		Cadmium (mg/kg)		Copper (mg/kg)		Iron (mg/kg)		Lead (mg/kg)		Manganese (mg/kg)		Zinc (mg/kg)		Sp. Conductance Saturated Paste (mmhos/cm)		Neutralization Potential (tons/1000)		Sulfur HCl Extractable %(w/w)		Sulfur HNO3 Extractable %(w/w)		Sulfur Hot Water Extractable %(w/w)		Sulfur Residual %(w/w)		Sulfur %(w/w)		Acid/Base Potential (tons/1000)	
		Result	Flag	Result	Flag	Result	Flag	Result	Flag	Result	Flag	Result	Flag	Result	Flag	Result	Flag	Result	Flag	Result	Flag	Result	Flag	Result	Flag	Result	Flag	Result	Flag	Result	Flag	Result	Flag
LOB-SG01-A-20101004	3	14,900		230		5		30.9		16,100		142		467		257		0.2		0.48		0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	-0.51	
LOB-SG02-A-20101004	3	4,550		6,470		103		48.2		27,400		1300		582		158		0.53		0		0.161		0.0853		0.269		0.05	U	0.526		-6.8	
LOB-SG03-A-20101004	3	23,500		439		7.6		21.2		19,000		607		165		550		0.083		0		0.05	U	0.05	U	0.05	U	0.05	U	0.0508		-0.9	
LOB-SG04-A-20101004	3	15,500		204		4.6		29.4		16,400		137		170		378		0.12		0.49		0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	-0.12	
LOB-SG05-A-20101004	3	11,600		197		6.8		271		12,400		127		593		315		0.15		0		0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	-0.86	
LOB-SG06-A-20101004	3	8,720		1,090		17.4		51.6		16,000		188		342		218		0.15		0		0.05	U	0.05	U	0.05	U	0.05	U	0.0604		-0.76	
LOB-SG07-A-20101004	3	8,760		229		5.9		44.4		12,600		139		762		179		0.26		1.2		0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	-0.21	
LOB-SG08-A-20101004	3	10,400		61.4		1.3		23.9		14,200		51.1		493		83.9		0.26		1.9		0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	1.5	
LOB-SG09-A-20101004	3	9,580		49.3		1.3		25.6		13,100		32.3		499		95.2		0.18		2.9		0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	2.3	
LOB-SG10-A-20101004	3	9,460		362		6.8		75.8		15,600		130		173		268		0.14		0		0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	-1.2	
LOB-SG11-A-20101004	3	5,760		133		2.9		24.1		12,200		49.5		385		121		0.15		1.4		0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.82	
LOB-SG12-A-20101004	3	10,100		138		3.6		26.6		12,800		53.7		373		274		0.26		0		0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	-0.63	
LOB-SG13-A-20101004	3	8,220		421		12.6		156		14,300		97		465		371		0.27		1.4		0.05	U	0.05	U	0.05	U	0.05	U	0.052		0.25	
Recreational Cleanup Guidelines		--		323		1,750		54,200		--		2,200		7,330		440,000		--		--		--		--		--		--		--		--	

Flag Qualifiers:
U - the compound was analyzed for, but not detected.

5.3.6.1 Waste Rock Volume Calculation

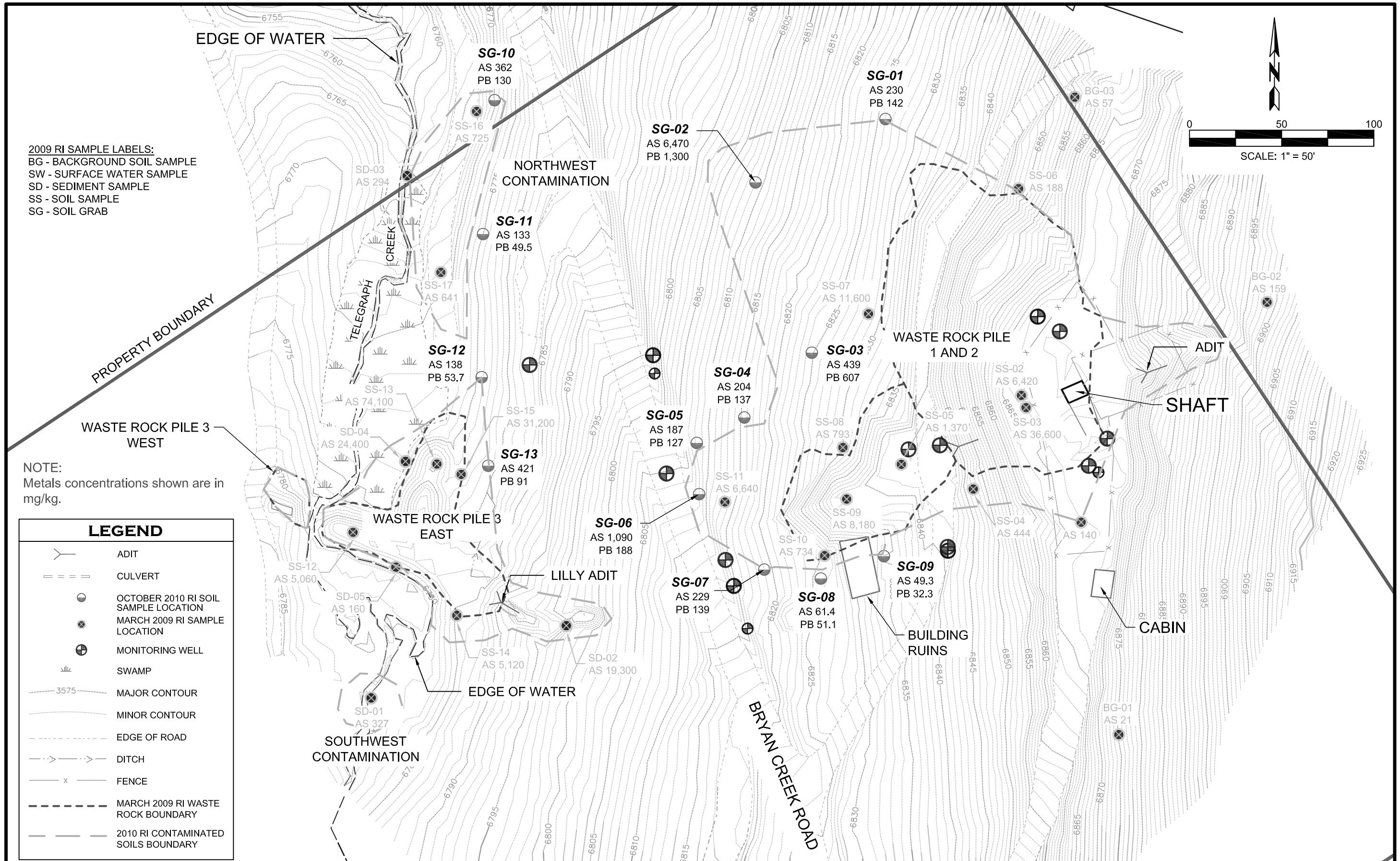
The volume of waste rock and contaminated soil was estimated using the soil sampling data collected in the 2010 RI along with results from the 2009 RI as shown on Figure 30. Since a limited number of samples have been collected to characterize the waste rock piles, the sample results were extrapolated to delineate the waste rock piles. However, significant data gaps in the regions surrounding the waste rock piles still exist and further characterization through additional sampling will be required if further refinement of this estimate is needed. The extents of the waste rock piles were evaluated using linear interpolation of the available sample data and visual observation of physical features. The waste rock piles and contaminated material were defined as areas that exceeded the DEQ/MWCB recreational cleanup guideline for arsenic of 323 milligrams per kilogram (mg/kg). The delineation of contaminated material is presented in Figure 30.

The delineation task identified five distinct units or areas, as shown on Figure 30 and listed in Table 23. The total volume of waste rock estimated in the 2009 RI was 3,430 cubic yards. Based on the additional sampling performed during this investigation, the amount of contaminated material was calculated to be approximately 470 cubic yards greater than this previous estimate, bringing the total estimated volume of contaminated material to approximately 3,900 cubic yards. The estimated contaminated material volumes are presented by area in Table 23.

Table 23. Waste Rock and Contaminated Soil Volume Estimate

Contaminated Material Location	Estimated Volume of Contaminated Material (cubic yards)
Waste Rock Piles 1 and 2	3,450
Waste Rock Pile 3 East	400
Waste Rock Pile 3 West	15
Southwest Contaminated Soil	20
Northwest Contaminated Soil	15
Total	3,900

The volume of contaminated material contained in the waste rock piles was estimated by comparing the existing ground surface to an assumed native ground surface. The existing undisturbed topographic contours outside the contaminated areas were extrapolated to create an assumed ground surface as it would have been before the waste rock piles were placed. The material above this original surface was considered to be contaminated waste rock. In areas where the natural contours were not visibly affected, a contamination depth of 6 inches was assumed in the estimate.



2009 RI SAMPLE LABELS:
BG - BACKGROUND SOIL SAMPLE
SW - SURFACE WATER SAMPLE
SD - SEDIMENT SAMPLE
SS - SOIL SAMPLE
SG - SOIL GRAB

NOTE:
Metals concentrations shown are in mg/kg.

LEGEND

- ADIT
- CULVERT
- OCTOBER 2010 RI SOIL SAMPLE LOCATION
- MARCH 2009 RI SAMPLE LOCATION
- MONITORING WELL
- SWAMP
- 3575 MAJOR CONTOUR
- MINOR CONTOUR
- EDGE OF ROAD
- DITCH
- FENCE
- MARCH 2009 RI WASTE ROCK BOUNDARY
- 2010 RI CONTAMINATED SOILS BOUNDARY

DRAWN: ADL	PROJECT NO.: 10103	TerraGraphics Environmental Engineering, Inc.	WASTE ROCK DELINEATION
PROJECT MANAGER: JWM	SCALE: 1" = 50'		SITE MAP
CHECKED: JWM	APPROVED: JWM		LILLY/ORPHAN BOY ABANDONED MINE SITE
	DATE: 12/8/10		FIGURE: 30
			DATE: 9/20/2011

5.4 Discussion

Results of this field investigation are discussed with respect to site-wide water quality and hydrogeology and an evaluation of the local aquifer characteristics.

5.4.1 Water Quality

Several observations presented here discuss how the water quality results indicate relationships between physical elements at the site. The physiochemical results from groundwater samples collected on September 29, 2010, showed that the bedrock aquifer had a similar pH to those samples collected from the shaft water during the period of October 20, 2010, (depth to water in shaft [DTW] >127 feet) to October 26, 2010, (DTW in shaft ~ 120 feet). During this period, the pH of the shaft water ranged from 5.8 to 6.0 and the DTW in the shaft was significantly below the 74-foot level Lilly drift (see Appendix C).

Field parameters were measured on groundwater collected from the five monitoring wells on September 29, 2010, prior to pumping the mine shaft water. pH values were near neutral at each well (6.28 to 7.79). Dissolved oxygen values were quite high and ranged from 6.55 mg/L in LOB-MW02 to 11.47 mg/L in LOB-MW03. ORP ranged from –35.7 millivolts (mV) in LOB-MW01 to 132 mV in LOB-MW04. Specific conductance values ranged from 446 to 2,028 micro mhos per centimeter (µmhos/cm). These data reflect a heterogeneous aquifer. Because baseline data were not collected for the mine shaft water, the hydraulic connection between the shaft and groundwater cannot be determined based on field parameters.

Groundwater samples collected from monitoring wells showed that the highest metals concentrations are in wells closest to the mine shaft (LOB-MW01 and LOB-MW02). LOB-MW02 had the highest concentrations of total aluminum, arsenic, iron, lead, and manganese prior to the pump being turned on. This well is the closest to the mine shaft, approximately 40 feet northwest of the shaft, and showed rapid response to pumping as well as significant water level decline.

Mine water was significantly cleaner during the later stages of pumping. This may be the result of the deeper water having less contact with mineralized rock than the shallower groundwater. Another possible explanation is that mine water was more impacted by acidic water from the Lilly drift during the earlier pumping stages.

Total metals concentrations in groundwater samples collected from the five new monitoring wells on September 29, 2010, were significantly lower than the total metals concentrations in water samples collected from the shaft and seeps (Figure 31 through Figure 35, Table 12, Table 18 and Table 21). This relationship indicates that the bulk of the AMD is likely being generated from reactions occurring in waste rock or mineralized zones around and within the drift.

There does not appear to be a consistent correlation between pH and total metal concentrations in the mine shaft water. The mine shaft water had low pH values from October 13 to 19, 2010 (3.3 to 5.0), but from October 20 to 26, 2010, the pH values were higher (5.8 to 6.0). Metals tend to mobilize at low pH ranges. However, metals concentrations were, on average, relatively low on October 13, 18, and 19, 2010, when the pH was also low and, beginning on October 20, 2010, the pH values were higher and the metals concentrations were generally lower. These results are somewhat inconsistent, but may again reflect “cleaner” water in the aquifer. It is likely that clean water in the aquifer and clean surface water from off site are coming in contact with

mineralized rock near the mine workings and waste rock on the surface, respectively, and becoming contaminated.

Metals concentrations measured in the seeps, mine shaft water, and monitoring wells are compared in Figure 31 through Figure 35. These comparisons show that metals, except lead, are highest in the seep water entering the 74-foot level drift and lowest in the monitoring wells.

5.4.2 Hydrogeology

5.4.2.1 Shaft Water Recovery

In general, water in the mine shaft was pumped during the day and not at night. Water level recovery rates were calculated when the pump was off between pumping events. Water levels rose after each pumping event. Based on the available data, the average recovery rates ranged from 5.6 to 6.5 gpm. This is the average recovery because only the first and last water level measurements were made for each time period during which the pump was off. Water level recovery was typically rapid initially followed by a slower, asymptotic recovery. The slower recovery rate computed is associated with the time when the pump had been off for a few days.

Hand measurements of depth to water in the shaft showed a total decline over the duration of dewatering to be over 72.5 feet (see Appendix C). The last depth to water measurement taken before the pump was turned off was recorded on October 21, 2010 at 11:20 am, approximately 25 hours prior to the pump being turned off permanently on October 22, 2010. Hand measurement data show water levels recovered over 32 feet within the first 6 days. By November 26, 2010, the water level had risen over 54 feet since October 21, 2010. Recovery was likely not complete at the time of the last measurement, as the water depth was still strongly trending upward.

5.4.2.2 Monitoring Well Responses

Responses to mine dewatering in monitoring wells can be seen in the graphs in Appendix E.

Water levels in LOB-MW01 were clearly affected by pumping the mine shaft. The transducer was not functioning properly from September 30, 2010 to October 12, 2010 so these data are missing. On October 12, 2010, the water level had dropped approximately 18 feet and continued to drop. After the pump was turned off water levels dropped for about 24 hours, were stable for about 24 hours, then began to recover. The water level in LOB-MW01 declined 35.0 feet over the pumping period. Water levels did recover although not to the initial water level elevation.

Water levels in LOB-MW02 were clearly affected by pumping the mine shaft. Water levels began declining approximately 25 minutes prior to the start of pumping; it is therefore difficult to separate the initial response from pumping the shaft and the antecedent trend in the well during the initial time period. The water level dropped to below the transducer sensor from October 6, 2010 until November 29, 2010, so the total drawdown from the start of pumping to the end is unknown. Water levels appeared to respond to the pump turning off and on prior to October 6, 2010. Water level drawdown n in LOB-MW02, located about 40 feet north-northwest of the mine shaft, was the greatest of the wells and slightly more than the drawdown in LOB-MW01, which is located approximately 40 feet south-southeast of the mine shaft. LOB-MW02 had a total head loss of approximately 30 feet during the test, whereas the total head loss was about 20 feet in LOB-MW01. Water levels in LOB-MW01 correlate better with the mine shaft pumping

than those in LOB-MW02, but this may be due to the loss of data when the water level fell below the transducer in LOB-MW02.

Water levels in LOB-MW03 began to decline about 5.5 hours after the start of pumping and continued to decline until November 24, 2010. Spikes in water levels were detected during the mine shaft pumping that may correlate with the cycling of the pump. Water levels declined over the duration of pumping by 6.0 feet. It is unknown why water levels continued to decline long after the pump was permanently turned off.

Water levels in LOB-MW04 were not noticeably affected by pumping water in the mine shaft. In fact, water levels rose 1.4 feet over the duration of the test, and showed over 2 feet of water level rise with oscillations after October 17, 2010. This well may be responding to land application water, but no data are available to corroborate this theory.

Water levels in LOB-MW05 rose approximately 0.05 feet within the first 6.5 hours after pumping started, remained fairly stable for about 1.5 days, and then began gradually declining on October 3, 2010, until approximately October 25, 2010. Water levels oscillated slightly and continued to decline until approximately November 25, 2010. The pre-pumping water level data suggest an antecedent trend of increasing water level in this well. Water level data in LOB-MW05 may not have been significantly impacted by pumping the mine shaft, but the increasing water level trend may mask a greater water level drawdown. Water levels fell 4.3 feet over the duration of the mine dewatering.

The closest monitoring wells to the shaft, LOB-MW01 and LOB-MW02, had dramatic water level responses to pumping from the mine shaft. LOB-MW01 had a fairly rapid recovery as did the mine shaft. Water levels in LOB-MW03 and LOB-MW05 were apparently less affected by pumping water in the shaft. There was no obvious correlation between LOB-MW04 (the farthest well) water levels and mine dewatering.

5.4.3 Aquifer Characteristics

To understand clearly whether surface water is becoming contaminated while in contact with waste rock piles and then entering the groundwater, it is necessary to determine whether the aquifer is confined or unconfined. If the aquifer is unconfined it would be possible for surface water to percolate into the mine workings. However, to determine conclusively whether the water seeping into the Lilly drift comes from local surface water, further testing would be required. A definitive determination in the fractured quartz monzonite aquifer at the Lilly/Orphan Boy Site is more complicated than a similar determination for a sedimentary rock aquifer with an obvious confining unit or lack thereof. Fractured rock aquifers can be confined by several different mechanisms causing fractures to be filled with impermeable material. One may speculate that the aquifer at the Lilly/Orphan Boy site is unconfined given the response in water levels in most of the monitoring wells to pumping the shaft, which is exposed to the atmosphere. However, to accurately determine if the aquifer is confined or unconfined, an aquifer test should be conducted to collect data that support a complete analysis. Storativity values for a confined aquifer are very low (0.00005 to 0.005); storativity values for an unconfined aquifer are high (0.01 to 0.30) (Freeze and Cherry, 1979).

The mine dewatering for this Phase II RI was not designed as an aquifer pump test and, therefore, did not produce ideal data for analysis of storativity. Since continuous pumping is required, an aquifer test analysis was attempted on the water level data from LOB-MW02 during

the initial few hours of pumping prior to the pump being turned off for the first time. This very short test did not produce data conducive to the required analysis for several reasons: the total drawdown is very small and is on the same order of magnitude as the transducer accuracy; the time of pumping is short; and the scatter in the data is large. As the drawdown was greatest in LOB-MW02, these conditions are even less conducive to aquifer testing using data from the other wells. For these reasons, it was impossible to fit a curve that would yield reliable results for the computation of storativity. Therefore, the confinement of the bedrock aquifer cannot be definitively determined with the available data.

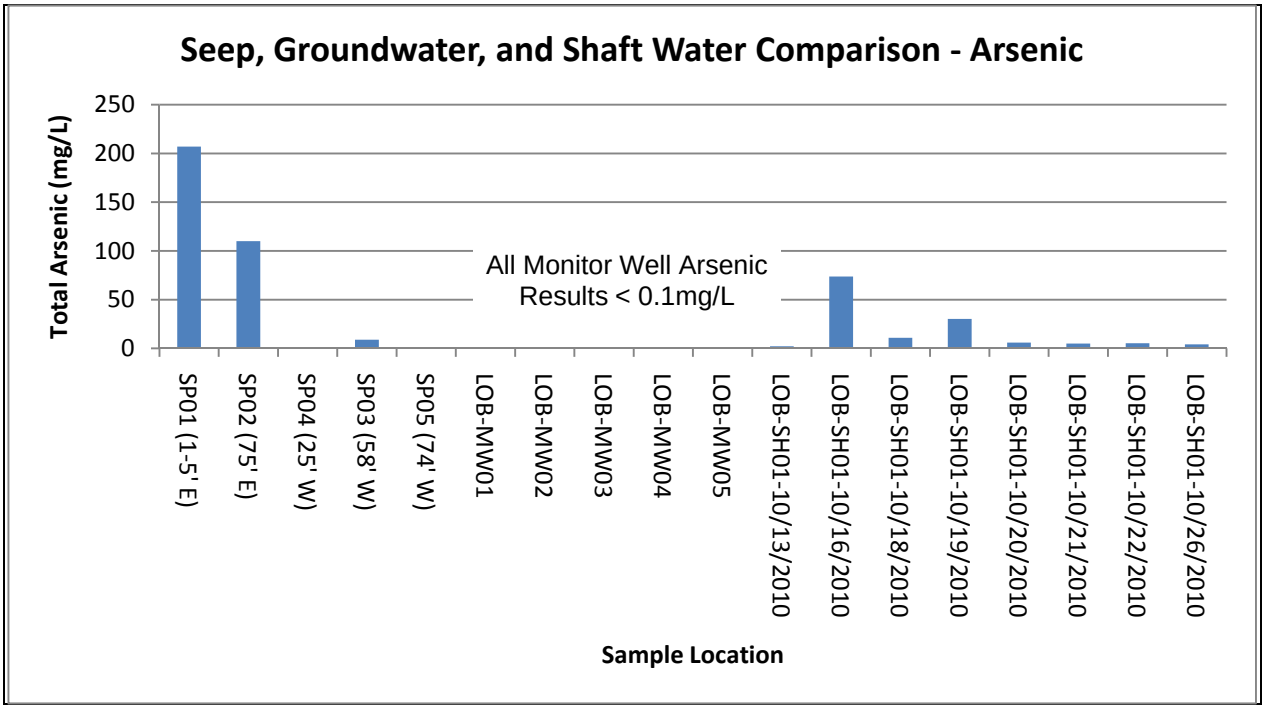


Figure 31. Seep, Groundwater, and Shaft Water Concentrations – Arsenic

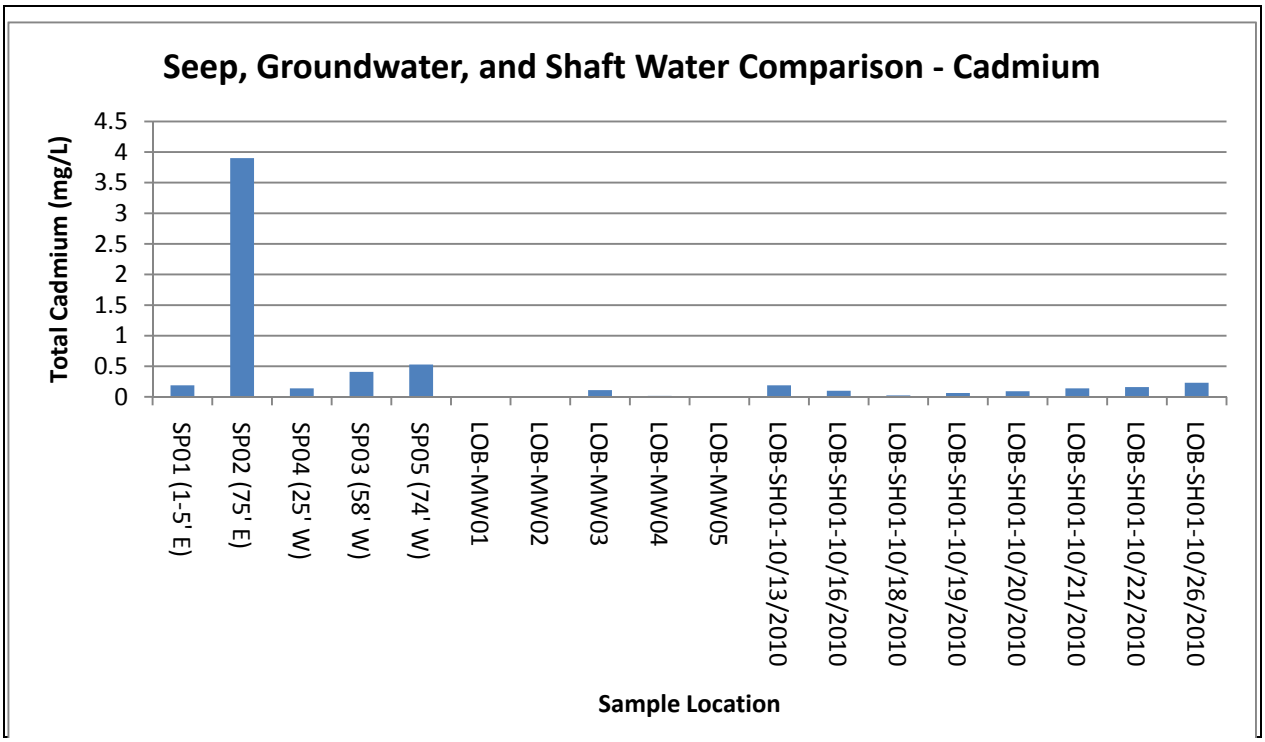


Figure 32. Seep, Groundwater, and Shaft Water Concentrations – Cadmium

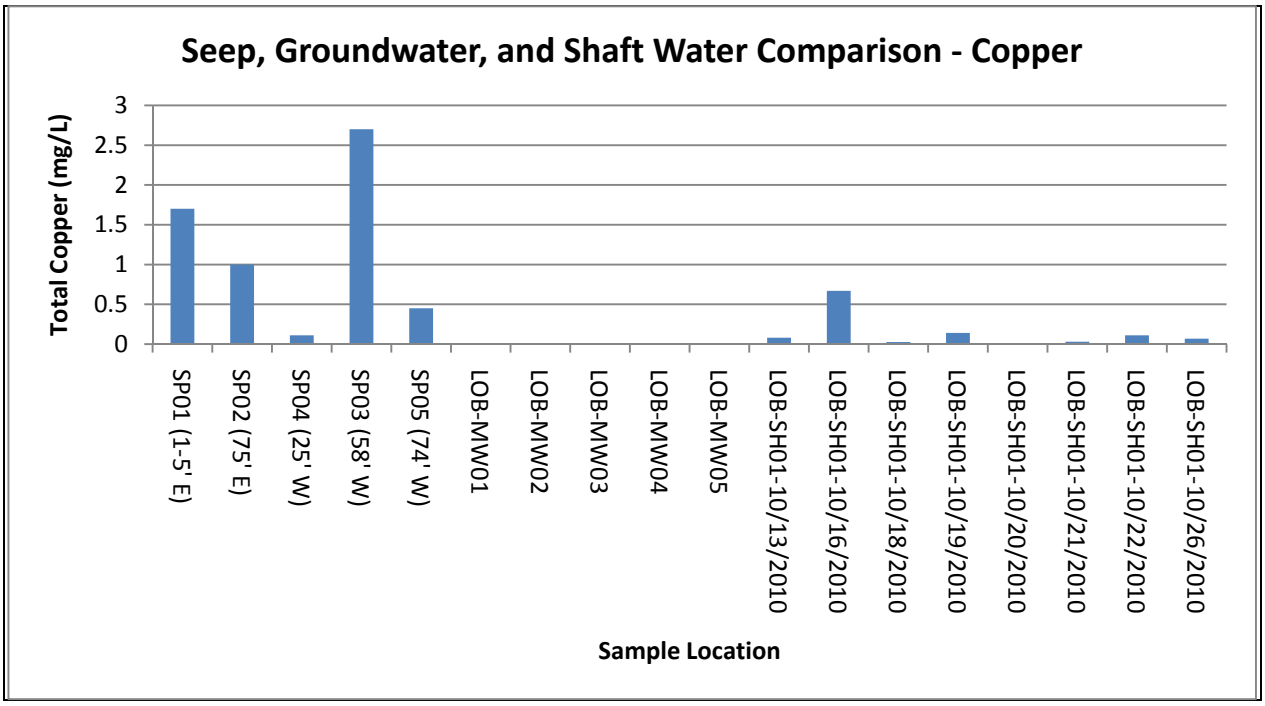


Figure 33. Seep, Groundwater, and Shaft Water Concentrations – Copper

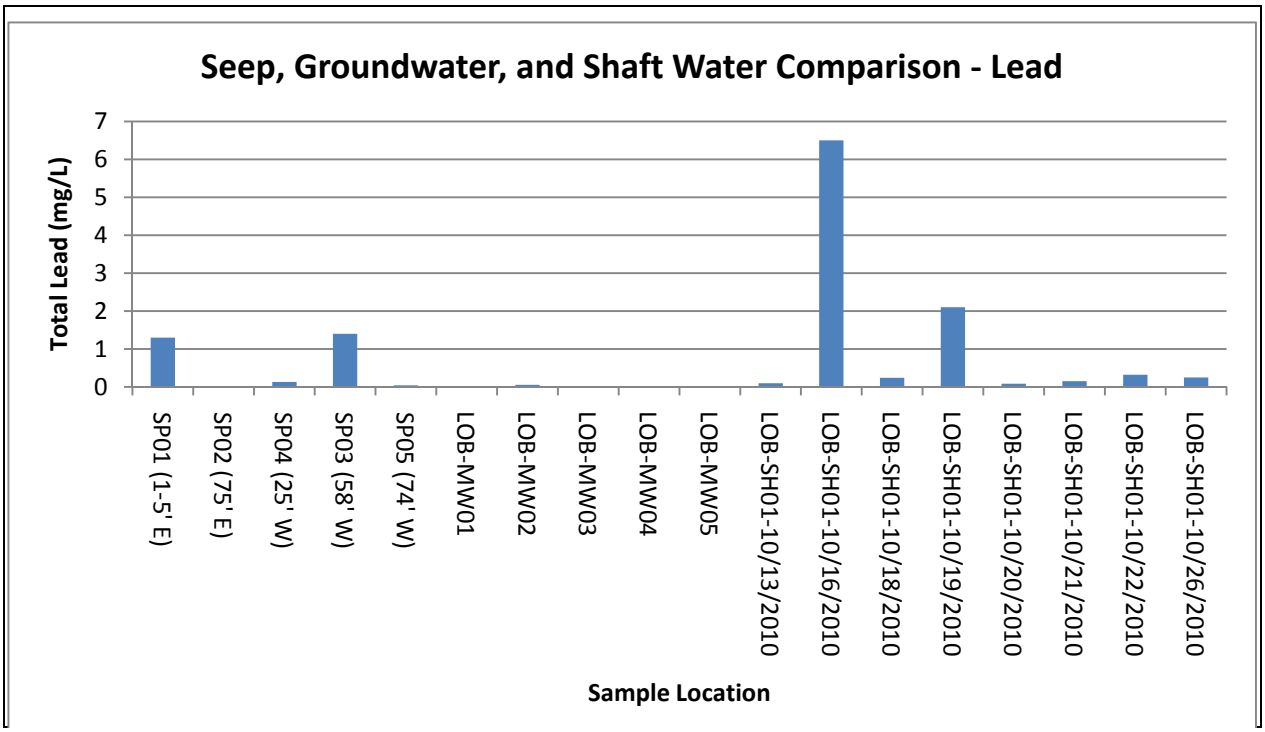


Figure 34. Seep, Groundwater, and Shaft Water Concentrations – Lead

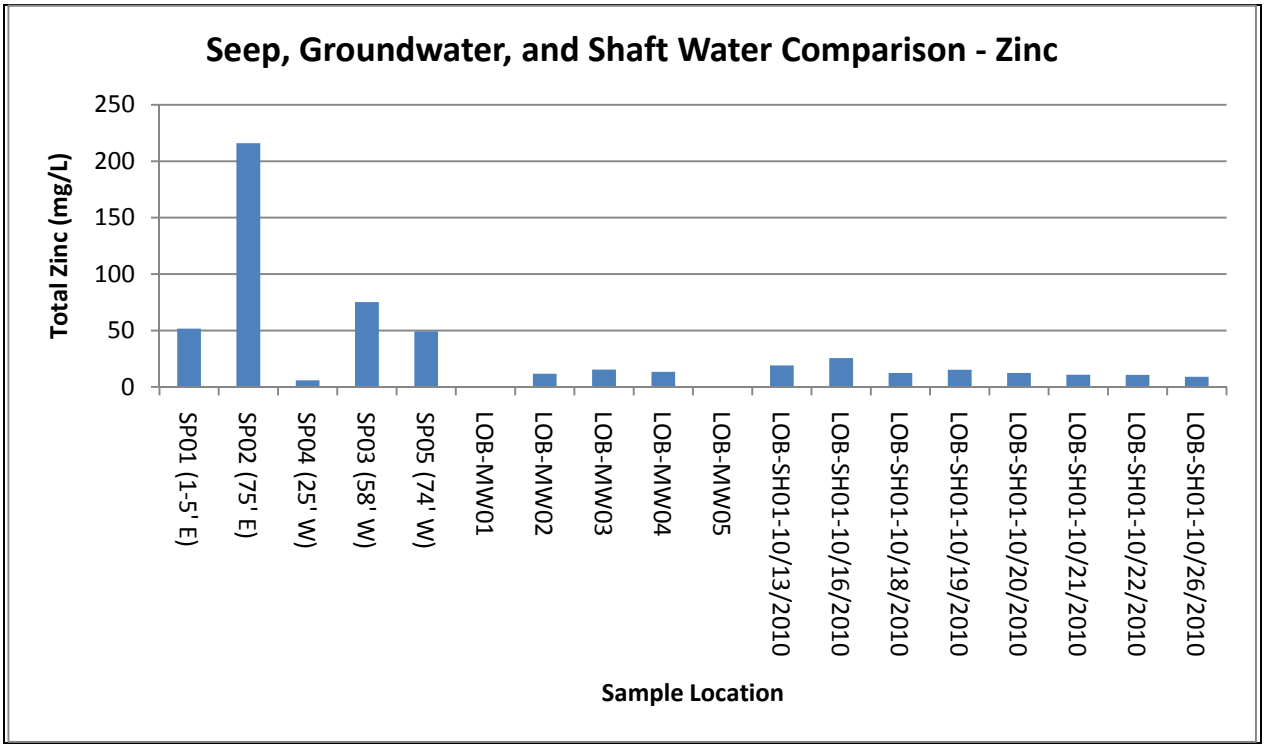


Figure 35. Seep, Groundwater, and Shaft Water Concentrations – Zinc

Section 6.0 Reclamation Alternatives

This assessment was prepared to identify potential reclamation action alternatives and the feasibility of carrying out each action for the source areas posing human health and ecological risks as previously identified in the 2009 RI (Tetra Tech, 2009). This assessment expands upon the preliminary assessment of reclamation alternatives presented in the 2009 RI. The reclamation alternatives will be further developed and analyzed as part of the EEE/CA process along with a review of Applicable or Relevant and Appropriate Requirements (ARARs).

Source control approaches to mitigating impacts of AMD include inflow controls, segregation of clean and contaminated flows, and bulkheads. Possible inflow controls at the Lilly/Orphan Boy Mine Site include waste rock management and management of surface water inflows. Segregation measures would require isolation and treatment of the highly contaminated water seeping into the Lilly drift. Finally, bulkheading may be used to stop groundwater from flowing out of the Lilly adit.

6.1 Surface Water Management

Reclamation activities for surface water management at this site could significantly reduce the recharge flow rates to the mine workings, especially in the spring when runoff rates from snow melt are highest. Although data were not collected during spring flows, it is reasonable to expect that a strong correlation exists between adit discharge rates and spring runoff. Surface water management is a low-cost, effective, and implementable reclamation action. While it is unlikely that surface water management alone will stop all discharge from the adit, a significant reduction in flow combined with on-site wetland treatment may result in returning metals loading to Telegraph Creek to pre-mining levels.

Surface water infiltration from precipitation and snow melt runoff may be a substantial source of mine water recharge and subsequent contamination, including seepage from a seasonal upgradient surface water collection pond located off site (Figure 36). As water contacts the mineralized waste rock and mineralized zones within the mine workings, and in particular the mineralized rock within and immediately adjacent to the discharging drift, the water becomes contaminated with metals before discharging through the adit to Telegraph Creek. Surface water management would likely limit the amount of runoff contacting the mineralized sources and reduce the recharge to the mine, resulting in a reduction of AMD volume and metals loading.

Surface water management is comprised of the three components described in the following sections: the off-site upgradient pond, surface water interception, and surface water runoff.

6.1.1 Off-site Upgradient Pond

The off-site pond is located upgradient of the mine on an adjacent owner's property (Figure 36). The seasonal pond collects surface water runoff on a bench above the mine site. The pond drains over the course of each season by a combination of evaporation and infiltration into the surrounding soils. Investigation of this pond's influence on the local hydrology was not performed because the landowner chose not to allow access. However, it is reasonable to assume overland flows from this area and surface water infiltrating the soils upgradient of the mine flow downgradient toward the mine and are collected in the mine workings. Rising water in the workings causes the water to flow out of the drift and contributes to AMD at the adit. If

the landowner allows access at a later date, these assumptions could be tested. Several options exist for reducing the impacts of discharges from the pond. Each of the following options would require an agreement with the adjacent landowner:

- The most effective and least expensive option is to fill the pond and grade the area to drain. This action would completely eliminate the source area and could be accomplished by filling and grading with local material. This action would be a permanent closure, highly effective at eliminating the source; in addition, it would be cost-effective and would utilize typical construction methods.
- Install a drainage channel. This action would completely eliminate the source area but would require long-term monitoring and minimal maintenance. Over a period of tens of years, the channel would likely silt in and become overgrown with vegetation that could block drainage of the pond or cause erosion in other areas as the capacity of the channel diminishes. This action would be cost-effective and would utilize typical construction methods.
- Install an impermeable pond liner. If the pond owner requires that the pond remain, it could be lined with an impermeable liner. This action would eliminate the source area but require long-term monitoring and minimal maintenance, as the liner could develop leaks over time. This option is implementable with typical construction methods but, due to the cost of the liner, would be more expensive than the previous two options.

6.1.2 Surface Water Interception

Surface water that infiltrates the overburden originates from upgradient sources of precipitation, snow melt, and the seasonal pond. These flows appear to be contacting the mineralized waste rock, where they become contaminated before infiltrating into the mine workings as noted by the high metal concentrations of the mine seeps. A portion of this water currently enters the mine workings and could be redirected with the installation of an interception swale. An interception swale installed above the mine workings serves multiple functions including control of infiltrating surface water, surface water runoff, and possibly a portion of the infiltration/seepage from the off-site upgradient pond. Because bedrock is shallow, this action would only collect surface water flowing through the overburden above the bedrock contact and route those flows away from the mine workings. Infiltration and seepage from the seasonal pond, if it has not been addressed by other actions, would likely completely or partially percolate into the bedrock fractures and bypass an on-site interception swale. This option would have a variable degree of cost depending on the site conditions, is implementable with typical construction methods, and would not require any coordination or agreements with adjacent property owners. However, it may only be partially effective in controlling any flow that enters the mine workings from the off-site pond.

6.1.3 Surface Water Runoff Control

Surface water runoff from the site and upgradient areas contacts mineralized waste rock, where it becomes contaminated before possibly infiltrating into the mine workings or discharging directly to Telegraph Creek. Filling any features that collect or pool water upgradient of the shaft and diverting surface water runoff away from any reclaimed features, the mine workings, any remaining waste rock, impacted soil, or mineralized rock would reduce contaminated surface

water discharges from the site. Both methods of surface water runoff discussed below are implementable and cost-effective, and would have minimal long-term monitoring and maintenance requirements.

- Surface Contouring – Surface contouring would be performed in conjunction with the installation of drainage swales and include filling of any subsidence and exploratory features such as test pits that are providing a conduit for infiltration of surface water to the mine workings. Surface contouring can shed surface water runoff toward the drainage swales and away from the site reclamation features and mine workings. Improved surface contouring would benefit revegetation and reduce erosion by minimizing flow paths and concentrating flows in drainage swales before rills develop in the cover soil.
- Drainage Swales – Drainage swales can collect and route either clean water or contaminated sources to a particular location for treatment, monitoring, or discharge. Properly designed drainage swales can also collect shallow groundwater flow and route these flows along with surface water away from reclaimed features or potential sources of contamination for discharge into Telegraph Creek.

6.2 Waste Rock Management

Waste rock piles at the site contain elevated metals levels above the risk scenarios presented in the 2009 RI and are sources of contamination. Waste rock management would reduce exposure to erosion, contact with the local ecosystem, and exposure to surface water, which is a source contributing to mine recharge and AMD.

Based on the data collected in the 2009 RI (Appendix K) and this Phase II RI, waste rock management, including contaminated soil, is considered a necessary component of the reclamation plan at the site to address human health and ecological risks. Waste rock and mineralized rock are exposed and in contact with water, which may infiltrate into the mine workings and contribute to AMD, surface water contamination, and human health and ecological risks at this site. The highest priority for removal should be Waste Rock Pile 3, as it directly impacts the water quality in Telegraph Creek. The volume of this pile is relatively small (approximately 415 cubic yards), so the benefit of removal would be very high in comparison to the cost.

Metals contamination at the site is believed to be derived from four sources: (1) the waste rock dumps, (2) impacted soil down-gradient of the waste rock dumps, (3) exposed mineralized zones in and around the mine workings, and (4) mineralized overburden that has collapsed into the adit. The volume of surficial waste rock piles was estimated to be 3,430 cubic yards in the 2009 RI; however, this estimate was updated in this investigation to include unaccounted-for volumes of impacted soil and sediment beneath and downgradient of the waste rock piles as well as mineralized rock in the collapsed adit. The revised estimated volume of waste rock and contaminated soil is about 3,900 cubic yards.

Due to site constraints, waste rock management will likely consist of a combination of waste consolidation and disposal in an off-site repository, an on-site repository, a landfill, and/or by partially backfilling the mine shaft and workings. These options will be discussed in further

detail below. Significant site constraints consist of a lack of clean cover soils, lack of repository space, and the remote location of the site.

6.2.1 Cover Soil

TerraGraphics performed an inventory of land ownership within a 2-mile radius of the site (Figure 37) and from the Lilly/Orphan Boy Mine Site to U.S. Highway 12 (Figure 38) to evaluate potential locations for borrow soil. The numbered parcels illustrated in Figures 37 and 38 correlate with the ownership information shown in Table 24. Ownership within the inventoried area consists primarily of private land and USDA Forest Service land, with a few parcels owned by DEQ, the City of Helena, and Powell County (mostly rights-of-way). Borrow material for use as cover soil is extremely limited at the site, but several possible privately-owned sources along Telegraph Creek Road can be seen on Figure 38.

6.2.2 On-site repository

Because of the steep topography and limitations due to property ownership, the potential for an on-site repository is limited; however, the possibility for on-site repository siting should not be completely discounted considering the relatively small volume of waste. The topographic constraints at the site may result in a large repository footprint relative to the volume of waste stored. A large footprint would require larger volumes of cover material. Analysis of an on-site repository was not completed as part of this investigation.

6.2.3 Off-site Repository

An inventory of land ownership within a 2-mile radius (Figure 37) of the site and along the main access route from U.S. Highway 12 (Figure 38) was performed as an initial step to evaluate the potential for an off-site repository. This review indicates that property available for an off-site repository in the immediate vicinity of the Lilly/Orphan Boy Mine Site is limited, but potential sites may exist in private land ownership along Telegraph Creek Road.

6.2.4 Landfill Disposal

If an on-site or off-site repository is not feasible, disposal of the wastes in a licensed landfill can be considered. Although this option is feasible, the wastes would need to analyzed for compliance and potentially amended to meet the landfill requirements. Additionally, due to the combination of the remote site location and the location of licensed landfills, the haul distances will likely be in excess of 50 miles. Hauling costs for landfill disposal may be high relative to the other disposal options.

6.3 Mine Water Discharge Management

Mine water discharging from the adit is a source of contamination, with metals concentrations elevated above the acute and chronic standards for surface water listed in DEQ-7. Mine water contamination at this site appears to be predominately from sources other than the bedrock aquifer. Surface water and waste rock management actions by themselves might significantly reduce mine water recharge and AMD from the adit. Source controls within the mine are possible, and additional mine water discharge management may be incorporated into waste rock management through on-site batching of the waste rock with Portland cement for use as a

cemented backfill plug within the shaft and workings to further stem the flow of mine discharges.

6.3.1 Cemented Waste Rock Backfill Plug of Shaft

A cemented waste rock backfill plug can be an effective source control technology that has the additional benefit of reducing the waste rock volume required for off-site disposal; at this site it could serve as part of the mine water management to stem the flow of water discharging from the adit. However, the primary inflow of contaminated water into the workings is taking place in the drift, so backfilling the shaft alone will not stop AMD from the adit. Partial backfill of the mine shaft could dispose of some portion of the waste rock on site. The waste rock would need to be screened to eliminate material larger than approximately 1-inch diameter and then batched with cement to buffer the material and form a backfill plug. A significant source of mine recharge was observed at the 35-foot level in the shaft during the summer of 2010. Cemented backfilling may be layered at this level with a permeable layer of inert rock or limestone to aid the flow of clean groundwater past the shaft. Preliminary testing done by Pioneer Technical Services indicated that smaller particle sizes (smaller than 1-inch) screened from the waste rock can be used in an aggregate for backfilling. However, overall results of the preliminary tests were mixed, and they conclude that further testing will be required to assure efficacy of the backfill material (Pioneer, 2009).

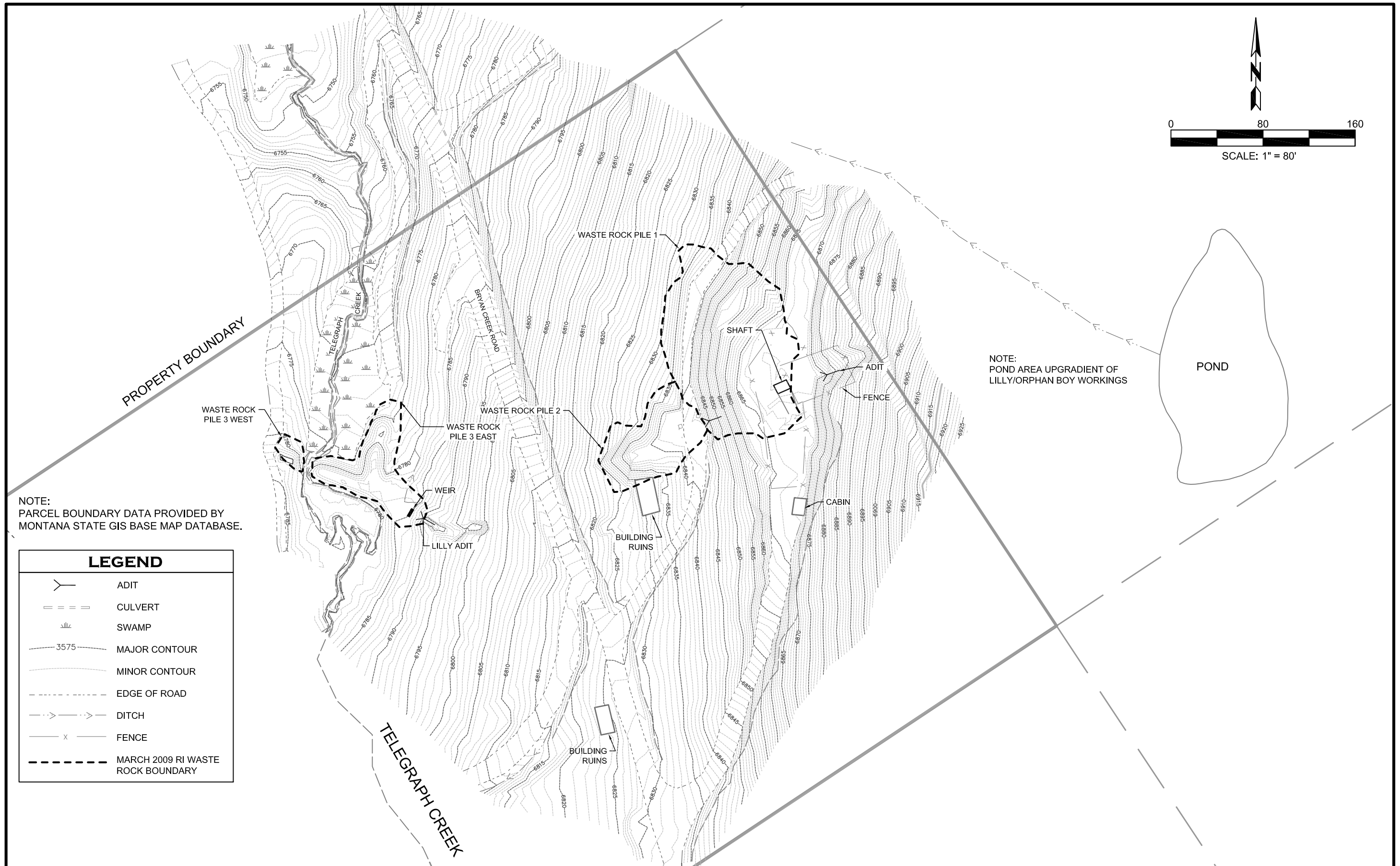
The costs associated with waste rock disposal may increase the cost-benefit of processing the waste rock on site and disposing of some material as cemented backfill plug in the mine shaft. This option would serve two purposes: first, it reduces the cost of waste rock disposal and second, it will plug portions of the mine workings. The combined reduction in recharge rates from surface water controls, reduction in mineralized contact area from the removal of waste rock, and potential plugging and buffering effects of the cemented backfill may be enough to reduce the AMD to acceptable levels.

6.3.2 Hydraulic Adit Plug

A hydraulic adit plug may be appropriate at the Lilly/Orphan Boy site. The primary function of a hydraulic adit plug is to significantly reduce AMD by re-establishing groundwater flow through the pre-mining pathways. The result would be a rise in water level in the mine, creating anoxic conditions by preventing the continuous flow of groundwater through the open, oxygenated mine workings and out the adit. Hydraulic adit plugs can be effective at reducing AMD but are not suited for all applications. This investigation has generally characterized the conditions required, but more thorough analysis will be required during the EEE/CA phase. Successful application of a hydraulic plug requires:

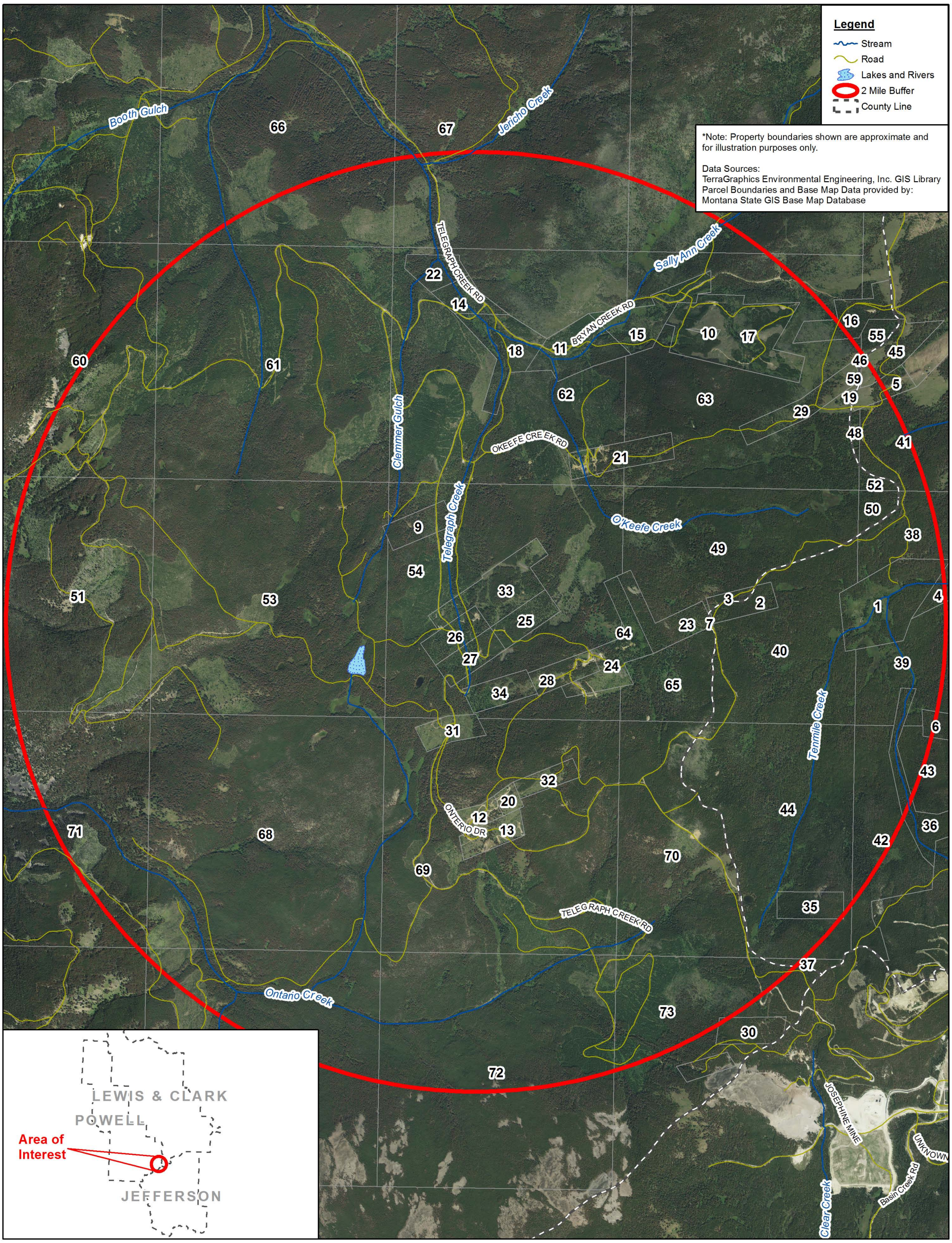
- An understanding of the pre- and post-plugging groundwater hydrogeology;
- Good access and understanding of the underground workings and natural features (faults, veins, shear zones, etc.);
- A section of competent rock at and upgradient of the plug location;
- Adequate overburden pressure to counteract the expected hydraulic head;

- No significant water-transmitting geologic structures or manmade groundwater pathways (mine workings, wells, exploratory drill holes) that could short circuit the plug and discharge to other workings, mines or the ground surface; and
- Quality construction materials and techniques during installation (Wireman and Stover, 2011).



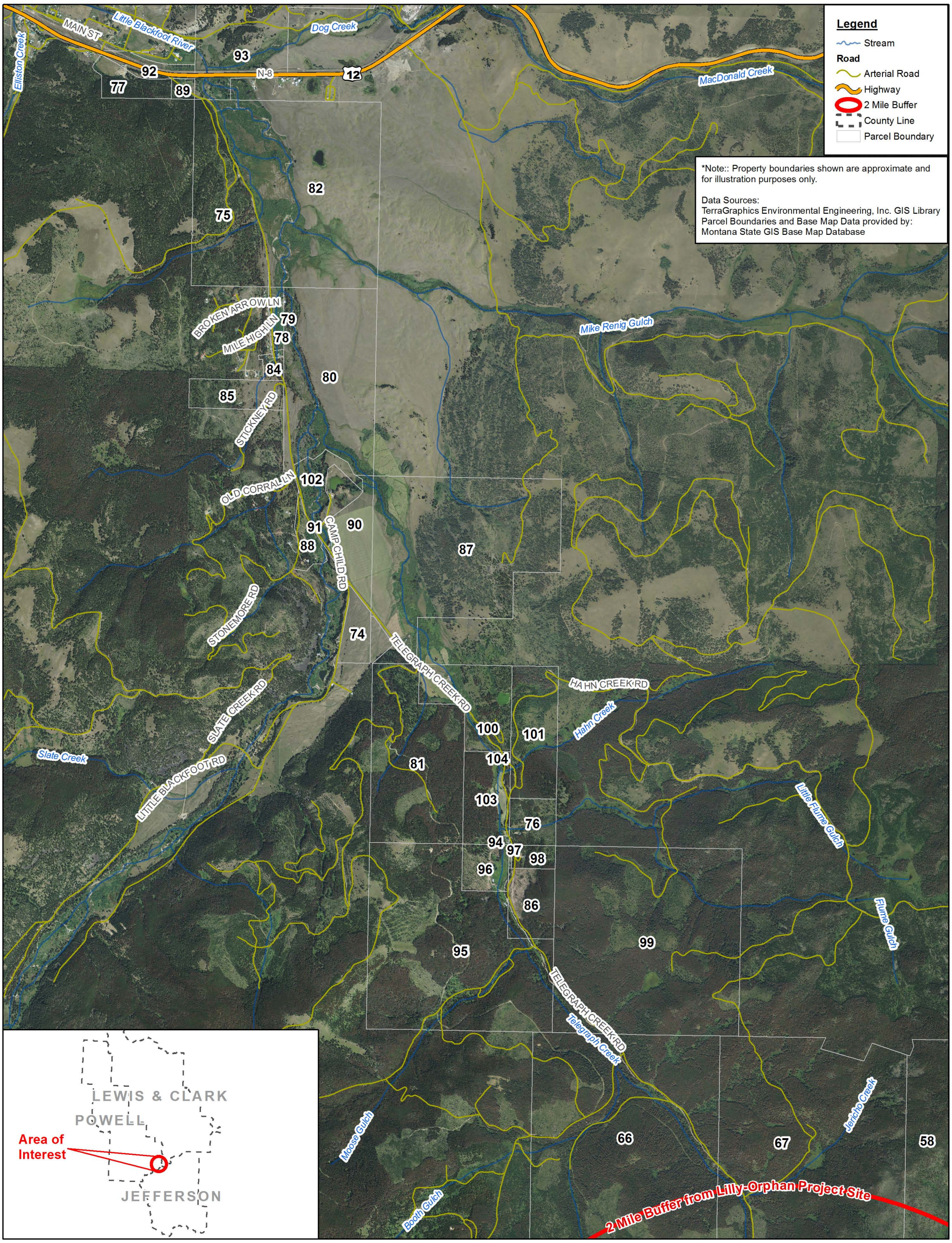
DRAWN: DJK	PROJECT NO.: 09210	TerraGraphics Environmental Engineering, Inc.	OFFSITE POND LOCATION MAP	LILLY/ORPHAN BOY ABANDONED MINE SITE	FIGURE: 36
PROJECT MANAGER: JWM	SCALE: AS SHOWN		SITE MAP		DATE: 9/7/2011
CHECKED: JWM	APPROVED: JWM				
	DATE: 2/15/2011				

Y:\09210 - Lilly-Orphan Boy Mine\E. Deliverables\a. Reports\Ph II RI\Drawings\FIGURE 10 OFFSITE POND LOCATION MAP.dwg



Project Name		Figure 37
Lilly Orphan Boy Phase II Reclamation Investigation Fieldwork Task Order #27	This map was produced using information obtained from several different sources that have not been independently verified. These sources have also not provided information on the precision and accuracy of the data. Information on this map is not a substitute for survey data.	Land Ownership Within a 2 mile Radius

TerraGraphics Environmental Engineering, Inc. www.TerraGraphics.com	File: W:\Montana\Lily-Orphan_Boy\mxds 2MileBuffer_aerial	Projection: NAD83 UTM12N	Map Scale: 1:25,500 0 0.25 0.5 Miles
	Print Date: September 7, 2011	Project Manager: J. Mickey	
	Project Number: #10103 - LOB Phase II	Cartographer: J. Mierzwinski	



Project Name		
Lilly Orphan Boy Phase II Reclamation Investigation Fieldwork Task Order #27	This map was produced using information obtained from several different sources that have not been independently verified. These sources have also not provided information on the precision and accuracy of the data. Information on this map is not a substitute for survey data.	**Figure 38 Land Ownership Along Telegraph Creek Road**

TerraGraphics Environmental Engineering, Inc. www.TerraGraphics.com	File: W:\Montana\Lily-Orphan_Boy\mxds\TelegraphCkParcels_aerial	Projection: NAD83 UTM12N	Map Scale: **1:32,000** 0 0.25 0.5 Miles
	Print Date: September 7, 2011	Project Manager: J. Mickey	
	Project Number: #10103 - LOB Phase II	Cartographer: J. Mierzwinski	

Table 24. Land Ownership
Vicinity of Lilly/Orphan Boy Mine Site

Map	Parcel ID	OwnCode	OwnerClass	Owner Name
1	0516831310105M000	40000	Local Government	CITY OF HELENA W
2	0516831440101M000	40000	Local Government	CITY OF HELENA W
3	28168114204010000	40000	Local Government	
4	0516831310101M000	10000	Private	COWDEN LESTER L III & DEBORA L
5	0516831230101M000	10000	Private	TANGEN L LINNEA
6	0516832410110M000	10000	Private	MANGER MARY ANN
7	05168314204010000	10000	Private	NEWMAN DAVE R
8	05168311104050000	10000	Private	LIGHTNING ROD LLC
9	2816811520101MINE	10000	Private	HORNE DALE E & JANET E
10	28168111201020000	10000	Private	SAGER, DANIEL G
11	28168110101010000	10000	Private	VAN BLARICOME ROYCE EUGENE
12	2816812220101M000	10000	Private	VERCILLO ANTHONY
13	2816812220102MINE	10000	Private	WATTERS JEFFREY A
14	28168110201030000	10000	Private	BAILEY, FREDERICK A
15	28168111201010000	10000	Private	HORTON PETER W
16	2816811220101MINE	10000	Private	HANNON GRETCHEN B
17	2816811110101MINE	10000	Private	SAGER, DANIEL G
18	28168110201020000	10000	Private	DAVIS WILHELMINE S
19	28168111401050000	10000	Private	
20	2816812220101M001	10000	Private	WAGNER GAYLYNN
21	28168110404010000	10000	Private	NEWMAN DAVE R
22	28168110201040000	10000	Private	POWERS, WILLIAM R
23	28168114201010000	10000	Private	NEWMAN DAVE R
24	28168115403010000	10000	Private	MANNING DOUGLAS
25	28168115402010000	10000	Private	BARNES CHARLES & RACHEL
26	28168115101010000	10000	Private	CHAQUETTE LINDSEY
27	2816811520102MINE	10000	Private	COLEMAN MERRILEE
28	28168115403020000	10000	Private	LITTLE RIVER DEV CORP
29	2816811140101MINE	10000	Private	LIGHTNING ROD LLC
30	2816812610101MINE	10000	Private	PENNINGTON, JOE
31	28168122201010000	10000	Private	LINDQUIST MICHAEL A
32	2816812220101MINE	10000	Private	THOMAS BRUCE A
33	28168115101020000	10000	Private	LITTLE RIVER DEV CORP
34	28168115403030000	10000	Private	MANNING DOUGLAS
35	05168323401010000	31000	State Government	MONTANA DEPT OF ENVIRONMENTAL
36	05168324201010000	31000	State Government	MONTANA DEPT OF ENVIRONMENTAL
37	05168326101010000	22100	USDA Forest Service	USDA FOREST SERVICE
38	05168313102010000	22100	USDA Forest Service	USDA FOREST SERVICE
39	05168313101010000	22100	USDA Forest Service	USDA FOREST SERVICE
40	05168314104010000	22100	USDA Forest Service	USDA FOREST SERVICE
41	05168312101020000	22100	USDA Forest Service	USDA FOREST SERVICE
42	05168324202010000	22100	USDA Forest Service	USDA FOREST SERVICE
43	05168324102010000	22100	USDA Forest Service	USDA FOREST SERVICE
44	05168323101010000	22100	USDA Forest Service	USDA FOREST SERVICE
45	05168312203010000	22100	USDA Forest Service	USDA FOREST SERVICE
46	05168311104010000	22100	USDA Forest Service	USDA FOREST SERVICE
47	05168311401020000	22100	USDA Forest Service	USDA FOREST SERVICE
48	05168311401010000	22100	USDA Forest Service	USDA FOREST SERVICE
49	28168114101010000	22100	USDA Forest Service	USDA FOREST SERVICE
50	28168113202010000	22100	USDA Forest Service	USDA FOREST SERVICE
51	28168117101010000	22100	USDA Forest Service	USDA FOREST SERVICE
52	28168112303010000	22100	USDA Forest Service	USDA FOREST SERVICE
53	28168116101010000	22100	USDA Forest Service	USDA FOREST SERVICE
54	28168115101030000	22100	USDA Forest Service	USDA FOREST SERVICE
55	28168112203010000	22100	USDA Forest Service	USDA FOREST SERVICE
56	28168129101010000	22100	USDA Forest Service	USDA FOREST SERVICE
57	28168128101010000	22100	USDA Forest Service	USDA FOREST SERVICE

Table 24. Land Ownership
Vicinity of Lilly/Orphan Boy Mine Site

Map	Parcel ID	OwnCode	OwnerClass	Owner Name
58	28168102101010000	22100	USDA Forest Service	USDA FOREST SERVICE
59	28168111401020000	22100	USDA Forest Service	
60	28168108101010000	22100	USDA Forest Service	USDA FOREST SERVICE
61	28168109101010000	22100	USDA Forest Service	USDA FOREST SERVICE
62	28168110101020000	22100	USDA Forest Service	USDA FOREST SERVICE
63	28168111101020000	22100	USDA Forest Service	USDA FOREST SERVICE
64	28168114302010000	22100	USDA Forest Service	USDA FOREST SERVICE
65	28168114301010000	22100	USDA Forest Service	USDA FOREST SERVICE
66	28168104101010000	22100	USDA Forest Service	USDA FOREST SERVICE
67	28168103101010000	22100	USDA Forest Service	USDA FOREST SERVICE
68	28168121101010000	22100	USDA Forest Service	USDA FOREST SERVICE
69	28168122101020000	22100	USDA Forest Service	USDA FOREST SERVICE
70	28168123201010000	22100	USDA Forest Service	USDA FOREST SERVICE
71	28168120101020000	22100	USDA Forest Service	USDA FOREST SERVICE
72	28168127101030000	22100	USDA Forest Service	USDA FOREST SERVICE
73	28168126101010000	22100	USDA Forest Service	USDA FOREST SERVICE
74	28177919401040000	10000	Private	HIGH PRAIRIE DIVIDE LLLP
75	28177907301010000	10000	Private	BECK, JOHN M
76	28177929401020000	10000	Private	THOMAS WILLIAM P
77	28177801401210000	10000	Private	CHRISTENSEN, DAVID K
78		88888	Right of Way	
79	28177918201010000	10000	Private	THERRIAULT HAROLD
80	28177918101010000	10000	Private	R V RANCH COMPANY
81	28177929202010000	22100	USDA Forest Service	USDA FOREST SERVICE
82	28177907101010000	10000	Private	R V RANCH COMPANY
83	28177918201300000	10000	Private	THERRIAULT BRIAN
84	28177918201180000	10000	Private	BACKSTROM JAMES M
85	28177918301010000	10000	Private	MORLEY JOYCE A
86	28177932101020000	10000	Private	DARFLER FAMILY LLC
87	28177920101010000	10000	Private	R V RANCH COMPANY
88	28177919101020000	10000	Private	STONER GUY F
89	28177801401050000	10000	Private	THOMAS BRANDON C
90	28177919101040000	10000	Private	R V RANCH COMPANY
91	28177919101110000	10000	Private	LONGMIRE E RICHARD
92		88888	Right of Way	
93	28177906101010000	10000	Private	BECK JOHN M
94	28177929401030000	10000	Private	HORNE DALE
95	28177932103010000	22100	USDA Forest Service	USDA FOREST SERVICE
96	28177932101040000	10000	Private	DARFLER FAMILY LLC
97	28177932101080000	10000	Private	LUBITZ, CLIFFORD G
98	28177932101100000	10000	Private	ELLIS RICHARD H
99	28177933101010000	22100	USDA Forest Service	USDA FOREST SERVICE
100	28177929101010000	10000	Private	MORGAN DAVID J
101	28177929101020000	22100	USDA Forest Service	USDA FOREST SERVICE
102	28177919101070000	10000	Private	R V RANCH COMPANY
103	28177929401040000	10000	Private	HORNE, DALE
104	28177929401060000	10000	Private	SAMUELSON MARK S

Section 7.0 Conclusions and Recommendations

This section discusses the conclusions and recommendations of the Phase II RI based on the results described in Section 5 of this report. The purpose of the Phase II RI was to determine if the AMD discharging from the collapsed Lilly adit into Telegraph Creek can be mitigated and/or stopped.

7.1 Conclusions

The relationship between relatively high concentrations of total metals in the shaft and seep water compared to the groundwater samples indicates that the bulk of the AMD is being generated from reactions occurring when water comes into contact with waste rock and mineralized zones around and within the drift. The native groundwater entering the workings from the bedrock aquifer appears to not be a major source of metals contamination. However, since baseline data from the shaft water were not collected, it is not possible to say definitively that groundwater at the site is "clean." Visual observation of the mine workings and measurements of the seep flow rates revealed that the seeps in the Lilly drift contribute a relatively small volume of water to the mine during the fall when soil moisture and groundwater levels are low. This suggests that the majority of inflow into the drift is from either groundwater or seeps in other locations within the workings. Although measurements were not made during the high runoff season, visual observations indicated that seep flows are likely to increase significantly during the spring. TerraGraphics observed relatively large quantities of water entering the east side of the shaft at approximately the 35-foot level during spring runoff. Eliminating surface water infiltration into the mine from areas upgradient of the shaft might reduce the amount of water in the workings and improve the quality of water discharging from the adit. However, installation of an adit plug may be necessary to completely eliminate AMD discharging from the Lilly adit.

The only analyte concentrations measured in the soil samples collected on October 4, 2010, that exceeded the Recreational Clean-up Guidelines established for the site were total arsenic from samples SG02, SG03, SG06, SG10, and SG13. These locations were included in the estimated 3,900 cubic yards of contaminated material on site. Total cadmium, copper, lead, manganese, and zinc concentrations in all of the 2010 soil samples collected during this investigation were significantly below their respective Recreational Clean-up Guidelines. These results indicate that the bulk of the heavily contaminated material at the site is associated with the waste rock piles.

7.2 Recommendations

Based upon the analytical results from samples collected during the Phase II RI and the preliminary assessment of reclamation alternatives, TerraGraphics concludes that removing waste rock and other contaminated material from the surface, and especially from the vicinity of Telegraph Creek, would be the most effective single action for improving overall water quality and reducing human health and ecological risks at the site. Once the waste rock is removed, controlling the sources of surface water infiltration through the mineralized zones above and immediately adjacent to the Lilly drift may significantly improve quality of water discharging

from the Lilly adit. If the goal is complete elimination of all AMD from the Lilly adit, an adit plug must also be fully evaluated. TerraGraphics recommends that the project be continued into the EEE/CA phase to fully evaluate the source control techniques discussed as part of the reclamation alternatives presented herein.

To gain the most benefit from the EEE/CA, TerraGraphics also recommends that monitoring of the groundwater and shaft water be continued into the near future. These monitoring events should be coordinated to coincide with, at a minimum, the low (March) and high (June) groundwater conditions at the site. This would allow for further evaluation of local water levels and the geochemical properties of the groundwater and shaft water.

Monitoring the shaft and wells after the local groundwater system has reached equilibrium would confirm whether water in the workings reaches the level of the Lilly drift during low water conditions. This information would shed further light on the primary source of the most contaminated water, which would help focus the emphasis of the EEE/CA. TerraGraphics further recommends that the quarterly sampling only be conducted on the groundwater monitoring wells and the shaft water, and that total metals be analyzed for in both. This would allow comparison to the data already gathered in this investigation.

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Appendix A

Field Notes

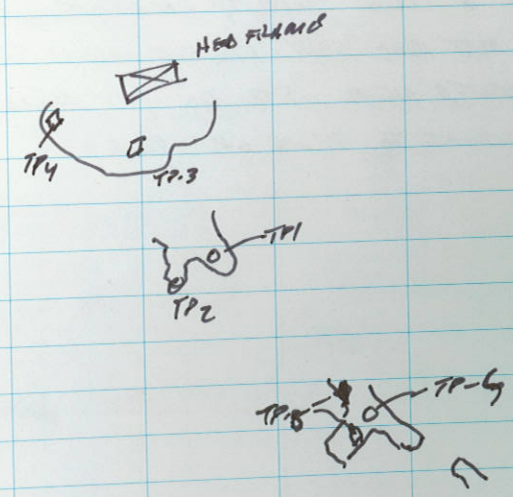
10/16/09

7:00 LEFT TOWN

8:00 ARRIVED AT SITE

8:40 H.R. ARRIVED AT INTERSECTION OF BRIAN CR. RD & TELEGRAPH CR. RD. UNLOADED EXCAVATOR APPROX. 1 MILES BELOW SITE.

PEBBLES 461 - 3660



10/16/09

9:15 BEGAN DIGGING.

TP1 12' DEEP
- 0 - 3' GRAY
3' - 4' BLACK
4' - 9' GRAY
9' - 12' ORANGE-REDDISH BROWN. COBBLES

TP-2 0-2' DARK BROWN 7' DEEP
2-3' - GRAY
3' - 6' - ORANGE BROWNISH

TP-3 0-1' LT. GRAY 7' DEEP
1'-1½' DARK GRAY
1½' - 7' LT. GRAY

TP-4 0-1½' ORANGE BROWN
1½-2½' LT. GRAY
2½ - 6' DARK GRAY
6' - 8' DARK REDDISH BROWN

RECLAIMED TP1 → TP4
BY 11:00

LOG. CONT. 10/16/07

LOWER TAILINGS

TP-5 REDDISH BROWN 0 - 7'

LT. GRAY ON N. SIDE OF PIT

TP-6

DEPTH 7' 12:00 FINISHED DIGGING

LT TO DARK GRAY

LOADED TRUCK @ 1:35 H.D. OFF SITE

LOB T018 1 of 1 9/23/10

12:08 - Bolan Drilling arrives @ Lawdog's Saloon in Elliston

13:28 - Arrive @ LOB site to begin drilling @ LOB-MW2

13:35 - Conduct tool box safety meeting & familiarize Bolan's crew w/ site and associated hazards.

15:17 - Compressor Trailer backed into fenced area near LOB-MW2. Begin drill rig set-up.

15:32 - Begin drilling LOB-MW2

17:39 - Reach 100' bgs on MW-2 - No water yet

18:25 - Reach 120' bgs on MW-2 - No water observed. Letting hole rest overnight to determine if water will enter the boring. Leaving drill string down hole in case it's decided to drill deeper.

19:00 - off-site

JM

LOB TO 18 1 of 3 9/24/10

7:54 - Arrive on-site to continue drilling.

7:59 - water in shaft @ 73.8' below measuring point on grate (cover)

8:04 - water in LOB MW-2 @ 69.5'

8:15 - Pond above the workings is dry

8:20 - shined a spot light into shaft. Flow into shaft was not observed.

8:33 - Begin tripping pipe in MW2 to install 6" PVC Casing

8:50 - Borehole caved in @ base to 113' bgs during removal of drill pipe. Well to be screened from 113' bgs to 93' bgs w/ 6" PVC, 20-slot screen.

9:31 - Begin installing 6" PVC casing in MW2

10:28 - Rock fell down ~~8~~ borehole and lodged @ 90' bgs. Re-enter hole w/ drill pipe to push rock to bottom before casing can be installed.

11:33 - Complete installing casing in LOB MW-2.

12:16 - Begin rig set-up to drill LOB-MW1

12:27 - Begin Drilling LOB-MW1

13:21 - Russ begins developing MW2 using surge block & trash pump

13:42 - Reach 90' bgs on LOB-MW1

LOB TO 18 2 of 3 9/24/10

13:56 - Complete drilling LOB-MW1 to 122' bgs and begin tripping out.

14:12 - In order to not block the gate on the north side of the fence, the piezometer located near MW2 will be placed adjacent to MW1

14:49 - Complete installing screen/casing in MW1

15:09 - Begin test pit excavation next to MW1 for piezometer installation.

- Test pit spoils consist of brownish-red med to coarse grained sands w/ cobbles up to 2' diameter
- Bedrock encountered @ 6' bgs prohibited excavator from digging any further.
- Installed piezometer from 6' bgs to 3' above ground surface (PZ-01)

15:25 - Begin rig set-up on LOB MW-5

15:32 - Begin Drilling LOB-MW5

16:16 - Complete drilling to 55' bgs on MW-5 and start tripping out.

16:30 - Finished installing screen & casing (2") in LOB-MW5

- No piezometer was installed adjacent to MW5 because bedrock was encountered @ 2.5' bgs.

LOB TO18 3 of 3 9/24/10

17:14 - Begin setting-up to drill LOB-MW3
- The road is too steep for the drill rig @ the staked location, MW3 was relocated approx. 20 yards south of staked location
17:29 - Start drilling LOB-MW3
17:32 - Start excavating test pit for piezometer installation @ location adjacent to LOB III
- Bedrock encountered @ 7' bgs stops excavating.
- Piezometer installed from contact w/ bedrock to 3' above ground surface
- Piezometer to be named PZ-02
18:21 - Chain break on drill rig at approx. 26' bgs on MW3. Boland to get parts and finish drilling tomorrow
18:30 - off site

JM

LOB TO18 1 of 3 9/25/10

7:55 - Arrive on-site to find Boland already working to repair the chain on the drill rig.
9:40 - Rig repaired. Continue drilling last 5 feet of LOB-MW3
- MW3 bore hole filled partially w/ GW overnight. Used extra water to clean out bore hole while drilling the remaining few feet.
10:06 - No recovery of chip sample @ 30' because of water in boring.
10:20 - Complete drilling/flushing MW3 bore hole
- GW @ 10.8' bgs in bore hole
10:22 - Begin installing screen & casing in MW3
10:35 - Complete filter pack & bentonite at MW3
10:47 - No water in PZ02
10:50 - GW @ 56.06' BTC in MW5
10:59 - Begin set-up to drill LOB-MW4
11:05 - Excavate test pit for PZ03. Material encountered is Red/Brown, med to coarse grained sand w/ boulders to 3' in diameter. No water in excavation until 5'. Test pit completed to bedrock contact @ 7.5' bgs. PZ03 installed

LOB TO 18 2 of 2 9/25/10

11:15 - Begin drilling MW-4 w/ Tri-cone bit. Hammer bit is not used to the total depth of 25' bgs because of soft nature of material.

- No clear indication of competent bedrock to ~~base~~ 21' bgs of MW4 boring.

11:35 - Complete MW4 boring to 25' bgs.

- Drilling became more difficult @ 21' bgs.

11:45 - Begin completion of MW4

12:02 - MW4 complete. Boland to return to site on 9/27/10 to cement wells & install flush mounts.

12:39 - Lock-up gates & off-site

JM

9/28/10 11:20 LOB TO 27

MET W/ RAIN FOR RENT CREW (BOB, NATHAN & BRENT) AT THE LAWDOG IN ELLISTON & LED THEM TO THE LOB SITE. BEGAN SITE ORIENTATION & SAFETY MEETING. WALKED OVER SITE W/ MAPS TO GO OVER SPRINKLER LINE LAYOUT OPTIONS, SW END OF SITE BETWEEN RD LOOP IS MARSHY.

2:00

CHRIS BOLAND, W/ BOLAND DRILLING, ARRIVED ON SITE TO FINISH WELLS & INSTALL FLUSH MOUNTS & CONCRETE. LEFT SITE @ ~5:45

RAIN FOR RENT CREW CUT & LAID OUT 4 LINES OF 2" POLY PIPE IN LENGTHS ~400'/EA OVER SITE & 6" OF MAIN ROAD. HELPED PULL LINE & LAYOUT. DECIDED 4" MAIN LINES WILL RUN ALONG N PROPERTY BOUNDARY & 2" SPRINKLER LINES WILL RUN SOUTHERLY ACROSS SITE.

5:35 RAIN FOR RENT CREW LEFT SITE.

5:50 LOCKED GATE & LEFT SITE. BACK IN HELENA ~6:39. WENT TO ROCK HAND & PURCHASED PICK AXE FOR PIPE ROAD CROSSING.

9/29/10

LOADED PAKE COOLERS W/ SAMPLE JUGS, WORK PLAN, TOOL SET, CAMERA, ETC, INTO TRUCK. PICKED UP SHACKLES FROM PEBBLES' OFFICE. DELIVERED CD OF PHOTOS & VIDEOS TAKEN FROM PLATFORM REMOVAL EFFORTS. WENT TO SITE TO MEET JEREMY & SAMPLING CREW @ ~ 10 AM. GANG THE SAP.

TRANSDUCERS DELIVERED TO OFFICE. HAD SKYLER, FROM RAIN FOR RENT, PICK THEM UP & BRING TO SITE SINCE HE WAS IN HELENA ON A PARTS RUN.

3:20

TOM'S CRANE SERVICE ARRIVED. SUPPOSED TO BE ON SITE AROUND 11:30/NOON. MET HIM @ LITTLE BLACKFOOT TURNOFF & LED HIM TO THE SITE.

3:45 BACK ON SITE & BEGAN UNLOADING FLATBED. 4" MAIN LINE DRAG INTO PLACE.

6:00

BRENT, RAIN FOR RENT TRUCK DRIVER, LEFT BACK FOR IDAHO FALLS TO GET 2ND LOAD OF EQUIPMENT. FINISHED ON SITE

6:45 & RAIN FOR RENT LEFT SITE.

6:50 TOM'S CRANE SERVICE LEFT SITE.

7:46 BACK @ PARKING GARAGE.

2:00

WENT TO MEET DAN NEWMAN AT HIS CABIN W/ PEBBLES. GOT VERBAL OK TO DO REPOSITORY INVESTIGATION ON HIS PROPERTY N & E OF MINE SITE & POND AREA.

9/30/10

GATHERED GEAR & PRINTED SAP & HASP FOR SHANA TO DO SOIL SAMPLING ON MONDAY. ON SITE & RAIN FOR RENT CREW IS INSTALLING MAIN LINE & TEES.

11:00

TOM'S CRANE SERVICE ARRIVES ON SITE & BEGIN LAYING POLY TANKS, SPILL GUARDS, & FILTER SYSTEM INTO PLACE AROUND SHAFT, WAITING FOR BRENT TO RETURN.

1:30

BRENT ARRIVES & TOM'S CRANE GOES TO ELLISTON TO MEET FREIGHT TRUCK & UNLOAD & BLING TO SITE. RAIN FOR RENT CREW INSTALLING LINES & WELDING PIPE TOGETHER.

11:30

BRIAN MOORE ARRIVED ON SITE & WORKING w/ RAIN FOR RENT CREW TO LEARN THEIR SYSTEM.

3:20

TOM'S CRANE SERVICE BACK ON SITE - LEFT SITE 6:45

7:02

FINISHED SETTING EQUIPMENT & PUMP TO ~100' LEVEL WILL WIRE & TEST TOMORROW.

10/1/10

PICKED UP FLOW METER, MET PEBBLES, DAWN, & MIKE

12:30 BRIAN ON SITE

4:45 SPRINKLER LINES FLUSHED & READY FOR USE

8:15 AFTER RUNNING SYSTEM ~ 2 HRS, WATER LEVEL IN SHAFT DROPPED 8" & SYSTEM KEEPS RECIRCULATING; AFTER SPEAKING W/ BOB, BRIAN SHUT SYSTEM DOWN TO TRY AGAIN ON SAT

10/2/10

SYSTEM KEEPS RECIRCULATING. VALVE APPEARS TO BE STUCK OR NOT WORKING AS NOT RELEASING WATER TO SPRINKLERS. NOT SURE IF pH METERS ARE CALIBRATED OTTHER. BOB WILL BE ON SITE MID-MORNING SUNDAY TO WORK ON SYSTEM.

10/3/10

BOB BACK ON SITE & ADJUSTED BOX OUTLET VALVE PRESSURE & FILTER BAGS. GOING OVER SYSTEM OPERATIONS W/ BRIAN. OPENED 2ND SPRINKLER LINE & PUMPING 100-120 GPM. SYSTEM OPERATING BETTER. WHEN SYSTEM STARTS RECIRCULATING, TURN OFF LMI INJECTION PUMP AS KEEPS LOADING NaOH.

Avg. Flow

LOB-SW05

Left Edge	Right Edge	Velocity	Depth
0.3'	1.4'		
0.4		.2	0.2
0.6'			0.2
0.8'			0.34
1'			0.4
1.2	1.2		0.44
	1.4'	0.3	0.8

Slow Flow/meanders/Pools

LOB-SW01

Left Edge	Right Edge	Velocity	Depth
0.2'	3.6'		
1.2	3.4'	.3	1.6'
↓		.2	.9'
1.8		.1	.9'
	2.4	0	1.25'
	3'	0	1.15'

LOB-SW06

Left Edge	Right Edge	Velocity	Depth
0	1'	.5	.25

Small channel/Branches/muck

1.2 Av Depth

2.24'

1.6 width

LOB-SW03

Left Edge	Right Edge	Velocity	Depth
← 1.6'	→	.2	1.2

Channel coated w/iron Pacipitates
grassy Banks

Road/Access culvert

inlet	outlet	Velocity	Depth
.4	.4		
	width .7'		.28

WATER QUALITY BOX FLOW GAUGE START 169,000,000 GALLONS

FILTER BOX - WHEN GAUGES FOR ~~EACH~~ DIFFER BY
25 PSI - TIME TO CHANGE FILTERS,
WANT THEM RUNNING @ 30 PSI

E POWER BOX - CONTROLS ~~PUMP~~ PUMP IN N RAW TANK
E SWITCH
W SWITCH - RECIRC PUMP IN W TANK

74.35' LEVEL BEFORE PUMPING STARTED

START OF PUMPING 3:15 PM 10/1/10

10/3/10
17:00 79.3

10/4/10
07:00 79.15
10:14 82.59 71,400 GAL PUMPED - OUT OF FILTERS - DONE PUMPING UNTIL FILTERS SHOW UP.
10:40 INSPECTED POOL @ COLLAPSED ADIT - IS DRY

10/5/10
11:00 FILTER SOCKS DELIVERED TO SITE BY JAMIE
PUMPING RESTARTED

10/6/10

BACK PRESSURE HOSE OUTLET FOR MAINTAINING VALVE
PRESSURE IN PLANT DISCHARGING ~ 2.1 GPM
BACK INTO SHAFT

10/7/10 98.35' DTW IN SHAFT @ 1:05 STARTED PUMPING AGAIN @ 12:10 136,700 GAL PUMPED
12:44 E MW-INJECTION WELL 1 WELL ON WR-2 DEPTH TO WATER 49.03' BOTTOM OF WELL
W MW-INJECTION WELL 2 WELL TD 52.4' DTW 51.10' 12:47

LOWERED PUMP 20' (ADDED 20' HOSE)

LOB III 24.99' 12:52

10/9/10

RAIN FOR RENT DELIVERED LARGER PUMP & PIPE TO HANDLE HIGHER HEAD. ARRIVED ~12:30. TOM'S CRANE ARRIVED ~1:00. REMOVED PUMP & PIPE FROM SHAFT BUT COULDN'T ADVANCE BEYOND ~106' - APPEARS TO BE A TIMBER IN THE WAY & COULDN'T WRESTLE PUMP AROUND IT. TRIED UNTIL 6:30 & NO LUCK. WAITING FOR BLUE RANGE TO CHECK IT OUT. PIPE STICKS UP OUT OF GROUND ~12' (ALUMINUM PIPE) SO CANNOT CONNECT TO SYSTEM. PUMP APPEARS TO BE BARELY IN WATER.

10/11/10

8:15 HEARD FROM LARRY HOFFMAN HE'S AWAITING A PART FOR HIS WINCH & WAS SHIPPED BY USPS. SINCE TODAY IS COLUMBUS DAY, HE'LL MOB TO SITE TOMORROW & BE THERE ~10AM.

10/10/10

RAINED SUNDAY NIGHT, STARTED ~2PM & STOPPED MONDAY ~1PM

11/11/10 MW-1 79.82' @ 12:26PM LEVEL NOT WORKING TEMP WORKING

MW-2 91.47' @ 12:48PM TRANSDUCER WORKING

MW-5 26.33' @ 12:58 PM "

MW-3 11.17' @ 1:05 TRANSDUCER WORKING

MW-4 8.18' @ 1:13 "

PZ-3 8.10' @ 1:14

PZ-2 DRY @ 1:16

PZ-1 DRY @ 1:20

V_T PUMPED 156,200 GALLONS

CALLED EQUIPCO (TRANSDUCER RENTAL COMPANY) & THEY ARE GETTING US A REPLACEMENT TRANSDUCER. CHRIS W/ EQUIPCO CALLED BACK @ 3:15 & IS SENDING US A NEW M30 TODAY - SHOULD HAVE IT TOMORROW & WE CAN RETURN FAULTY M30 BY GROUND MAIL.

10/12

BLUE RANGE ON SITE, UNLOADING WINCH & LADDERS OFF SITE @ ~3:30. LADDERS EXTENDED TO ~80' TIMBERS LOOK OK.

REPLACEMENT TRANSDUCER DELIVERED, REPROG & DEPLOYED DTW 79.49 @ ~5:40PM

FINALLY GOT TO DEPTH @ 6:16

WATER PUMPED IN SHAFT DOWN TO LOR. 26' @ 5:30

10/13/10 SUNNY, HIGH 60's

BRIAN MOORE, PEBBLES, DEVIN, PAUL & CURT (OF BLUE RANGE ON SITE). LADDERS ARE BEING SET & STABILIZED.

INVESTIGATED PUMP & ON A TIMBER - CAN BE MOVED TO LOWER PUMP. TOM'S CRANE SERVICE ON SITE AT 2:20.

DEWATERED AGAIN TO 102', CURT WENT DOWN SHAFT TO GUIDE PUMP & CRANE LIFTED PUMP. ONLY ABLE TO LOWER PUMP ~6'. WILL DEWATER & SEE WHERE WE'RE AT.

AFTER PAUL & CURT CLEARED THE SHAFT FOR ENTRY, WENT DOWN SHAFT & SHOVELED MANURE SUBSTRATE OUT OF WAY TO ACCESS 76' LEVEL (LILLY TUNNEL) ROCK LOOKS OK BUT CLEARER WAY FOR BLUE RANGE TO EVALUATE SAFETY. SILL IN TUNNEL IS ~3' ABOVE FLOOR & NOT 1' BELOW ROOF OF LEVEL.

NO SEEPS OBSERVED.

SAW PLATFORM IS SITTING ON TIMBERS, ONLY 1 BROKEN CABLE OBSERVED.

OBTAINED RAW MINE WATER SAMPLE @ 181,800 GALLONS

LEFT SITE 6:~~00~~ 15 TS FILTERED TO 200 MESH

BLUE RANGE (CURT & PAUL) ON SITE @ 9:45

LEFT SITE @ 5:20

LEFT SITE ~ 4:30

MEASURED MINE LEVELS 25', 50' & 76'

SW03 SAMPLE TIME 1900

SW07 SAMPLE TIME 1915

MINE WATER SAMPLE 200 MESH FILTERED

10/14/10 SUNNY WARM 70°s

PUMPING STOPPED AT 195,100 GAL SO PAUL & CURT CAN WORK ON THE LADDERS. WATER LEVEL IN SHAFT @ ~102'.2' @ 9:30 AM

BEING ACCOMPANIED BY PAUL, OF BLUE RANGE, WENT UG TO INSPECT LILLY TUNNEL, GEOLOGY, STATUS & SEEPS. HARDLY ANY WATER SEEPING IN. TUNNEL IS COLLAPSED ~105'-110' FROM SHAFT TO THE W & ENDS 92' E OF SHAFT.

CABLES CUT FROM W PLATFORM. L = 106.5' SO PLATFORMS NOT SET 125' DEEP BUT ~ 98' BGS.

CALL FROM PEBBLES - MEET W/ DAN NEWMAN 9:30 @ HIS CABIN ON TUESDAY TO DISCUSS REPOSITORY ON HIS LAND

10/15

JAMIE & I SET GW SEEP CAPTURES @ W SIDE

80' N SIDE,	10:35
74' N SIDE,	10:45
58' ON FLOOR (ROOF DRIP)	10:50
25' IN FLOOR (ROOF DRIP)	11:05
15' IN FLOOR " "	11:15

BEST COLLECTION CLEAR

E SIDE SEEPS

N FACE 89' (1 TUB) 11:25

S FACE IN CUT (SEVERAL DRIPS) 75' IN CUT 11:30

N FACE 1-5' SEVERAL DRIPS 11:40

171,2700 GALLONS TOTAL 100 GPM

227,400 12:58PM 107' DOWNSTROOD

10/17 8:30-1

CAME TO SITE TO LOWER PUMP FROM 109' TO 135'

HAD TO GO DOWN THE SHAFT PUSHING PUMP & PIPE SO NOT RESTING ON A TIMBER.

10/18 CHECKED 51' LEVEL & STOPING w/ CURT TOOK PHOTOS OF STOPED AREA AT TIMBER BRIDGE

CHECKED WATER COLLECTION IN 74'

TOOK PHOTOS 1-5' E 2 500mL BOTTLES FILLED 12:27

TOOK PHOTOS 75' E 2 250mL BOTTLES FILLED 12:33 ENOUGH FOR 250mL MORE

<500mL @ #1 W 25' WEST IN FLOOR ROOF DRY

58' W FILLED BOTTLES

DTW 12:45 117.5'

EXPOSED LEVEL 114' LEVEL

25' LEVEL ~10' TO S

34-40 EXPOSED TO E HANGING WALL ~25' TO E

51' LEVEL

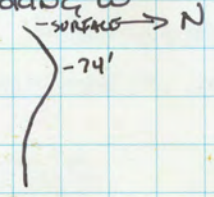
86' TO PLATFORM W

SHAFT ANGLES DOWN TO N TO 74' LEVEL THEN BACK TO S FOR REMAINDER WE EXPOSED.

LAST PHOTOS ARE 114' LEVEL

PYRITE IN ROOF

SHAFT CROSS SECTION LOOKING W



10/19/10

MET PEBBLES @ DAN NEWMAN'S CABIN, W/ STEVE OPP

PEBBLES WILL BE ON VACATION 10/30 FOR 2 WKS

→ WATER & REPOSITORY INVESTIGATION → SCHEDULE W/ JEREMY. TEST PITS, WELL?, PIEZO?, MATERIAL TESTING (PIONEER) USUALLY < $5K

→ SOIL AMENDMENTS 1-3% ORGANICS IS ACCEPTABLE

JERRY GANGSTEAD - EQ. OPERATOR RECOMMENDED BY DAN NEWMAN - BOUGHT SURE THING CLAIM & RECLAIMING & BUILDING A HOME THERE. LIVES IN AVON

SURVEY, TEST PIT

↳ FOR DESIGN - CAN WE DO THE SURVEY

↳ DIL TOTAL STATION RENTAL TO SURVEY SUPPLIES

LOCATED PUMP 20'

68' LEVEL PHOTOS 1376 & 1377

LOOKING S OXIDIZED & GOES IN ~25' L 4' W BETWEEN TIMBERS 6' h TO TIMBERS BUT NO ROOF IS 8' h

81' LEVEL WHEELBARROW LEVEL TO E 4' W x 5' h 10/18 PHOTOS

41' STOPPED IMMEDIATELY E OF SHAFT

SOME WATER INFILTRATION

PHOTOS 1378-1381

25' LEVEL TO S 8' & EXTENDS ~15' W & 15' E WHERE APPEARS TO BE CAVED

THIS LEVEL IS DRY & CANNOT GO E OR W OF THE SHAFT AS IS HEAVILY TIMBERED.

PHOTOS 1382-1385

127.15' DTW

LEFT SITE 1:30 172 35100 235,100 GAL

BEGAN TO GATHER SURVEYING SUPPLIES FOR SHOOTING MWs & POTENTIAL REPOSITORY AREA ON DAN NEWMAN'S PROPERTY.

10/20/10

RENTED SURVEY EQUIPMENT FROM HELENA BLUEPRINT & SURVEY SUPPLIES FROM H.B. & ROCK HAND. WENT TO SITE TO TOPO SURVEY DAN NEWMAN'S ACCESS ROAD & REPOSITORY SITE. ALSO SHOT THE NEW MWs. ~3:30 GOT CALL TO CANCEL THE SURVEY & COVER UP SURVEY MARKS. JERRY GANGSTEAD SHOWED UP SOMETIME ~11 - 12:30. GAVE HIM PEBBLES NAME & # & SAID TO CALL. JAMIE MONTGOMERY HELPED SURVEY.

10/21/10

TO PHOTOS 1402 WORKING WAY FROM SHAFT TO W END TO COLLAPSE. W END DIPS FASTER DUE TO FAULTING (NORMAL) & TO KICK UP W/ VEIN

1403-1432 PHOTOS FROM E END WORKING TO SHAFT

COLLECTED SOME WATER SAMPLES, OTHER COLLECTION AREAS WERE DRY.

PHOTOS 1386-1391 LOOKING DOWN SHAFT FROM THE ~95' LEVEL & @ PLATFORM
1391 IS MUCK @ 114' LEVEL LOOKING W

146.85' DEWATERED LEVEL 10:10

COLLECTED SAMPLES (PARTIAL) FROM:

74' W | 1L ~~500mL~~ TS 10/21/10 TS 10/21/10 ~~(TO TEST pH)~~ 11:55
58' W | 1L ~~500mL~~ TS 10/21/10 (TO TEST pH)
35' W | 500mL 11:23
74' W | 250mL 11:29
80' W 2 500mL 11:31

NOTHING TO COLLECT ON E SIDE

10/22/10 11:04
172,94700 GALLONS PUMPED VOLUME
↳ 394,700 GALLONS @ 100 GPM

MET PEBBLES & LISA N. W/ EPA TMDL GROUP FOR SITE TOUR. THEY LEFT THE SITE ~ 11:05.
TOOK WATER SAMPLES & RETURNED TO TOWN.
SCHEDULING TEAR DOWN OF SITE W/ RAIN FOR RENT, TOM'S CRANE SERVICE, & LARRY HOFFMAN.
MON PM TUESDAY AM

FRIDAY (LAST DAY OF PUMPING) 11:22AM
STOPPED PUMPING AT 172,97,000 ⇒ 397,000 GAL
AS PUMP IS EXPOSED & SUCKING AIR.

10/23-24 NO PUMPING
RAINED SUNDAY & FROZE
NO PUMPING 10/25 FROZE & 1" SNOW
10/26 ON SITE W/ BRIAN & LARRY HOFFMAN
LARRY CHECKING BOTTOM OF SHAFT ABOVE WATER LEVEL. DEPTH TO WATER ~120', WATER SAMPLE OBTAINED IN A 5 GAL BUCKET & JARS FILLED ON SURFACE. @ 11:42AM
PUMPED VOLUME TOTAL = 172,97,000 → 397,000 GAL
LIGHTLY SNOWING 26°F ~10-20 mph WIND
OVERCAST, ~3" SNOW ON GROUND

10/28/10

MET BRIAN MOORE ON SITE TO PREPARE FOR RAIN FOR RENT PICK UP OF THEIR EQUIPMENT, USED ~210 GALLONS OF 10% NaOH, SPRINKLER LINES LOOKED OK & SPRINKLERS ARE STILL FREE SPINNING. MEASURED DTW 114.92'.

10/29/10

CALL FROM BRIAN THAT CAST IRON OR ALL VALVE @ FILTER OUTLET SPLIT SO COULD NOT DO A LAST DEWATERING EFFORT. BRIAN DRAINED LINES & LEFT SITE

11/1/10 TEMP LOW 40s.

MET BRIAN ON SITE FOR RAIN FOR RENT DEMOB SHOT LOCATION OF SW07 W/TRIMBLE GEOXT DTW IN SHAFT 111.2 @ 4:02 PM

RAIN FOR RENT & TOM'S CRANE SERVICE ARRIVED AT 2:00, FINISHED LOADING SYSTEM ON 2 TRAILERS @ 3:50 THEN MOVED TO LOAD ON SEMI, TOM'S CRANE LEFT SITE AT 5:30 & RAIN FOR RENT LEFT AT 6.

11/2/10

ARRIVED 9:30 JAMIE M

TOM'S CRANE CLOUDY 47°F

LARRY BLUE RANGE

BRIAN T.G. SUB - RAIN FOR RENT

LARRY WENT DOWN SHAFT TO GUIDE PUMP

O.T. COMPLETED @ 10:15

CRANE MOBILIZED OUT @ 10:40

SET TRANSDUCER @ 125' IN N. EAST COMPARTMENT

WATER LEVEL @ 10:50 A.M. 110.85

RAIN FOR RENT REMOVED SPRINKLER LINES.

W/ BRIAN SUPERVISING

J.M. LEFT SITE @ 11:20 A.M.

74' LEVEL SEEP SAMPLES

25' W 2 500mL; 1 HNO_3 250mL

80' W 2 250mL; 1 500mL; 1 HNO_3 250mL

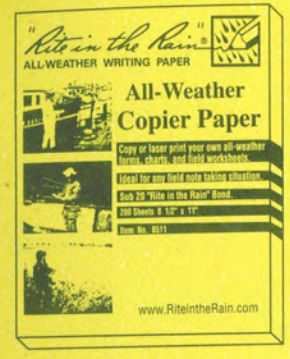
74' W 1 500mL; 1 HNO_3 250mL

58' W 1 1L; 2 500mL; 2 250mL; 1 HNO_3 250mL

1-5' E 1 500mL; 1 HNO_3 250mL

75' E 1 250mL; 1 HNO_3 250mL; 1 1L

"Rite in the Rain"®
ALL-WEATHER WRITING PAPER



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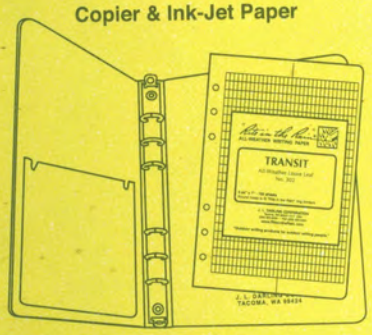
Bound Books



Loose Leaf / Ring Binder

Memo Books

All-Weather Pens

Notebooks

www.RiteintheRain.com

NOTE

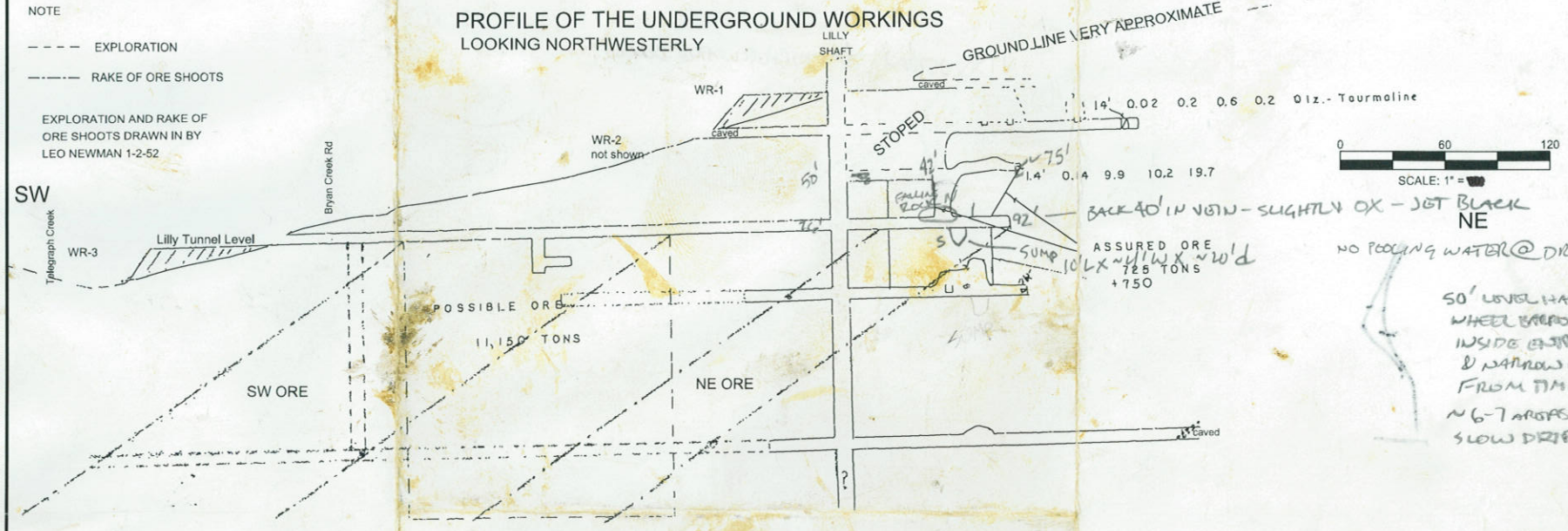
- - - - EXPLORATION

—·—·— RAKE OF ORE SHOOTS

EXPLORATION AND RAKE OF ORE SHOOTS DRAWN IN BY LEO NEWMAN 1-2-52

PROFILE OF THE UNDERGROUND WORKINGS

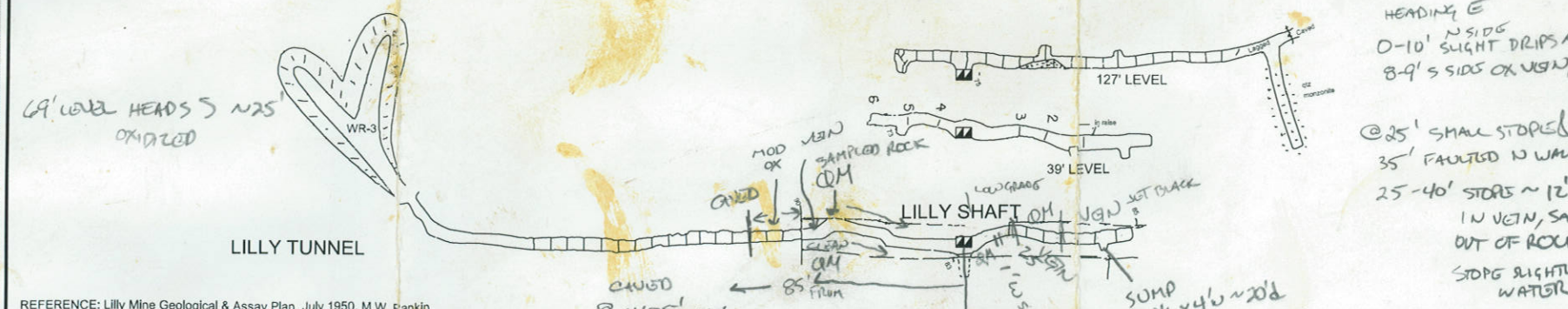
LOOKING NORTHWESTERLY



NO POOLING WATER @ DRIPS

50' LEVEL HAS A WHEEL BARROW JUST INSIDE ENTRANCE & NARROW OPENING FROM TIMBERS ~6-7 AREAS OF VERY SLOW DRIPS & CONDITIONS

PLAN VIEW OF THE UNDERGROUND WORKING LEVELS



HEADING E
N SIDE
0-10' SLIGHT DRIPS ALONG WALL
8-9' S SIDE OX VEIN, WET

@25' SMALL STOPE N IN VEIN
35' FAULTED N WALL N FAILING
25-40' STOPE ~12' HIGH IN VEIN, SALTS COMING OUT OF ROCK
STOPE SLIGHTLY MAKING WATER

40-50 CAVING N FACE

SUMP ~20' DEEP @ S END ~10'L x 4'

REFERENCE: Lilly Mine Geological & Assay Plan, July 1950, M.W. Rankin

DRAWN: TLS	PROJECT NO.: 09210	TerraGraphics Environmental Engineering, Inc.	1950 MINE WORKINGS MAP
ENGINEER: TLS	SCALE: AS SHOWN		MAP PROVIDED BY DAVE NEWMAN
CHECKED: TLS	APPROVED: TLS		LILLY/ORPHAN BOY ABANDONED MINE SITE
	DATE: 8/16/10		FIGURE: 3 / DATE: 8/20/2010

GOING W: BARELY MAKING WATER ~78'
" 17-20' OX
35' SWALL ~5' WIDE OX — PART OF VEIN
0-10' OX IN ROOF SLT WET BOTH WALLS OX

40-60 STOPED ~20' h
DTW - KNEE HIGH

TerraGraphics
Environmental Engineering, Inc.

SURFACE WATER SAMPLING RECORD

PROJECT: LOB	STATION NAME: LOB-SW01
PROJECT NUMBER:	SAMPLE NUMBER: LOB-SW01-A-20100929
LOCATION: Lilly ORPHAN BOY	WEATHER: 65°F SUNNY
DATE: 9/29/10 TIME: 12:00	SAMPLERS: DH

WATER QUALITY PARAMETERS

pH	Temperature (°C) °F	S.C. (µ/cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)
7.50	43.54	107	11.34	92.1	29.8

SAMPLES

Analyte*	Total Metals	Dissolved Metals	Ion/Physio		
Sample ID	SW01-A →				
Time	12:00 →				
Preservative	HNO_3 →		None		
Filtered?	N	Y	N		
Container	250mL	250mL	500mL		

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: Grassy with Trees
Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):
Stream-bed Description: Muddy
Water Quality Description (i.e. cloudy, odor, etc.): Clear

FLOW MEASUREMENTS:
Area (ft^2):
Velocity (ft/sec):
Discharge (Q) (cfs):

NOTES:

*Fill in prior to field work

TerraGraphics
Stream Discharge Form

TerraGraphics
ENVIRONMENTAL ENGINEERING, INC.

Site: LOB-SW01 Gage Reading: _____ Gage Time: _____

Levelogger: Yes / No (circle one) Download Time: _____

Date: 10/1/10 Discharge Time: _____

Field Crew: TS, BM

Discharge Measurements

	Tape (ft)	Width (ft)	Depth (ft)	Area (ft^2)	Velocity (ft/sec)	Velocity (ft/sec)	Discharge (cfs)
LWE	0.2						
1	1.2	0.5	0.9	0.45	0.2		0.09
2	1.8	0.6	0.9	0.54	0.1		0.054
3	2.4	0.6	1.25	0.75	0		—
4	3	0.6	1.45	0.87	0		—
5	3.4	0.6	1.6	0.96	0.3		0.288
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
RWE	3.6						

Total Flow: 0.432

Comments: UPSTREAM OF WR-3
SLOW FLOWING, LAMINAR STREAM
GRASSY BANKS

TerraGraphics
Environmental Engineering, Inc.

SURFACE WATER SAMPLING RECORD

PROJECT: LOB	STATION NAME: LOB-SW03
PROJECT NUMBER:	SAMPLE NUMBER: LOB-SW03-A-20100929
LOCATION: Lilly ORPHAN Bay	WEATHER: Clear, 60°F
DATE: 9/29/10 TIME: 11:35	SAMPLERS: DH

WATER QUALITY PARAMETERS

pH	Temperature (°C) °F	S.C. (µ/cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)
7.60	44.84	141	11.17	92.4	51.5

SAMPLES

Analyte*	Total Metals	Dissolved Metals	Physio/ION		
Sample ID	SW03-A →		→		
Time	11:35 →		→		
Preservative	HNO_3 →		None		
Filtered?	N	Y	N		
Container	250mL	250mL	500mL		

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: Grassy, well vegetated
Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):
Stream-bed Description: muddy
Water Quality Description (i.e. cloudy, odor, etc.): Clear w/ no odor

FLOW MEASUREMENTS:
Area (ft^2):
Velocity (ft/sec):
Discharge (Q) (cfs):

NOTES:

*Fill in prior to field work

TerraGraphics
Stream Discharge Form

TerraGraphics
ENVIRONMENTAL ENGINEERING, INC.

Site: LOB-SW03 Gage Reading: _____ Gage Time: _____

Levelogger: Yes / (No) (circle one) Download Time: _____

Date: 10/1/10 Discharge Time: _____

Field Crew: TS, BM

Discharge Measurements

	Tape (ft)	Width (ft)	Depth (ft)	Area (ft^2)	Velocity (ft/sec)	Velocity (ft/sec)	Discharge (cfs)
LWE	0						
1	0.8	1.6	1.2	1.92	0.2		0.384
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
RWE	1.6						

Total Flow: 0.384

Comments: N DOWNSTREAM SAMPLE LOCATION
ON PROPERTY LINE
SLOW FLOWING LAMINAR STREAM
GRASSY BANKS W/ IRON PRECIPITATES COATING EVERYTHING IN CHANNEL

TerraGraphics
Environmental Engineering, Inc.

SURFACE WATER SAMPLING RECORD

PROJECT: LOB	STATION NAME: LOB - SW05
PROJECT NUMBER:	SAMPLE NUMBER: LOB-SW05-A-20100929
LOCATION: Lilly ORPHAN BOY	WEATHER: 70°F, Sunny
DATE: 9/29/10 TIME: 12:10	SAMPLERS: DH

WATER QUALITY PARAMETERS

pH	Temperature (°C) °F	S.C. (µ/cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)
7.52	49.23	101	11.25	92.2	56.6

SAMPLES

Analyte*	Total Metals	Dissolved Metals	Physio/Ions		
Sample ID	SW-05-A	→	→		
Time	12:10	→	→		
Preservative	HNO_3	HNO_3	None		
Filtered?	No	Yes	No		
Container	250 ml	250 ml	500 ml		

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: Grassy, Well vegetated, Trees present
Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):
Stream-bed Description: Sand and Rock
Water Quality Description (i.e. cloudy, odor, etc.): Clear

FLOW MEASUREMENTS:
Area (ft^2):
Velocity (ft/sec):
Discharge (Q) (cfs):

NOTES:

*Fill in prior to field work

TerraGraphics
Stream Discharge Form

TerraGraphics
ENVIRONMENTAL ENGINEERING, INC.

Site: LOB-SW05 Gage Reading: _____ Gage Time: _____

Levelogger: Yes / No (circle one) Download Time: _____

Date: 10/1/10 Discharge Time: _____

Field Crew: TS, BM

Discharge Measurements

	Tape (ft)	Width (ft)	Depth (ft)	Area (ft^2)	Velocity (ft/sec)	Velocity (ft/sec)	Discharge (cfs)
LWE	0.3'						
1	0.4	0.2	0.2	0.04	0.2		0.008
2	0.6	0.2	0.2	0.04	—		—
3	0.8	0.2	0.34	0.068	—		—
4	1	0.2	0.4	0.08	—		—
5	1.2	0.2	0.44	0.088			—
6	1.4	0.1	0.8	0.08	0.3		0.024
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
RWE	1.4'						

Total Flow: 0.032

Comments: S UPSTREAM SAMPLE LOCATION
ON PROPERTY LINE
SLOW FLOWING LAMINAR STREAM, MEANDERS & SMALL POOLS

TerraGraphics
Environmental Engineering, Inc.

SURFACE WATER SAMPLING RECORD

PROJECT: LOB	STATION NAME: LOB-SW06
PROJECT NUMBER:	SAMPLE NUMBER: LOB-SW06-A-20100929
LOCATION: ~~SW06~~ Lilly orphan Boy	WEATHER: 60°F, Sunny
DATE: 9/29/10 TIME: 11:45	SAMPLERS: DH

WATER QUALITY PARAMETERS

pH	Temperature (°C)	S.C. (µ/cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)
7.54	46.64	122	11.08	83.9	44.0

SAMPLES

Analyte*	Total Metals	Dissolved Metals	Ions/Physio		
Sample ID	SW06-A →				
Time	11:45 →				
Preservative	~~%~~ HNO_3	~~%~~ HNO_3	~~%~~ None		
Filtered?	N	Y	N		
Container	250ml	250ml	500ml		

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: Grassy, well vegetated.
Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):
Stream-bed Description: Muddy
Water Quality Description (i.e. cloudy, odor, etc.): Clear, No ODOR

FLOW MEASUREMENTS:
Area (ft^2):
Velocity (ft/sec):
Discharge (Q) (cfs):

NOTES:

*Fill in prior to field work

TerraGraphics
Stream Discharge Form

TerraGraphics
ENVIRONMENTAL ENGINEERING, INC.

Site: LOB-SW06 Gage Reading: _____ Gage Time: _____

Levelogger: Yes / No (circle one) Download Time: _____

Date: 10/1/10 Discharge Time: _____

Field Crew: TS, BM

Discharge Measurements

	Tape (ft)	Width (ft)	Depth (ft)	Area (ft^2)	Velocity (ft/sec)	Velocity (ft/sec)	Discharge (cfs)
LWE	0						
1	0.5	1	0.25	0.25	0.5		0.125
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
RWE	1						

Total Flow: 0.125

Comments: JUST DOWNSTREAM OF WR-3
DEEP CREEK W/ LOW FLOW & GRASSY BANKS
LAMINAR FLOW
SMALL CHANNEL W/ BRANCHES IN THE STREAM & MUCKY, IRON PRECIPITATE COATS EVERYTHING

TerraGraphics
Environmental Engineering, Inc.

SURFACE WATER SAMPLING RECORD

Duplicate

PROJECT: LOB	STATION NAME: LOB-SW06
PROJECT NUMBER:	SAMPLE NUMBER: LOB-SW06-D-20100929
LOCATION: Gilly ORPHAN BOY	WEATHER: 65°F SUNNY
DATE: 9/29/10 TIME: 11:50	SAMPLERS: DH

WATER QUALITY PARAMETERS

pH	Temperature (°C)°F	S.C. (µ/cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)
7.48	47.01	119	10.98	93.5	43.6

SAMPLES

Analyte*	Total Metals	Dissolved Metal	Ion/Physio		
Sample ID	SW06-D →				
Time	11:50 →				
Preservative	HNO3 →		None		
Filtered?	N	Y	N		
Container	250mL	250 mL	500mL		

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: Grassy
Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):
Stream-bed Description: muddy
Water Quality Description (i.e. cloudy, odor, etc.): Clear

FLOW MEASUREMENTS:
Area (ft^2):
Velocity (ft/sec):
Discharge (Q) (cfs):

NOTES:

*Fill in prior to field work

TerraGraphics
Environmental Engineering, Inc.

SURFACE WATER SAMPLING RECORD

Field Blank

PROJECT: LOB	STATION NAME: LOB SW06
PROJECT NUMBER:	SAMPLE NUMBER: LOB-SW06-B-20100929
LOCATION: Lilly ORPHAN BOY	WEATHER: 70°F SUNNY
DATE: 9/28/10 TIME: 12:45	SAMPLERS: DH

WATER QUALITY PARAMETERS

pH	Temperature (°C)	S.C. (___/cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)

SAMPLES

Analyte*	Total Metals	Dissolved Metals	Ion/Physio		
Sample ID	SW06-B →				
Time	12:45 →				
Preservative	HNO_3 →		NONE		
Filtered?	N	Y	N		
Container	250 mL	250 mL	~~500 mL~~ 500 mL		

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: _____

Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):

Stream-bed Description: _____

Water Quality Description (i.e. cloudy, odor, etc.): _____

FLOW MEASUREMENTS:

Area (ft^2):

Velocity (ft/sec):

Discharge (Q) (cfs):

NOTES:

*Fill in prior to field work

TerraGraphics
Environmental Engineering, Inc.

SURFACE WATER SAMPLING RECORD

Rinsate Blank

PROJECT: LOB	STATION NAME: LOB-SW06
PROJECT NUMBER:	SAMPLE NUMBER: LOB-SW06-C-20100929
LOCATION: Lilly Orphan Boy	WEATHER: 70°F, SUNNY
DATE: 9/29/10 TIME: 12:55	SAMPLERS: DH

WATER QUALITY PARAMETERS

pH	Temperature (°C)	S.C. (___/cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)

SAMPLES

Analyte*	Total Metals	Dissolved Metals	Ions/Physio		
Sample ID	SW06-C →	→	→		
Time	12:55 →	→	→		
Preservative	HNO_3 →	→	None		
Filtered?	N	Y	N		
Container	250mL	250mL	500mL		

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: _____

Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):

Stream-bed Description: _____

Water Quality Description (i.e. cloudy, odor, etc.): _____

FLOW MEASUREMENTS:

Area (ft^2):

Velocity (ft/sec):

Discharge (Q) (cfs):

NOTES:

*Fill in prior to field work

TerraGraphics
Environmental Engineering, Inc.

GROUNDWATER SAMPLING RECORD

Project: BH - Remedial Design Data Collection	Well Number: LOB-MW1
Project Number: 5080	Sample Number: LOB-MW1-A-20100929
Location: LOB	Weather: 70°F, sunny, slight breeze
Date: 9/29/10	Sampler(s):
Depth to Bottom (ft):	Purge Time:
Depth to Water (ft): 46.19	Purge Method: Low Flow
DTB-DTW (ft):	Volume Measurement Method:
1 Well Volume (gal):	Purge Volume (Volume x 3) (gal):

Conversion Factors (height x factor= 1 well volume)	¾" diameter 0.023	1" diameter 0.041	1 ½" diameter 0.092	2" diameter 0.163	4" diameter 0.652	8" diameter 2.611

GROUNDWATER DATA

Purged Volume (gal)	Time	pH	S.C. (µS/cm)	Temp (°C)	Dissolved Oxygen mg/L	Dissolved Oxygen %	ORP (mV)
	13:24	6.98	741	49.01	9.98	84.9	-12.1
	13:24	7.17	693	46.21	9.98	75.2	-28.4
	13:25	7.28	628	43.79	8.43	68.6	-35.7

Sampling Date:		Sampling Method:		Time Sampled: 13:26	
Container	Volume	Preservative	Cooled	Filtered	Analyte
Poly	~~1L~~ 250 ml	HNO3	~~Y~~	~~Y~~ N	~~DM~~ Total metals
Poly	~~1L~~ 500 ml	~~HNO3~~ None	~~Y~~	N	~~TP, Hard~~ Ions/Physio

Chain of Custody: Yes/No	Duplicate Sample Number:
Chain of Custody Number:	Replicate Sample Number:
Laboratory:	
Method of Shipment:	
Split With:	

Notes: Well pumped dry during purging. Shut off pump & allowed to recharge for ½-hour before sampling. Parameter stabilization did not get a chance to occur.

Transducer hung @ 115' below bottom of ~~well cap~~ casing (Total Depth = 115')

TerraGraphics
Environmental Engineering, Inc.

GROUNDWATER SAMPLING RECORD

Project: BH - Remedial Design Data Collection	Well Number: LOB - MW2
Project Number: 5080	Sample Number: LOB-MW2-A-20100929
Location: LOB	Weather: 56°F, sunny, light breeze
Date: 9/29/10	Sampler(s): JM/BM
Depth to Bottom (ft):	Purge Time:
Depth to Water (ft): 70.82'	Purge Method: Low Flow
DTB-DTW (ft):	Volume Measurement Method:
1 Well Volume (gal):	Purge Volume (Volume x 3) (gal):

Conversion Factors (height x factor= 1 well volume)	¾" diameter 0.023	1" diameter 0.041	1 ½" diameter 0.092	2" diameter 0.163	4" diameter 0.652	8" diameter 2.611

GROUNDWATER DATA

Purged Volume (gal)	Time	pH	S.C. (__S/cm)	Temp (°C)	Dissolved Oxygen mg/L	Dissolved Oxygen %	ORP (mV)
	12:13	6.48	2026	41.82	6.55	52.1	46.0
	12:13	6.49	2031	41.84	6.53	51.8	45.3
	12:13	6.47	2028	41.80	6.55	51.9	45.8

Sampling Date:		Sampling Method:		Time Sampled: 12:14	
Container	Volume	Preservative	Cooled	Filtered	Analyte
Poly	~~1L~~ 250 ml	HNO3	Y	~~X~~ N	~~DM~~ Total Metals
Poly	~~1L~~ 500 ml	~~HNO3~~ None	Y	N	~~TP, Hard~~ Ions/Physio

Chain of Custody: Yes/No	Duplicate Sample Number: LOB-MW2-D-20100929
Chain of Custody Number:	Replicate Sample Number:
Laboratory: Pace	
Method of Shipment:	
Split With:	

Notes:

Transducer hung @ ~~[illegible]~~ 90' below top of casing

TerraGraphics
Environmental Engineering, Inc.

GROUNDWATER SAMPLING RECORD

Project: BH - Remedial Design Data Collection	Well Number: L013 - MW2
Project Number: 5080	Sample Number: L013-MW2-D-20100929
Location: L013	Weather: 56°F, Sunny, light breeze
Date: 9/29/10	Sampler(s): JM/RM
Depth to Bottom (ft):	Purge Time:
Depth to Water (ft):	Purge Method: Low Flow
DTB-DTW (ft):	Volume Measurement Method:
1 Well Volume (gal):	Purge Volume (Volume x 3) (gal):

Conversion Factors (height x factor= 1 well volume)	¾" diameter 0.023	1" diameter 0.041	1 ½" diameter 0.092	2" diameter 0.163	4" diameter 0.652	8" diameter 2.611

GROUNDWATER DATA

Purged Volume (gal)	Time	pH	S.C. (__S/cm)	Temp (°C) °C	Dissolved Oxygen mg/L	Dissolved Oxygen %	ORP (mV)
	13:18	6.70	2047	42.63	6.97	55.8	52.1
	13:20	6.59	2026	41.87	6.70	53.4	47.7
	13:21	6.48	2031	41.83	6.53	51.9	45.3

Sampling Date:		Sampling Method:		Time Sampled: 12:15	
Container	Volume	Preservative	Cooled	Filtered	Analyte
Poly	1L 250 ml	HNO3	~~Y~~	~~Y~~ N	~~DM~~ Total Metals
Poly	1L 500 ml	~~HNO3~~ None	~~Y~~	N	~~TP, Hard~~ Ions/Physio

Chain of Custody: Yes/No	Duplicate Sample Number:
Chain of Custody Number:	Replicate Sample Number:

Laboratory:
Method of Shipment:
Split With:

Notes: Duplicate

TerraGraphics
Environmental Engineering, Inc.

GROUNDWATER SAMPLING RECORD

Project: BH - Remedial Design Data Collection	Well Number: LOB-MW2
Project Number: 5080	Sample Number: LOB-MW2-B-20100929
Location: LOB	Weather: 56°F, Sunny
Date: 9/29/10	Sampler(s): JM/RM
Depth to Bottom (ft):	Purge Time:
Depth to Water (ft):	Purge Method: Low Flow
DTB-DTW (ft):	Volume Measurement Method:
1 Well Volume (gal):	Purge Volume (Volume x 3) (gal):

Conversion Factors (height x factor= 1 well volume)	¾" diameter 0.023	1" diameter 0.041	1 ½" diameter 0.092	2" diameter 0.163	4" diameter 0.652	8" diameter 2.611

GROUNDWATER DATA

Purged Volume (gal)	Time	pH	S.C. (__S/cm)	Temp (°C)	Dissolved Oxygen mg/L	Dissolved Oxygen %	ORP (mV)

Sampling Date: 9/29/10		Sampling Method:		Time Sampled: 12:30	
Container	Volume	Preservative	Cooled	Filtered	Analyte
Poly	~~1L~~ 250 ml	HNO3	Y	~~Y~~ No	~~DM~~ Total Metals
Poly	1L 500 ml	~~HNO3~~ None	Y	~~N~~ No	TP, Hard Ions/phys.o

Chain of Custody: Yes/No	Duplicate Sample Number:
Chain of Custody Number:	Replicate Sample Number:

Laboratory:
Method of Shipment:
Split With:

Notes: Field Blank of Distilled H_2O

TerraGraphics
Environmental Engineering, Inc.

GROUNDWATER SAMPLING RECORD

Project: BH - Remedial Design Data Collection	Well Number: L013 · MW2
Project Number: 5080	Sample Number: L013-MW2-C-20100929
Location: L013	Weather: 57°F
Date: 9/29/10	Sampler(s): JM/RM
Depth to Bottom (ft):	Purge Time:
Depth to Water (ft):	Purge Method: Low Flow
DTB-DTW (ft):	Volume Measurement Method:
1 Well Volume (gal):	Purge Volume (Volume x 3) (gal):

Conversion Factors (height x factor= 1 well volume)	¾" diameter 0.023	1" diameter 0.041	1 ½" diameter 0.092	2" diameter 0.163	4" diameter 0.652	8" diameter 2.611

GROUNDWATER DATA

Purged Volume (gal)	Time	pH	S.C. (__S/cm)	Temp (°C)	Dissolved Oxygen mg/L	Dissolved Oxygen %	ORP (mV)

Sampling Date: 9/29/10		Sampling Method:		Time Sampled: 12:31	
Container	Volume	Preservative	Cooled	Filtered	Analyte
Poly	~~1L~~ 250 ml	HNO3	Y	~~Y~~ N	~~DM~~ Total Metals
Poly	~~1L~~ 500 ml	~~HNO3~~ None	~~Y~~ Y	N	~~TP, Hard~~ Ion, Physio

Chain of Custody: Yes/No	Duplicate Sample Number:
Chain of Custody Number:	Replicate Sample Number:

Laboratory:

Method of Shipment:

Split With:

Notes: Rinseate Blank of bladder pump tubing

TerraGraphics
Environmental Engineering, Inc.

GROUNDWATER SAMPLING RECORD

Project: BH - Remedial Design Data Collection	Well Number: LOB-MW3
Project Number: 5080	Sample Number: LOB-MW3-A-20100929
Location: LOB (MW-3)	Weather: 75°F, Sunny, clear skies, slight wind
Date: 9/29/10	Sampler(s): JM/RM
Depth to Bottom (ft):	Purge Time:
Depth to Water (ft): 8.11'	Purge Method: Low Flow
DTB-DTW (ft):	Volume Measurement Method:
1 Well Volume (gal):	Purge Volume (Volume x 3) (gal):

Conversion Factors (height x factor= 1 well volume)	¾" diameter 0.023	1" diameter 0.041	1 ½" diameter 0.092	2" diameter 0.163	4" diameter 0.652	8" diameter 2.611

GROUNDWATER DATA

Purged Volume (gal)	Time	pH	S.C. (__S/cm)	Temp (°~~C~~ F)	Dissolved Oxygen mg/L	Dissolved Oxygen %	ORP (mV)
	14:24	7.25	1478	44.33	11.45	94.4	55.0
	14:26	7.21	1480	44.32	11.46	94.8	54.9
	14:27	7.20	1481	44.37	11.47	95.0%	54.6

Sampling Date: 9/29/10	Sampling Method: Low Flow		Time Sampled: 14:28		
Container	Volume	Preservative	Cooled	Filtered	Analyte
Poly	~~1L~~ 250 ml	HNO3	(Y)	~~Y~~ N	~~DM~~ Total Metals
Poly	~~1L~~ 500 ml	~~HNO3~~ None	(Y)	N	~~TP, Hard~~ Ions, physio

Chain of Custody: Yes/No	Duplicate Sample Number:
Chain of Custody Number:	Replicate Sample Number:

Laboratory:
Method of Shipment:
Split With:

Notes:

Transducer hung @ 25' below bottom of well cap (Total Depth = 25'-3")

TerraGraphics
Environmental Engineering, Inc.

GROUNDWATER SAMPLING RECORD

Project: BH - Remedial Design Data Collection	Well Number: LOB-MW4
Project Number: 5080	Sample Number: LOB-MW4-A-20100929
Location: LOB Mine	Weather: 78°F, clear skies, slight breeze
Date: 9/29/10	Sampler(s): JM/RM
Depth to Bottom (ft):	Purge Time:
Depth to Water (ft): 8.31'	Purge Method: Low Flow
DTB-DTW (ft):	Volume Measurement Method:
1 Well Volume (gal):	Purge Volume (Volume x 3) (gal):

Conversion Factors (height x factor= 1 well volume)	¾" diameter 0.023	1" diameter 0.041	1 ½" diameter 0.092	2" diameter 0.163	4" diameter 0.652	8" diameter 2.611

GROUNDWATER DATA

Purged Volume (gal)	Time	pH	S.C. (__S/cm)	Temp (~~°C~~ F)	Dissolved Oxygen mg/L	Dissolved Oxygen %	ORP (mV)
	14:48	6.29	1697	43.42	9.27	75.3	131.0
	14:48	6.27	1698	43.40	9.25	75.0	131.9
	14:49	6.28	1698	43.42	9.23	74.9	132.0

Sampling Date:		Sampling Method:		Time Sampled: 14:50	
Container	Volume	Preservative	Cooled	Filtered	Analyte
Poly	~~1L~~ 250 ml	HNO3	Y	~~Y~~ N	~~DM~~ Total Metals
Poly	~~1L~~ 500 ml	~~HNO3~~ None	Y	N	~~TP, Hard~~ Ions/Physio

Chain of Custody: Yes/No	Duplicate Sample Number:
Chain of Custody Number:	Replicate Sample Number:
Laboratory:	
Method of Shipment:	
Split With:	

Notes:

Transducer installed w/ 20' of monofilament - tied to bottom of well cap
Well cap sticks down 3" from top of casing (Total depth = 20'-3")

TerraGraphics
Environmental Engineering, Inc.

GROUNDWATER SAMPLING RECORD

Project: BH - Remedial Design Data Collection	Well Number: L03 - MW5
Project Number: 5080	Sample Number: L03-MW5-A-20100929
Location: L03	Weather: 72°F, sunny, slight breeze
Date: 9/29/10	Sampler(s): JM/RM
Depth to Bottom (ft):	Purge Time:
Depth to Water (ft): 27.36'	Purge Method: Low Flow
DTB-DTW (ft):	Volume Measurement Method:
1 Well Volume (gal):	Purge Volume (Volume x 3) (gal):

Conversion Factors (height x factor= 1 well volume)	¾" diameter 0.023	1" diameter 0.041	1 ½" diameter 0.092	2" diameter 0.163	4" diameter 0.652	8" diameter 2.611

GROUNDWATER DATA

Purged Volume (gal)	Time	pH	S.C. (__S/cm)	Temp (°~~C~~ F)	Dissolved Oxygen mg/L	Dissolved Oxygen %	ORP (mV)
	1350	7.79	446	47.67	9.77	83.2%	28.2

Sampling Date: 9/29/10	Sampling Method: low flow		Time Sampled: 14:20		
Container	Volume	Preservative	Cooled	Filtered	Analyte
Poly	~~1L~~ 250 ml	HNO3	(Y)	~~Y~~ N	~~DM~~ Total Metals
Poly	1L 500 ml	~~HNO3~~ None	(Y)	(N)	~~TP, Hard~~ Ions, Physio

Chain of Custody: Yes/No	Duplicate Sample Number:
Chain of Custody Number:	Replicate Sample Number:
Laboratory:	
Method of Shipment:	
Split With:	

Notes: Well pumped dry after purging approx. 1.5 gal. Parameter stabilization not possible, Sample collected after letting well recover for 1/2-hour

Transducer hung @ 50' below bottom of well cap (Total depth: 50'-3")

TerraGraphics
Environmental Engineering, Inc.

SURFACE WATER SAMPLING RECORD

PROJECT:	STATION NAME:
PROJECT NUMBER:	SAMPLE NUMBER:
LOCATION: LOB-SW07	WEATHER:
DATE: 10/2/10 TIME: 1444	SAMPLERS:

WATER QUALITY PARAMETERS

pH	Temperature (°C)°F	S.C. (µS/cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)
6.71	45.88	158	11.70	98	133.2

4.9 NTU

SAMPLES

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: _____
Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):
Stream-bed Description: _____
Water Quality Description (i.e. cloudy, odor, etc.): _____

FLOW MEASUREMENTS:
Area (ft^2):
Velocity (ft/sec):
Discharge (Q) (cfs):

NOTES:

*Fill in prior to field work

TerraGraphics
Stream Discharge Form

TerraGraphics
ENVIRONMENTAL ENGINEERING, INC.

Site: LOB-SW07 Gage Reading: _____ Gage Time: _____

Levelogger: Yes / (No) (circle one) Download Time: _____

Date: 10/1/10 Discharge Time: _____

Field Crew: TS, BM

Discharge Measurements

	Tape (ft)	Width (ft)	Depth (ft)	Area (ft^2)	Velocity (ft/sec)	Velocity (ft/sec)	Discharge (cfs)
LWE							
1	INLET				0.4		
2	OUTLET	0.7	0.28		0.4		0.0784
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
RWE							

Total Flow: 0.0784

Comments: DOWNSTREAM OF LILLY CLAIM
AT DOWNSTREAM DISCHARGE OF CULVERT
LAMINAR FLOW
ROAD MATERIAL OVERHANGS ABOVE CULVERT - COULD ONLY MEASURE FLOW WHERE
PORTION OF CREEK IS FLOWING: WIDTH 0.7' DEPTH 0.28' V 0.4 FT/S

TerraGraphics
Environmental Engineering, Inc.

~~SURFACE~~ WATER SAMPLING RECORD

PROJECT:	STATION NAME:
PROJECT NUMBER:	SAMPLE NUMBER:
LOCATION: Tank #1	WEATHER:
DATE: 10/2/10 TIME: 1125	SAMPLERS:

WATER QUALITY PARAMETERS

pH	Temperature (~~°C~~)F	S.C. (µS/cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)
4.95	40.82	108.3	3.07	23.9	45.3

17.6 NTU+

SAMPLES

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: _____
Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):
Stream-bed Description: _____
Water Quality Description (i.e. cloudy, odor, etc.): _____

FLOW MEASUREMENTS:
Area (ft^2):
Velocity (ft/sec):
Discharge (Q) (cfs):

NOTES:

*Fill in prior to field work

TerraGraphics
Environmental Engineering, Inc.

SURFACE WATER SAMPLING RECORD

PROJECT:	STATION NAME:
PROJECT NUMBER:	SAMPLE NUMBER:
LOCATION: LOB-SW05	WEATHER:
DATE: 10/7/10 TIME: 0800	SAMPLERS:

WATER QUALITY PARAMETERS

pH	Temperature (°~~C~~)F	S.C. (µS/cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)
7.83	43.01	111	11.70	94.2	78.4

3.8 NTU*

SAMPLES

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: _____
Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):
Stream-bed Description: _____
Water Quality Description (i.e. cloudy, odor, etc.): _____

FLOW MEASUREMENTS:
Area (ft^2):
Velocity (ft/sec):
Discharge (Q) (cfs):

NOTES:

*Fill in prior to field work

TerraGraphics
Environmental Engineering, Inc.

SURFACE WATER SAMPLING RECORD

PROJECT:	STATION NAME:
PROJECT NUMBER:	SAMPLE NUMBER:
LOCATION: LOB-SW07	WEATHER:
DATE: 10/7/10 TIME: 0840	SAMPLERS:

WATER QUALITY PARAMETERS

pH	Temperature (°C)F	S.C. (µS/cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)
7.32	42.44	173	11.27	90.2	83.7

4.6 NTU*

SAMPLES

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: _____
Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):
Stream-bed Description: _____
Water Quality Description (i.e. cloudy, odor, etc.): _____

FLOW MEASUREMENTS:
Area (ft^2):
Velocity (ft/sec):
Discharge (Q) (cfs):

NOTES:

*Fill in prior to field work

TerraGraphics
Environmental Engineering, Inc.

MINE ~~SURFACE~~ WATER SAMPLING RECORD

PROJECT:	STATION NAME: SHAFT
PROJECT NUMBER:	SAMPLE NUMBER:
LOCATION: SHAFT WATER - RAW 181,800 GAL	WEATHER: SUNNY 70°s
DATE: 10/13/10 TIME: 5:55	SAMPLERS: TS

WATER QUALITY PARAMETERS

pH	Temperature (°C) °F	S.C. (µS/cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)
5.54	41.51	1190	11.48	90.9	150.1

SAMPLES

10.9 NTU TURBIDITY

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: _____
Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):
Stream-bed Description: _____
Water Quality Description (i.e. cloudy, odor, etc.): _____

FLOW MEASUREMENTS:
Area (ft^2):
Velocity (ft/sec):
Discharge (Q) (cfs):

OBTAINED FROM DRAIN PORT OF FILTER BANK
RAW SAMPLE

NOTES:

*Fill in prior to field work

TerraGraphics
Environmental Engineering, Inc.

SURFACE WATER SAMPLING RECORD

PROJECT:	STATION NAME: LOB-SW03
PROJECT NUMBER:	SAMPLE NUMBER:
LOCATION: LOB-SW03	WEATHER: Sunny Clear
DATE: 10/13/10 TIME: 1900	SAMPLERS: Br

WATER QUALITY PARAMETERS

pH	Temperature (°C)	S.C. (µs /cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)
6.85	41.25	147	12.92	101.5	106.3

4.8 NTU*

SAMPLES

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: _____
Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):
Stream-bed Description: _____
Water Quality Description (i.e. cloudy, odor, etc.): _____

FLOW MEASUREMENTS:
Area (ft^2):
Velocity (ft/sec):
Discharge (Q) (cfs):

NOTES:

*Fill in prior to field work

TerraGraphics
Environmental Engineering, Inc.

SURFACE WATER SAMPLING RECORD

PROJECT:	STATION NAME: LOB-SW07
PROJECT NUMBER:	SAMPLE NUMBER:
LOCATION: Culvert	WEATHER: Dark Clear sky
DATE: 10/13/10 TIME: 1915	SAMPLERS:

WATER QUALITY PARAMETERS

pH	Temperature (°C) F	S.C. (µS /cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)
6.96	41.66 F	166	12.75	100.8	106.5

4.5 NTU*

SAMPLES

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: _____
Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):
Stream-bed Description: _____
Water Quality Description (i.e. cloudy, odor, etc.): _____

FLOW MEASUREMENTS:
Area (ft^2):
Velocity (ft/sec):
Discharge (Q) (cfs):

NOTES:

*Fill in prior to field work

TerraGraphics
Environmental Engineering, Inc.

~~SURFACE~~ WATER SAMPLING RECORD

PROJECT:	STATION NAME: LOB
PROJECT NUMBER:	SAMPLE NUMBER:
LOCATION: Shaft water - Raw 171282	WEATHER: Sunny / Clear
DATE: 10/15/10 TIME: 1300	SAMPLERS:

WATER QUALITY PARAMETERS

pH	Temperature (~~°C~~ °F)	S.C. (µs/cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)
5.90	42.60	174	9.42	75.5	130.5

32.6 NTU

SAMPLES

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: _____
Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):
Stream-bed Description: _____
Water Quality Description (i.e. cloudy, odor, etc.): _____

FLOW MEASUREMENTS:
Area (ft^2):
Velocity (ft/sec):
Discharge (Q) (cfs):

NOTES:

*Fill in prior to field work

TerraGraphics
Environmental Engineering, Inc.

SURFACE WATER SAMPLING RECORD

PROJECT:	STATION NAME:
PROJECT NUMBER:	SAMPLE NUMBER:
LOCATION: LOB-SW03	WEATHER:
DATE: 10/15/10 TIME: 1300	SAMPLERS: BM

WATER QUALITY PARAMETERS

pH	Temperature (°C) F	S.C. (µS/cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)
7.00	43.97	221	11.1	89.9	87.4

6.8 NTU

SAMPLES

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: _____
Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):
Stream-bed Description: _____
Water Quality Description (i.e. cloudy, odor, etc.): _____

FLOW MEASUREMENTS:
Area (ft^2):
Velocity (ft/sec):
Discharge (Q) (cfs):

NOTES:

*Fill in prior to field work

TerraGraphics
Environmental Engineering, Inc.

SURFACE WATER SAMPLING RECORD

PROJECT:	STATION NAME: SW-07
PROJECT NUMBER:	SAMPLE NUMBER:
LOCATION: LOB-SW07-A-20101015	WEATHER:
DATE: 10/15/10 TIME: 1318	SAMPLERS: BM

WATER QUALITY PARAMETERS

pH	Temperature (°C) F	S.C. (µs/cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)
7.01	41.67	215	11.25	89.1	96.7

5.7 NTU

SAMPLES

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: _____
Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):
Stream-bed Description: _____
Water Quality Description (i.e. cloudy, odor, etc.): _____

FLOW MEASUREMENTS:
Area (ft^2):
Velocity (ft/sec):
Discharge (Q) (cfs):

NOTES:

*Fill in prior to field work

TerraGraphics
Environmental Engineering, Inc.

SURFACE WATER SAMPLING RECORD

PROJECT:	STATION NAME:
PROJECT NUMBER:	SAMPLE NUMBER:
LOCATION: LOB-SW03	WEATHER:
DATE: 10/17/10 TIME: 0920	SAMPLERS: BM

WATER QUALITY PARAMETERS

pH	Temperature (°C) F	S.C. (µS/cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)
7.15	36.09	163	9.23	67.5	56.9

4.8 NTU

SAMPLES

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: _____
Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):
Stream-bed Description: _____
Water Quality Description (i.e. cloudy, odor, etc.): _____

FLOW MEASUREMENTS:
Area (ft^2):
Velocity (ft/sec):
Discharge (Q) (cfs):

NOTES:

*Fill in prior to field work

TerraGraphics
Environmental Engineering, Inc.

SURFACE WATER SAMPLING RECORD

PROJECT:	STATION NAME:
PROJECT NUMBER:	SAMPLE NUMBER:
LOCATION: LOB-SW07	WEATHER:
DATE: 10/12/10 TIME: 0930	SAMPLERS: BM

WATER QUALITY PARAMETERS

pH	Temperature ~~°C~~ °F	S.C. (µS /cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)
7.07	36.56	193	10.43	77.0	75.8

4.6 NTU

SAMPLES

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: _____

Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):

Stream-bed Description: _____

Water Quality Description (i.e. cloudy, odor, etc.): _____

FLOW MEASUREMENTS:

Area (ft^2):

Velocity (ft/sec):

Discharge (Q) (cfs):

NOTES:

*Fill in prior to field work

TerraGraphics
Environmental Engineering, Inc.

SURFACE WATER SAMPLING RECORD

PROJECT:	STATION NAME:
PROJECT NUMBER:	SAMPLE NUMBER:
LOCATION: LOB-SW03	WEATHER:
DATE: 10/18/10 TIME: 0850	SAMPLERS: JM

WATER QUALITY PARAMETERS

pH	Temperature (°C) F	S.C. (µS/cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)
7.51	34.36	174	5.75	40.5	72.3

5.0 NTU

SAMPLES

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: _____
Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):
Stream-bed Description: _____
Water Quality Description (i.e. cloudy, odor, etc.): _____

FLOW MEASUREMENTS:
Area (ft^2):
Velocity (ft/sec):
Discharge (Q) (cfs):

NOTES:

*Fill in prior to field work

TerraGraphics
Environmental Engineering, Inc.

SURFACE WATER SAMPLING RECORD

PROJECT:	STATION NAME:
PROJECT NUMBER:	SAMPLE NUMBER:
LOCATION: ~~SW0~~ LOB-SW07	WEATHER:
DATE: 10/18/10 TIME: 0900	SAMPLERS: BM

WATER QUALITY PARAMETERS

pH	Temperature (°~~C~~)F	S.C. (µS /cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)
7.32	34.47	200	7.88	56.0	84.2

4.5 ~~%~~ NTU

SAMPLES

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: _____
Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):
Stream-bed Description: _____
Water Quality Description (i.e. cloudy, odor, etc.): _____

FLOW MEASUREMENTS:
Area (ft^2):
Velocity (ft/sec):
Discharge (Q) (cfs):

NOTES:

*Fill in prior to field work

TerraGraphics
Environmental Engineering, Inc.

SURFACE WATER SAMPLING RECORD

PROJECT:	STATION NAME:
PROJECT NUMBER:	SAMPLE NUMBER:
LOCATION: LOB-SW03	WEATHER: Sunny / Clear
DATE: 10/19/10 TIME: 1545	SAMPLERS: BM

WATER QUALITY PARAMETERS

pH	Temperature (~~°C~~) F	S.C. (µS/cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)
6.84	39.47	234	9.41	72.1	96.5

6.5 NTU

SAMPLES

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: _____
Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):
Stream-bed Description: _____
Water Quality Description (i.e. cloudy, odor, etc.): _____

FLOW MEASUREMENTS:
Area (ft^2):
Velocity (ft/sec):
Discharge (Q) (cfs):

NOTES:

*Fill in prior to field work

TerraGraphics
Environmental Engineering, Inc.

SURFACE WATER SAMPLING RECORD

PROJECT:	STATION NAME:
PROJECT NUMBER:	SAMPLE NUMBER:
LOCATION: LOB-SW07	WEATHER:
DATE: 10/19/10 TIME: 1605	SAMPLERS: 3M

WATER QUALITY PARAMETERS

pH	Temperature (°C) F	S.C. (µS/cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)
6.91	38.86	244	8.91	67.7	100.9

5.0 NTU

SAMPLES

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: _____
Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):
Stream-bed Description: _____
Water Quality Description (i.e. cloudy, odor, etc.): _____

FLOW MEASUREMENTS:
Area (ft^2):
Velocity (ft/sec):
Discharge (Q) (cfs):

NOTES:

*Fill in prior to field work

TerraGraphics
Environmental Engineering, Inc.

SURFACE WATER SAMPLING RECORD

PROJECT:	STATION NAME:
PROJECT NUMBER:	SAMPLE NUMBER:
LOCATION: LOB-SW03	WEATHER:
DATE: 10/20/10 TIME: 0900	SAMPLERS: BM

WATER QUALITY PARAMETERS

pH	Temperature (~~°C~~) F	S.C. (µS/cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)
7.38	34.51	213	0.21	1.5	97.9

5.1 NTU

SAMPLES

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: _____
Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):
Stream-bed Description: _____
Water Quality Description (i.e. cloudy, odor, etc.): _____

FLOW MEASUREMENTS:
Area (ft^2):
Velocity (ft/sec):
Discharge (Q) (cfs):

NOTES:

*Fill in prior to field work

TerraGraphics
Environmental Engineering, Inc.

SURFACE WATER SAMPLING RECORD

PROJECT:	STATION NAME:
PROJECT NUMBER:	SAMPLE NUMBER:
LOCATION: 40B-SW07	WEATHER:
DATE: 10/20/10 TIME: 0915	SAMPLERS: BM

WATER QUALITY PARAMETERS

pH	Temperature (°C) F	S.C. (µS/cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)
7.13	34.68	249	0.26	1.8	105.7

7.0 NTU

SAMPLES

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: _____
Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):
Stream-bed Description: _____
Water Quality Description (i.e. cloudy, odor, etc.): _____

FLOW MEASUREMENTS:
Area (ft^2):
Velocity (ft/sec):
Discharge (Q) (cfs):

NOTES:

*Fill in prior to field work

TerraGraphics
Environmental Engineering, Inc.

SURFACE WATER SAMPLING RECORD

PROJECT:	STATION NAME:
PROJECT NUMBER:	SAMPLE NUMBER:
LOCATION: LOB-SW07	WEATHER: Clear
DATE: 10/21/10 TIME: 1305	SAMPLERS: BM

WATER QUALITY PARAMETERS

pH	Temperature (°C) F	S.C. (µS/cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)
7.52	36.08	116	3.81	27.8	70.6

5.5 NTU

SAMPLES

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: _____
Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):
Stream-bed Description: _____
Water Quality Description (i.e. cloudy, odor, etc.): _____

FLOW MEASUREMENTS:
Area (ft^2):
Velocity (ft/sec):
Discharge (Q) (cfs):

NOTES:

*Fill in prior to field work

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SURFACE WATER SAMPLING RECORD

PROJECT:	STATION NAME:
PROJECT NUMBER:	SAMPLE NUMBER:
LOCATION: LOB-SW03	WEATHER: Clear
DATE: 10/22/10 TIME: 1300	SAMPLERS: BM

WATER QUALITY PARAMETERS

pH	Temperature (°C)F	S.C. (µS/cm)	D.O. (mg/l)	D.O. (% Sat)	ORP (mV)
8.02	40.08	3	2.71	20.9	84.4

6.3 NTU

SAMPLES

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Analyte*					
Sample ID					
Time					
Preservative					
Filtered?					
Container					

Streambank Description: _____
Water Flow Type (circle one): Laminar Stagnant Turbulent Other(describe):
Stream-bed Description: _____
Water Quality Description (i.e. cloudy, odor, etc.): _____

FLOW MEASUREMENTS:
Area (ft^2):
Velocity (ft/sec):
Discharge (Q) (cfs):

NOTES:

*Fill in prior to field work

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WELL NUMBER LOB - MW1

PROJECT NUMBER 10098
PROJECT NAME LOB TO 18
LOCATION Lilly - Orphan Boy Mine
DRILLING METHOD Air Hammer Drill (6")
SAMPLING METHOD Collect Drill cuttings
GROUND ELEVATION 6866.88
TOP OF CASING 6868.55
LOGGED BY JWM
REMARKS

DATE STARTED September 24, 2010
DATE COMPLETED September 24, 2010
CASING TYPE/DIAMETER PVC, 2-inch
SCREEN TYPE/SLOT/LENGTH PVC, 20-slot, 20 feet
GRAVEL PACK TYPE 10/20 Colorado Silica sand
GROUT TYPE/QUANTITY Bentonite chips
DEPTH TO WATER 93'
GROUND WATER ELEVATION

SAMPLE ID.	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH	WELL DIAGRAM
		5			0-6' FILL - WASTE ROCK, GRAY AND DARK YELLOWISH BROWN		Fill/Colluvium
		10			6'-9' GLACIAL TILL - FINE SANDY SILT, WITH GRAVEL, RED, MOIST -- EASY DRILLING	9'	Fill/Colluvium
		15			9-18' WEATHERED QUARTZ MONZONITE, TRACE LEAD & ZINC VEINLETS WITH IRON STAINING, LIGHT BROWN -- DRILLING MORE DIFFICULT @ ~10' -- COLOR BECOMES GRAY AND LIGHT BROWN, DIFFICULT DRILLING @ ~14'		Bedrock Bentonite 2" PVC Casing Bentonite Bedrock
		20			18'-38' OXIDIZED ZONE - QUARTZ MONZONITE, WITH IRON STAINING, BROWN AND DARK YELLOWISH BROWN, EASY DRILLING		
		25			-- COLOR BECOMES BROWN @ ~28'		
		30			-- COLOR BECOMES DARK YELLOWISH BROWN @ ~33'		

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WELL NUMBER LOB-MW1

PROJECT NUMBER
PROJECT NAME
LOCATION
DRILLING METHOD
SAMPLING METHOD
GROUND ELEVATION
TOP OF CASING
LOGGED BY
REMARKS

DATE STARTED
DATE COMPLETED
CASING TYPE/DIAMETER
SCREEN TYPE/SLOT/LENGTH
GRAVEL PACK TYPE
GROUT TYPE/QUANTITY
DEPTH TO WATER
GROUND WATER ELEVATION

SAMPLE ID.	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH	WELL DIAGRAM
		35					
					38'- WEATHERED QUARTZ MONZONITE, GRAY, EASY DRILLING		
		45					
					-- COLOR BECOMES LIGHT BROWNISH GRAY @ ~44'		
		50					Bedrock
					-- COLOR BECOMES LIGHT GRAY @ ~ 49'		
		55					Bentonite
					-- COLOR BECOMES GRAY AND LIGHT BROWN @ ~54'		2" PVC Casing
		60					
					-- OXIDIZED ZONE, DARK YELLOWISH BROWN @ 62-67'		Bentonite
		65					Bedrock
					-- WITH LEAD AND ZINC VEINLETS, GRAY @ 69'-93'		Bedrock

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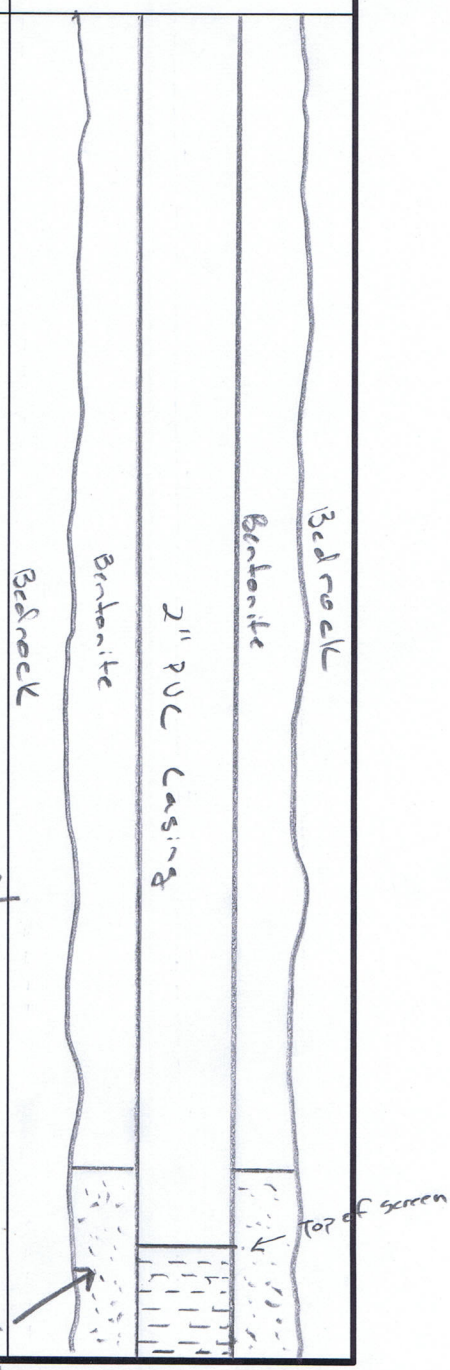
WELL NUMBER LOB - MW1

PROJECT NUMBER
PROJECT NAME
LOCATION
DRILLING METHOD
SAMPLING METHOD
GROUND ELEVATION
TOP OF CASING
LOGGED BY
REMARKS

DATE STARTED
DATE COMPLETED
CASING TYPE/DIAMETER
SCREEN TYPE/SLOT/LENGTH
GRAVEL PACK TYPE
GROUT TYPE/QUANTITY
DEPTH TO WATER
GROUND WATER ELEVATION

SAMPLE ID.	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH	WELL DIAGRAM
		70					
		75					
		80					
		85			-- COLOR BECOMES GRAY AND LIGHT BROWN @ ~ 84'		
		90					
					-- WITH FINE BLACK FLECKS (BIOTITE?), DARK GRAY, 93'-97'	▽	
		95					
					-- COLOR BECOMES LIGHT BROWNISH GRAY @ ~ 97'		
		100				100'	
						102'	
						filter pack	



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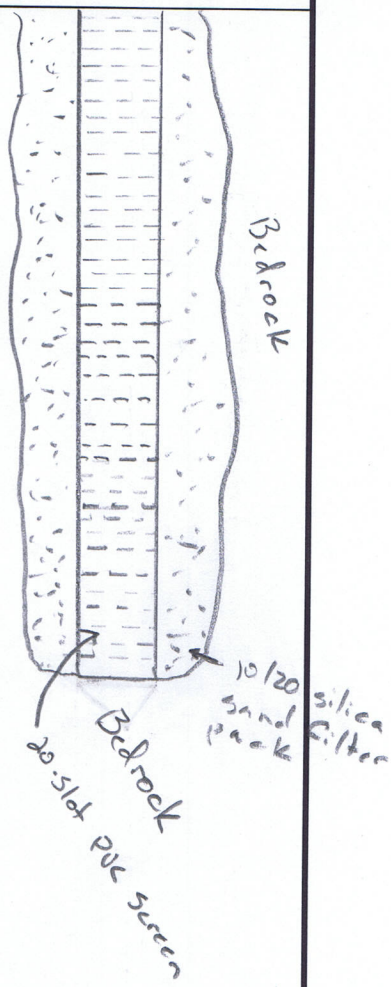
WELL NUMBER L03-MW1

PROJECT NUMBER
PROJECT NAME
LOCATION
DRILLING METHOD
SAMPLING METHOD
GROUND ELEVATION
TOP OF CASING
LOGGED BY
REMARKS

DATE STARTED
DATE COMPLETED
CASING TYPE/DIAMETER
SCREEN TYPE/SLOT/LENGTH
GRAVEL PACK TYPE
GROUT TYPE/QUANTITY
DEPTH TO WATER
GROUND WATER ELEVATION

SAMPLE ID.	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH	WELL DIAGRAM
		105					
		110 ~~5~~					
		115 ~~10~~					
		120 ~~15~~					
					BOTTOM OF BORING @ ~122'		
		20					
		25					
		30					



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WELL NUMBER LOB - MW2

PROJECT NUMBER 10098
PROJECT NAME LOB T018
LOCATION Lilly-Orphan Boy Mine
DRILLING METHOD Air Hammer Drill (10" bit)
SAMPLING METHOD Collect Drill cuttings
GROUND ELEVATION
TOP OF CASING 6867.50
LOGGED BY JWM
REMARKS

DATE STARTED September 23, 2010
DATE COMPLETED September 24, 2010
CASING TYPE/DIAMETER PVC, 6-inch
SCREEN TYPE/SLOT/LENGTH PVC, 20-slot, 20 feet
GRAVEL PACK TYPE 10/20 Silica Sand
GROUT TYPE/QUANTITY Bentonite Chips
DEPTH TO WATER 69.5' AD 9/24/10
GROUND WATER ELEVATION

SAMPLE ID.	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH	WELL DIAGRAM
		5, 10, 15, 20, 25, 30			0-17' FILL - WASTE ROCK, GRAY AND DARK YELLOWISH BROWN, EASY DRILLING	Fill	Fill
					17'-27' WEATHERED QUARTZ MONZONITE, WITH IRON STAINING, TRACE LEAD AND ZINC VEIN LETS, BROWN, MODERATE DIFFICULTY DRILLING -- DRILLING BECOMES DIFFICULT @ ~20'	Bedrock	Bentonite; 6" PVC well casing; Bentonite
					27'-37' QUARTZ MONZONITE AND LEAD/ZINC VEIN, VERY DARK GRAY, DIFFICULT DRILLING		Bedrock

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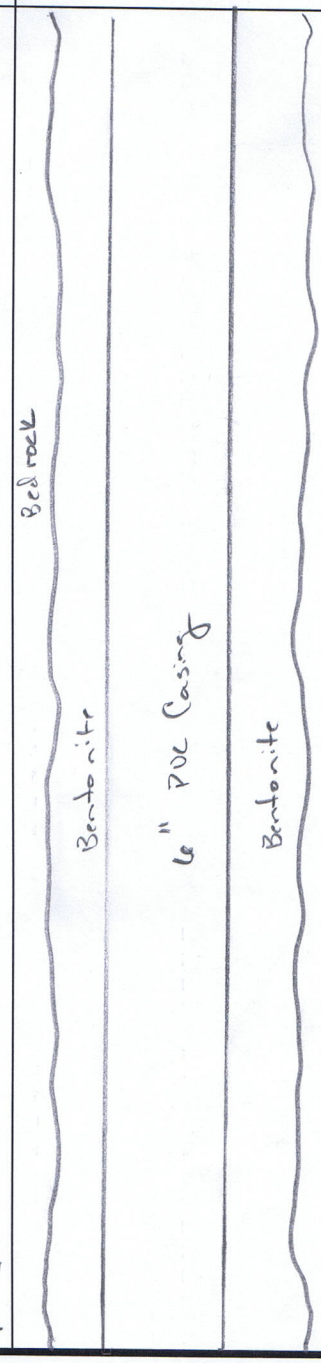
WELL NUMBER LOB-MW2

PROJECT NUMBER
PROJECT NAME
LOCATION
DRILLING METHOD
SAMPLING METHOD
GROUND ELEVATION
TOP OF CASING
LOGGED BY
REMARKS

DATE STARTED
DATE COMPLETED
CASING TYPE/DIAMETER
SCREEN TYPE/SLOT/LENGTH
GRAVEL PACK TYPE
GROUT TYPE/QUANTITY
DEPTH TO WATER
GROUND WATER ELEVATION

SAMPLE ID.	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH	WELL DIAGRAM
		35					
		40			37'-58' WEATHERED QUARTZ MONZONITE, TRACE LEAD AND ZINC VEINLETS AND IRON STAINING, LIGHT BROWN AND GRAY, DIFFICULT DRILLING		
		45					
		50			-- DRILLING SLIGHTLY EASIER @ 50'		
		55			-- DRILLING DIFFICULT @ 55'		
		60			58'-92' OXIDIZED ZONE - QUARTZ MONZONITE, WITH IRON STAINING, BROWN AND DARK YELLOWISH BROWN, DIFFICULT DRILLING		
		65					
					DRILLING SLIGHTLY EASIER @ ~70'	69.5' ▽	



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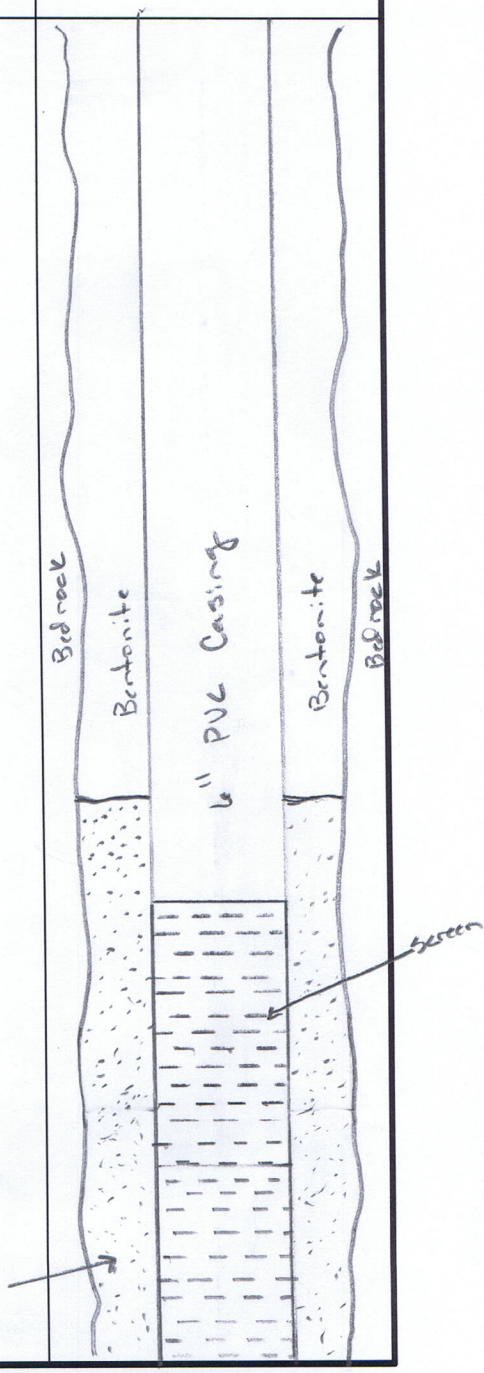
WELL NUMBER L03-MW2

PROJECT NUMBER
PROJECT NAME
LOCATION
DRILLING METHOD
SAMPLING METHOD
GROUND ELEVATION
TOP OF CASING
LOGGED BY
REMARKS

DATE STARTED
DATE COMPLETED
CASING TYPE/DIAMETER
SCREEN TYPE/SLOT/LENGTH
GRAVEL PACK TYPE
GROUT TYPE/QUANTITY
DEPTH TO WATER
GROUND WATER ELEVATION

SAMPLE ID.	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH	WELL DIAGRAM
		70					
		75					
		80			-- DRILLING BECOMES DIFFICULT @ 82'		
		85					
					92' - QUARTZ MONZONITE, GRAY, DIFFICULT DRILLING		
		90					
		95					
		100					



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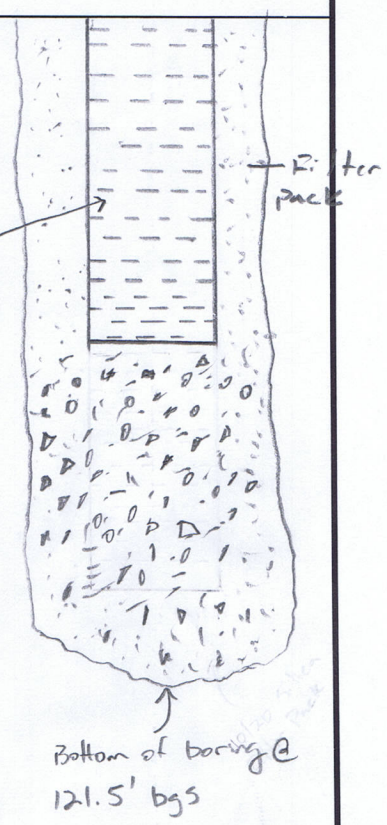
WELL NUMBER L03-MW2

PROJECT NUMBER
PROJECT NAME
LOCATION
DRILLING METHOD
SAMPLING METHOD
GROUND ELEVATION
TOP OF CASING
LOGGED BY
REMARKS

DATE STARTED 9/23/10
DATE COMPLETED 9/24/10
CASING TYPE/DIAMETER
SCREEN TYPE/SLOT/LENGTH
GRAVEL PACK TYPE
GROUT TYPE/QUANTITY
DEPTH TO WATER
GROUND WATER ELEVATION

SAMPLE ID.	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH	WELL DIAGRAM
		105					
					-- BORING CAVED FROM 113'-121.5' WHILE REMOVING DRILL PIPE ON 9/24/10		
		110					
							6" PVC 20-slot screen
		115					
					BOTTOM OF BORING @ ~121.5'		
		120					
		125					
		25					
		30					



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WELL NUMBER LOB - MW 3

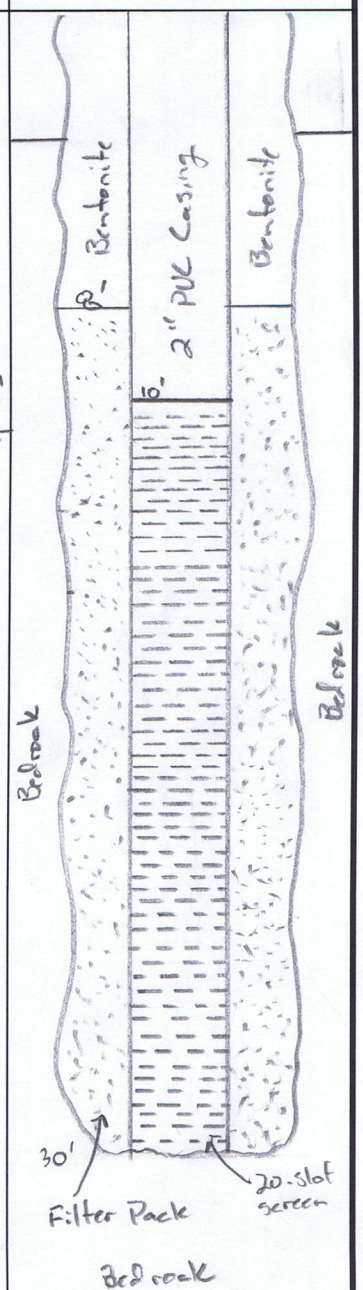
PAGE 1 OF 1

PROJECT NUMBER 10098
PROJECT NAME LOB TO 18
LOCATION Lilly - Orphan Boy Mine
DRILLING METHOD Air Hammer Drill
SAMPLING METHOD collect cuttings
GROUND ELEVATION
TOP OF CASING 6804.48
LOGGED BY TWM
REMARKS Flush mount in road

DATE STARTED September 24, 2010
DATE COMPLETED September 25, 2010
CASING TYPE/DIAMETER PVC - 2"
SCREEN TYPE/SLOT/LENGTH PVC, 20-slot, 20-feet
GRAVEL PACK TYPE 10/20 Colorado Silica Sand
GROUT TYPE/QUANTITY Bentonite chips
DEPTH TO WATER 28' WD ; 10.8' 9/25/10
GROUND WATER ELEVATION

SAMPLE ID.	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
					0-3' FILL - WASTE ROCK MIXED WITH GLACIAL TILL	
		5			3'-22' WEATHERED QUARTZ MONZONITE, TRACE IRON STAINING, BROWN, DIFFICULT DRILLING	
		10				10.8'
		15				
					-- COLOR BECOMES LIGHT BROWN @ ~ 18'	
		20				
					22' - QUARTZ MONZONITE, GRAY, DIFFICULT DRILLING	
		25				
		30			BOTTOM OF BORING @ ~ 30'	

WELL DIAGRAM



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Environmental Engineering, Inc.

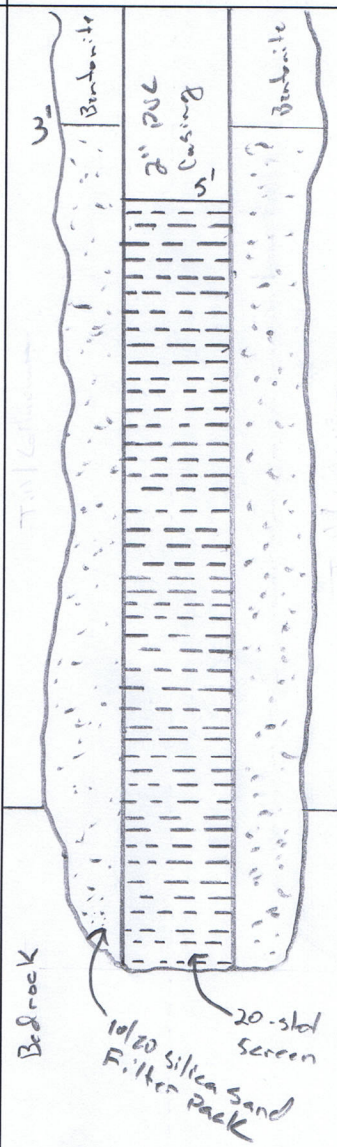
WELL NUMBER LOB - MW4

PROJECT NUMBER 10098
PROJECT NAME LOB TO IB
LOCATION Lilly - Orphan Boy Mine
DRILLING METHOD Air Hammer Drill | Tri cone
SAMPLING METHOD Collect cuttings
GROUND ELEVATION
TOP OF CASING 6782.63
LOGGED BY JWM
REMARKS Flush mount in road

DATE STARTED September 25, 2010
DATE COMPLETED September 25, 2010
CASING TYPE/DIAMETER PVC 2-inch
SCREEN TYPE/SLOT/LENGTH PVC, 20-slot, 2-inch
GRAVEL PACK TYPE 10/20 Colorado Silica sand
GROUT TYPE/QUANTITY Bentonite chips
DEPTH TO WATER 24'
GROUND WATER ELEVATION

SAMPLE ID.	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
					0-4' COLLUVIUM AND FILL	
		5			4'-21' HIGHLY WEATHERED QUARTZ MONZONITE, WITH IRON STAINING, GRAY AND DARK YELLOWISH BROWN, EASY DRILLING	
		10				
		15				
		20				
					21' - WEATHERED QUARTZ MONZONITE, MOTTLED DARK GRAY, GRAY, AND DARK YELLOWISH BROWN, DIFFICULT DRILLING	21'
		25			BOTTOM OF BORING @ ~25'	24' ▽
		30				

WELL DIAGRAM



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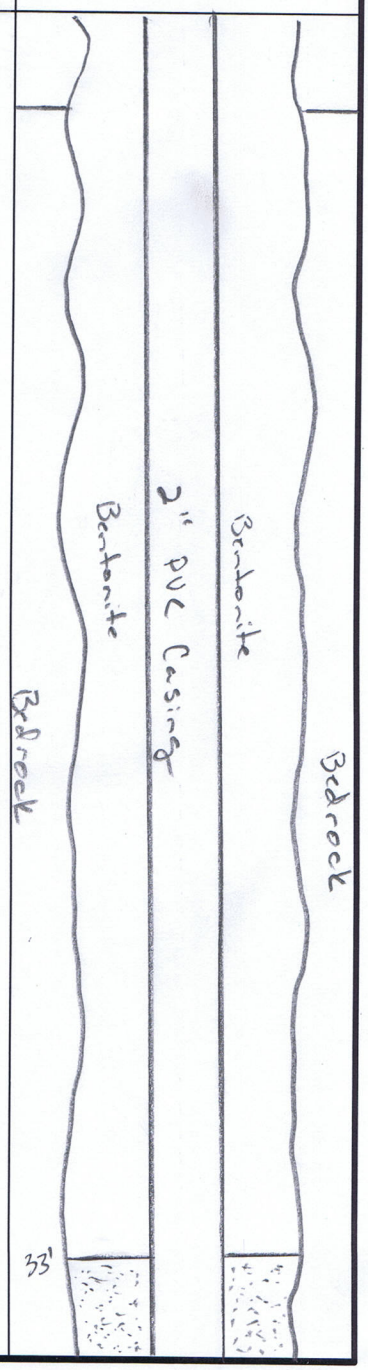
WELL NUMBER LOB-MW5

PROJECT NUMBER 10098
PROJECT NAME LOB TO IB
LOCATION Lilly - Orphan Boy Mine
DRILLING METHOD Air Hammer Drill
SAMPLING METHOD Collect cuttings
GROUND ELEVATION
TOP OF CASING 6840.14
LOGGED BY JWM
REMARKS Flush mount

DATE STARTED September 24, 2010
DATE COMPLETED September 24, 2010
CASING TYPE/DIAMETER 2" PVC
SCREEN TYPE/SLOT/LENGTH PVC, 20-slot, 20 feet
GRAVEL PACK TYPE 10/20 Colorado silica sand
GROUT TYPE/QUANTITY Bentonite chips
DEPTH TO WATER 55' 9/25/10
GROUND WATER ELEVATION

SAMPLE ID.	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH	WELL DIAGRAM
					0-2.5' MIX OF WASTE ROCK AND GLACIAL TILL, DARK BROWN		
					2.5-19' OXIDIZED ZONE - QUARTZ MONZONITE, WITH IRON STAINING, DARK YELLOWISH BROWN, DIFFICULT DRILLING		
		5					
		10					
		15			--DRILLING BECOMES MODERATELY DIFFICULT @ ~15'		
		20			19'- HIGHLY WEATHERED QUARTZ MONZONITE, TRACE IRON STAINING, BROWN, EASY DRILLING		
		25			--DRILLING BECOMES MODERATELY DIFFICULT @ ~25'		
		30					
					--COLOR BECOMES GRAY @ ~35'		



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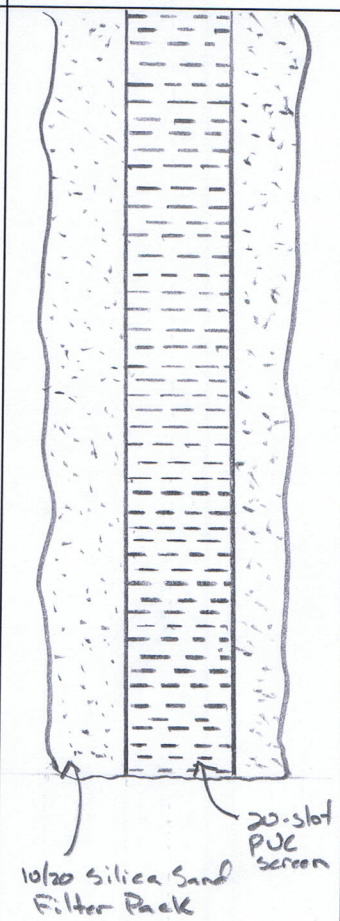
WELL NUMBER L03 - MW5

PROJECT NUMBER
PROJECT NAME
LOCATION
DRILLING METHOD
SAMPLING METHOD
GROUND ELEVATION
TOP OF CASING
LOGGED BY
REMARKS

DATE STARTED
DATE COMPLETED
CASING TYPE/DIAMETER
SCREEN TYPE/SLOT/LENGTH
GRAVEL PACK TYPE
GROUT TYPE/QUANTITY
DEPTH TO WATER
GROUND WATER ELEVATION

SAMPLE ID.	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH	WELL DIAGRAM
		35					
		40			-- COLOR BECOMES BROWN @ ~40'		
		45					
		50					
		55			BOTTOM OF BORING @ ~55'	55'	
		60					
		30					



Appendix B

Land Application System Photos

Photo Date: 9/29/10

:

Photo Date: 9/29/10

Photo Date: 9/29/10

Photo Date: 9/29/10

Photo Date: 9/30/10

Photo Date: 9/30/10

Photo Date: 9/30/10

Photo Date: 9/30/10

Photo Date: 9/30/10

Photo Date: 9/30/10

Photo Date: 9/30/10

Photo Date:

Photo Date: 9/30/10

Photo Date: 9/30/10

Photo Date: 9/30/10

Photo Date: 10/1/10

Photo Date: 10/1/10

Photo Date: 10/1/10

Photo Date: 10/1/10

Photo Date: 10/12/10

Photo Date: 10/1/10

Photo Date: 10/1/10

Description: Panoramic view: Rain for Rent plant setup.

Photo Date: 10/12/10

Description: Upper sprinkler line.

Photo Date: 10/12/10

Description: Upper sprinkler line.

Photo Date: 10/12/10

Description: Upper sprinkler line.

Photo Date: 10/19/10

Description: Sprinkler line.

Photo Date: 10/26/10

Description: Snow-covered site.

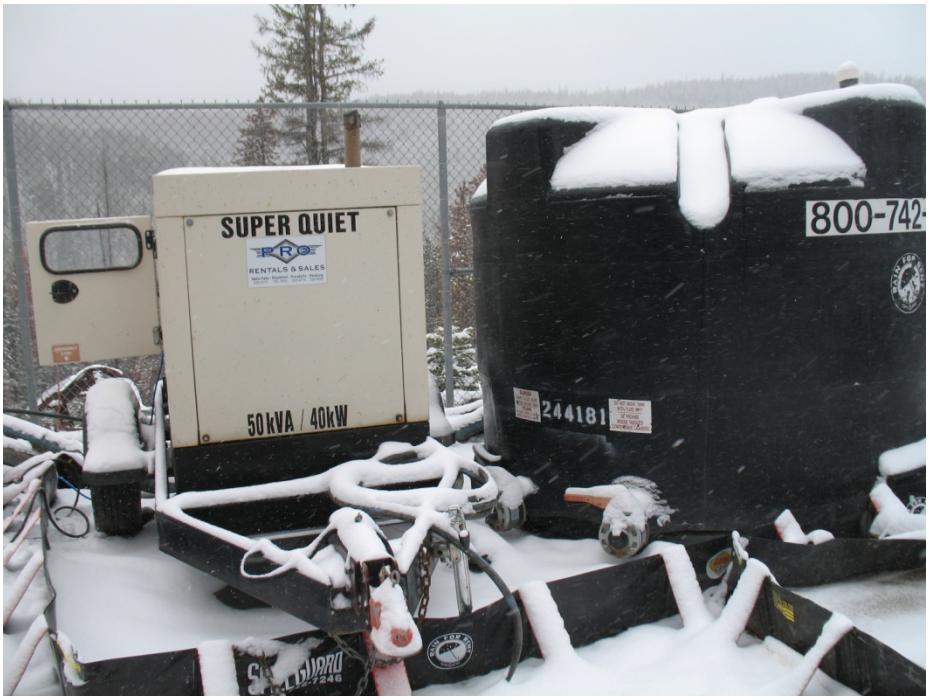


Photo Date: 10/26/10

Description: Snow-covered site.

Photo Date: 10/26/10

Description: Snow-covered site.

Appendix C

Mine Dewatering Log

LILLY/ORPHAN BOY MINE DEWATERING & LAND APPLICATION PROGRAM

Equipment rented & installed by Rain for Rent 9/29/10 to 11/2/10

Compilation of Field Dewatering Log Notes

Flow meter startup reading	16,900,000	gallons
Flow meter ending reading	17,297,000	gallons
Total Volume treated & land applied	**397,000**	**gallons**

DATE	TIME	PUMPING RATE (gpm)	FLOW METER READING (x100 gallons)	PUMPED VOLUME* (gallons)	DEPTH TO WATER IN SHAFT† (feet)	NOTES	RECHARGE RECOVERY (GPM)
10/01/10	15:15	100	169,000	0	74.3	Start of pumping & treatment	
10/01/10	18:30	100	169,160	16,000	74.8	Dewatering Lilly Tunnel	
10/02/10	08:00	80	169,171	17,100	74.35		
10/03/10	08:00	100			74.39		
10/03/10	15:30	100-120	169,482	48,200	78.2		
10/03/10	17:00	100-120	169,580	58,000	79.3	Startup, testing, and calibration complete	
10/03/10	18:00	100-120	169,632	63,200			
10/04/10	7:00				79.15	Recovery rate 10/3 to 10/5	5.7
10/04/10	10:14	100-120	169,714	71,400	82.59	Out of filters	
10/05/10	08:00		169,714	71,400	79.45	Filter in @ 11:15 AM 100's	
10/05/10	12:00	100-120	169,714	71,400	79.45	Start	
10/05/10	14:00	100	169,781	78,100	83.62	Filter Change	
10/05/10	14:30	100	169,800	80,000	84.73	Filter Change - 200's	
10/05/10	15:15	100	169,826	82,600	84.81	Filter Change	
10/05/10	19:00	100	169,927	92,700	89.1	Shut down & Fuel	
10/06/10	08:00	100	169,927	92,700	87.2		
10/06/10	09:20	100-120	169,982	98,200	91.1		
10/06/10	10:30		170,039	103,900		Filter Change	
10/06/10	11:00	100	170,077	107,700	94.85		
10/06/10	11:50	100	170,131	113,100	96.68	Top of pump/lower pump	
10/06/10	13:00	100-120	170,131	113,100		Restart	
10/06/10	14:40		170,202	120,200		Filter Change	
10/06/10	14:50	100-120	170,211	121,100	99.1		
10/06/10	16:00	100	170,283	128,300	102.58		
10/06/10	16:20		170,302	130,200	102.81	Filter/ need more hose	
10/07/10	12:10	100-120	170,302	130,200	97.94	Startup	
10/07/10	13:05	100-120	170,365	136,500	98.35	Recovery rate10/6 to 10/12	5.5
10/07/10	14:45	100-120	170,481	148,100	104.9		
10/07/10	16:20		170,562	156,200	106.2	Shut down	
10/08/10	08:00				103.21		
10/09/10	08:00				99.8	Rain for Rent delivered & installed larger pump.	
10/11/10	08:30				96	Trouble lowering pump in shaft due to Al pipe	
10/12/10	08:00		170,562	156,200	94.35		
10/12/10	12:30	100-120				Start	
10/12/10	15:49	100-120	170,622	162,200	96.71		
10/12/10	17:00	100-120	170,701	170,100	100.5		
10/12/10	17:30	100-120	170,738	173,800	102.25	Pump out of water	
10/13/10	08:35		170,738	173,800	99.16		
10/13/10	14:40					Start Pump	
10/13/10	15:16	100-120	170,782	178,200	101.4		
10/13/10	16:20	100-120	170,798	179,800			
10/13/10	17:30	100-120	170,798	179,800	102.5	Recovery rate 10/12 to 10/14	5.5
10/13/10	17:45					Start	
10/13/10	18:45		170,871	187,100		Stop	
10/14/10	09:30	100-120	170,871	187,100	102.2		
10/14/10	10:45		170,951	195,100		Stop	
10/14/10	16:51	100-120				Start	
10/14/10	19:05		171,097	209,700		Filter Change	
10/14/10	20:00		171,140	214,000		Stop	
10/15/10	08:00	100-120	171,140	214,000		Start	
10/15/10	10:29	100-120	171,257	225,700		Shut down for obtaining Lilly tunnel seep samples	
10/15/10	11:20				107.9		
10/15/10	12:30	100-120	171,257	225,700		Restart	
10/15/10	12:58	100	171,274	227,400	107		
10/15/10	18:00					Filter change	
10/15/10	19:00		171,614	261,400			
10/16/10	08:00		171,614	261,400		Ice in filter cylinder & lines	
10/16/10	13:15	100-120	171,726	272,600		Filter change; dewatering 114' level, pumping muck	
10/16/10	13:45		171,740	274,000		Filter change	
10/16/10	14:25		171,761	276,100		Filter change	
10/16/10	15:30		171,786	278,600		Filter change	
10/16/10	16:05		171,797	279,700		Filter change	
10/16/10	17:15		171,841	284,100		Out of water, need to lower pump	

DATE	TIME	PUMPING RATE (gpm)	FLOW METER READING (x100 gallons)	PUMPED VOLUME* (gallons)	DEPTH TO WATER IN SHAFT† (feet)	NOTES	RECHARGE RECOVERY (GPM)
10/17/10	11:30		171,841	284,100	111.5	Start	
10/17/10	12:45		171,940	294,000		Filter change	
10/17/10	13:20		171,971	297,100		Filter change	
10/17/10	14:15	100-120	171,997	299,700		Filter change	
10/17/10	15:10		172,040	304,000		Filter change	
10/17/10	16:45		172,112	311,200		Filter change	
10/17/10	17:30		172,130	313,000		Lost pump pressure, lowering pump	
10/18/10	12:45				117.5		
10/18/10	15:12	100-120	172,130	313,000	117.6	Start	
10/18/10	17:38		172,254	325,400		Lost pump pressure, lowering pump	
10/19/10	09:30	100-120	172,254	325,400		Start Pump	
10/19/10	10:35		172,351	335,100		Lost pump pressure, lowering pump	
10/19/10	12:30		172,351	335,100	127.15	Lowered pump 20'	
10/19/10	13:15	100-120	172,351	335,100		Start Pump	
10/19/10	14:20		172,412	341,200		Filter change, Recovery rate 10/17 to 11/1	5.2
10/19/10	15:25		172,446	344,600		Filter change	
10/19/10	17:05		172,513	351,300		Filter change	
10/19/10	17:40		172,543	354,300		Filter change	
10/19/10	18:30	100-120	172,577	357,700			
10/20/10	08:30	100-120	172,577	357,700		Start pump	
10/20/10	11:25		172,714	371,400		Lost pump pressure, lowering pump	
10/21/10	08:00	100-120				Start pump	
10/21/10	10:10		172,835	383,500	146.85		
10/22/10	09:30	100-120	172,835	383,500		Start Pump	
10/22/10	11:20		**172,970**	**397,000**		Lowered pump; **pumping completed**	
10/25/10	08:00	---	---	---	switch boxes	Frozen/snow	
10/26/10	11:00	---	---	---	~ 120' estimated	Drain tanks for removal	
10/28/10	11:43	---	---	---	114.92		
11/01/10	16:02	---	---	---	111.2	Rain for Rent equipment removed from site.	
11/02/10	10:50	---	---	---	110.85	Transducer installed in shaft at 125' below collar.	
11/11/10	10:10	---	---	---	107.2	Having trouble getting water level reading in shaft.	
11/26/10	~11:00	---	---	---	92.45		
12/02/10	12:00	---	---	---		Transducers removed from wells & shaft.	
						Average Recharge Rate:	5.5

Recharge rate ranges from 5.2 gpm to 5.7 gpm

*Mine water was pumped from shaft, filtered, and adjusted for pH to be between 5 and 9 units prior to land application.

† Depth to water in the shaft measured from the top of the northeastern shaft cover grate.

Recharge rate calculated between 10/3 and 10/5 at 79.3' level

Recharge rate calculated between 10/6 and 10/12 at 96.7' level

Recharge rate calculated between 10/12 and 10/14 at 102.2' level

Recharge rate calculated between 10/17 and 11/1 at 111.2' level

Appendix D

Well Boring Logs

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MONITORING WELL NUMBER LOB - MW01

PROJECT NUMBER 10098
PROJECT NAME LOB TO 18
LOCATION Lilly/Orphan Boy Mine
DRILLING METHOD Air hammer drill (6" bit)
SAMPLING METHOD Collect drill cuttings
GROUND ELEVATION 6866.88
TOP OF CASING 6868.55
LOGGED BY JWM
REMARKS Chip samples obtained on five-foot intervals

DATE STARTED 9/24/2010
DATE COMPLETED 9/24/2010
CASING TYPE/DIAMETER PVC, 2" diameter
SCREEN TYPE/SLOT/LENGTH PVC, 20-slot, 20'
GRAVEL PACK TYPE 10/20 Colorado Silica Sand
GROUT TYPE/QUANTITY Bentonite chips
DEPTH TO WATER 93', 66.19' on 9/29/2010
GROUNDWATER ELEVATION 6802.36'

SAMPLE ID.	% RECOVERY	SPT	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH	WELL DIAGRAM
							0-6' - Fill - Waste Rock, gray and dark yellowish-brown		Fill
5				5					
					ML		6-9' - Glacial Till - Fine Sandy SILT, with gravel, red, moist -- easy drilling		Till
10				10			9-18' - Weathered Quartz Monzonite, trace lead and zinc veinlets with iron staining, light brown -- drilling more difficult @ ~10'		Bedrock
15				15			-- color becomes gray and light brown, difficult drilling @ ~14'		
20				20			18-38' - Oxidized zone - Quartz Monzonite, with iron staining, brown and dark yellowish-brown, easy drilling		
25				25					
30				30			-- color becomes brown @ ~28'		
35							-- color becomes dark yellowish-brown @ ~33'		

WELL DIAGRAM: 2" PVC Casing; Bentonite; Bedrock

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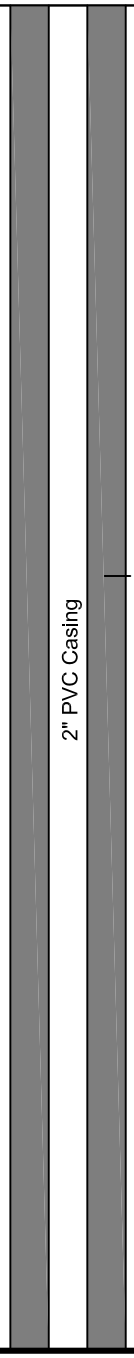
Environmental Engineering, Inc.

MONITORING WELL NUMBER LOB - MW01

PROJECT NUMBER 10098
PROJECT NAME LOB TO 18
LOCATION Lilly/Orphan Boy Mine
DRILLING METHOD Air hammer drill (6" bit)
SAMPLING METHOD Collect drill cuttings
GROUND ELEVATION 6866.88
TOP OF CASING 6868.55
LOGGED BY JWM
REMARKS Chip samples obtained on five-foot intervals

DATE STARTED 9/24/2010
DATE COMPLETED 9/24/2010
CASING TYPE/DIAMETER PVC, 2" diameter
SCREEN TYPE/SLOT/LENGTH PVC, 20-slot, 20'
GRAVEL PACK TYPE 10/20 Colorado Silica Sand
GROUT TYPE/QUANTITY Bentonite chips
DEPTH TO WATER 93', 66.19' on 9/29/2010
GROUNDWATER ELEVATION 6802.36'

SAMPLE ID.	% RECOVERY	SPT	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH	WELL DIAGRAM
				35			18-38' - Oxidized zone - Quartz Monzonite, with iron staining, dark yellowish-brown		
							38' - Weathered Quartz Monzonite, gray, easy drilling		
40				40					
							-- color becomes light brownish-gray @ ~44'		
45				45					
							-- color becomes light gray @ ~49'		
50				50					Bentonite
							-- color becomes gray and light brown @ ~54'		
55				55					
60				60					
							-- Oxidized zone, dark yellowish-brown @ 62-67'		
65				65					
70							-- color becomes gray with lead and zinc veinlets @ 69-93'		



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MONITORING WELL NUMBER LOB - MW01

PROJECT NUMBER 10098
PROJECT NAME LOB TO 18
LOCATION Lilly/Orphan Boy Mine
DRILLING METHOD Air hammer drill (6" bit)
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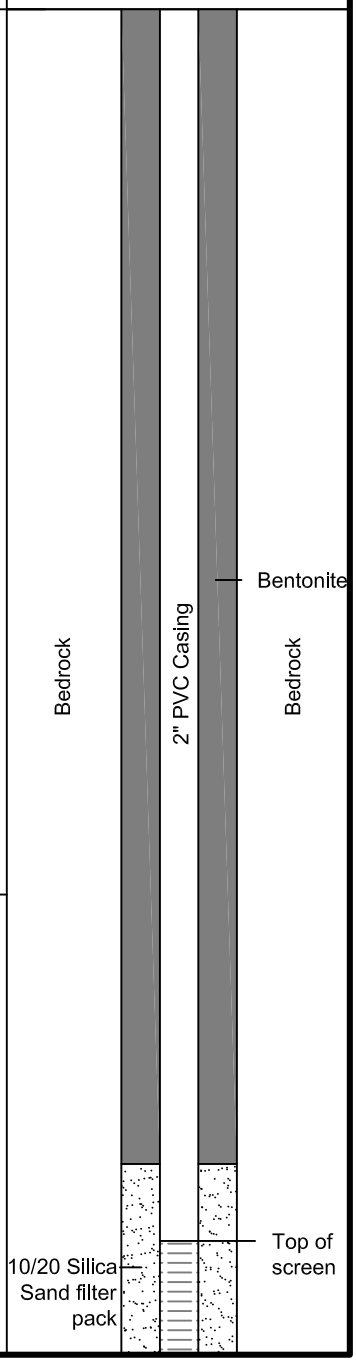
GROUND ELEVATION 6866.88
TOP OF CASING 6868.55
LOGGED BY JWM
REMARKS Chip samples obtained on five-foot intervals

DATE STARTED 9/24/2010
DATE COMPLETED 9/24/2010
CASING TYPE/DIAMETER PVC, 2" diameter
SCREEN TYPE/SLOT/LENGTH PVC, 20-slot, 20'
GRAVEL PACK TYPE 10/20 Colorado Silica Sand
GROUT TYPE/QUANTITY Bentonite chips
DEPTH TO WATER 93', 66.19' on 9/29/2010
GROUNDWATER ELEVATION 6802.36'

SAMPLE ID.	% RECOVERY	SPT	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
				70			38' - Weathered Quartz Monzonite, gray, with lead and zinc veinlets, easy drilling	
75				75				
80				80				
							-- color becomes gray and light brown @ ~84'	
85				85				
90				90				
							-- color becomes dark gray with fine black flecks (biotite?) @ 93-97'	▽
95				95				
							-- color becomes light brownish-gray @ ~97'	
100				100				
105								

WELL DIAGRAM



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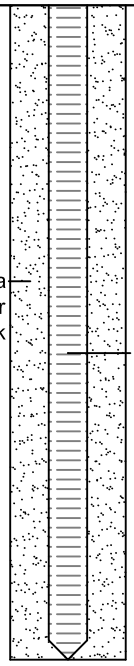
Environmental Engineering, Inc.

MONITORING WELL NUMBER LOB - MW01

PROJECT NUMBER 10098
PROJECT NAME LOB TO 18
LOCATION Lilly/Orphan Boy Mine
DRILLING METHOD Air hammer drill (6" bit)
SAMPLING METHOD Collect drill cuttings
GROUND ELEVATION 6866.88
TOP OF CASING 6868.55
LOGGED BY JWM
REMARKS Chip samples obtained on five-foot intervals

DATE STARTED 9/24/2010
DATE COMPLETED 9/24/2010
CASING TYPE/DIAMETER PVC, 2" diameter
SCREEN TYPE/SLOT/LENGTH PVC, 20-slot, 20'
GRAVEL PACK TYPE 10/20 Colorado Silica Sand
GROUT TYPE/QUANTITY Bentonite chips
DEPTH TO WATER 93', 66.19' on 9/29/2010
GROUNDWATER ELEVATION 6802.36'

SAMPLE ID.	% RECOVERY	SPT	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH	WELL DIAGRAM
				105			38' - Weathered Quartz Monzonite, light brownish-gray, easy drilling		
110				110					10/20 Silica Sand filter pack
115				115					20-slot PVC screen
120				120					Bedrock / Bedrock
							Bottom of boring @ ~122'		
				125					
				130					
				135					



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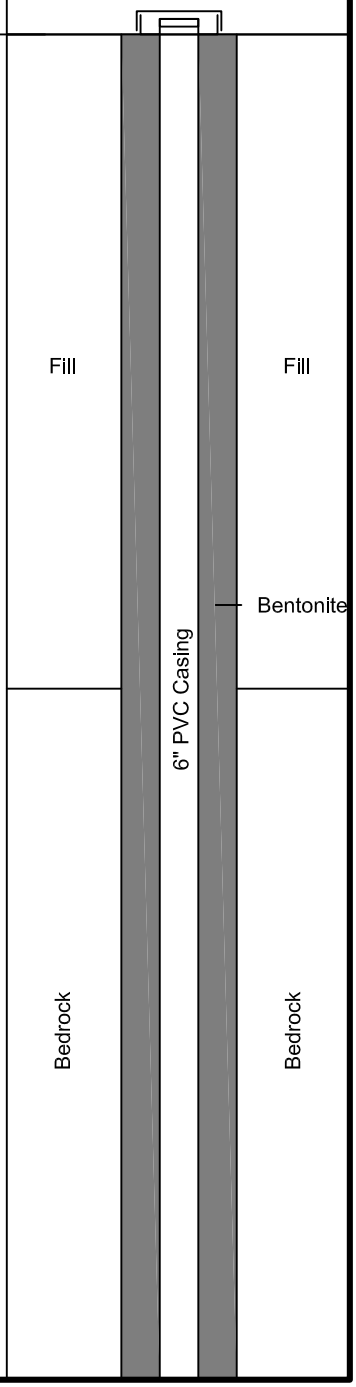
MONITORING WELL NUMBER LOB - MW02

PROJECT NUMBER 10098
PROJECT NAME LOB TO 18
LOCATION Lilly/Orphan Boy Mine
DRILLING METHOD Air hammer drill (10" bit)
SAMPLING METHOD Collect drill cuttings
GROUND ELEVATION
TOP OF CASING 6867.50
LOGGED BY JWM
REMARKS Chip samples obtained on five-foot intervals

DATE STARTED 9/23/2010
DATE COMPLETED 9/24/2010
CASING TYPE/DIAMETER PVC, 6" diameter
SCREEN TYPE/SLOT/LENGTH PVC, 20-slot, 20'
GRAVEL PACK TYPE 10/20 Colorado Silica Sand
GROUT TYPE/QUANTITY Bentonite chips
DEPTH TO WATER 69.5' AD 9/24/2010, 70.82' on 9/29/2010
GROUNDWATER ELEVATION 6796.68'

SAMPLE ID.	% RECOVERY	SPT	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							0-17' - Fill - Waste Rock, gray and dark yellowish-brown, easy drilling	
				5				
				10				
				15				
							17-27' - Weathered Quartz Monzonite, with iron staining, trace lead and zinc veinlets, brown, moderately difficult drilling	
				20			-- drilling becomes difficult @ ~20'	
				25				
							27-37' - Quartz Monzonite and lead/zinc vein, very dark gray, difficult drilling	
				30				
				35				

WELL DIAGRAM



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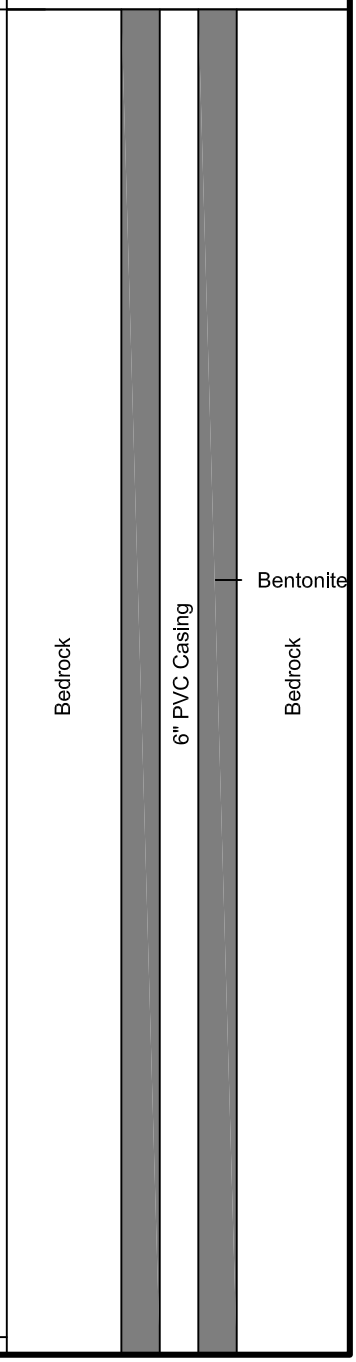
MONITORING WELL NUMBER LOB - MW02

PROJECT NUMBER 10098
PROJECT NAME LOB TO 18
LOCATION Lilly/Orphan Boy Mine
DRILLING METHOD Air hammer drill (10" bit)
SAMPLING METHOD Collect drill cuttings
GROUND ELEVATION
TOP OF CASING 6867.50
LOGGED BY JWM
REMARKS Chip samples obtained on five-foot intervals

DATE STARTED 9/23/2010
DATE COMPLETED 9/24/2010
CASING TYPE/DIAMETER PVC, 6" diameter
SCREEN TYPE/SLOT/LENGTH PVC, 20-slot, 20'
GRAVEL PACK TYPE 10/20 Colorado Silica Sand
GROUT TYPE/QUANTITY Bentonite chips
DEPTH TO WATER 69.5' AD 9/24/2010, 70.82' on 9/29/2010
GROUNDWATER ELEVATION 6796.68'

SAMPLE ID.	% RECOVERY	SPT	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
				35			27-37' - Quartz Monzonite and lead/zinc vein, very dark gray, difficult drilling	
							37-58' - Weathered Quartz Monzonite, trace lead and zinc veinlets and iron staining, light brown and gray, difficult drilling	
40				40				
45				45				
50				50			-- drilling slightly easier @ ~50'	
55				55			-- drilling difficult @ ~55'	
							58-92' - Oxidized Zone - Quartz Monzonite, with iron staining, brown and dark yellowish-brown, difficult drilling	
60				60				
65				65				
70							-- drilling slightly easier @ ~70'	▽

WELL DIAGRAM



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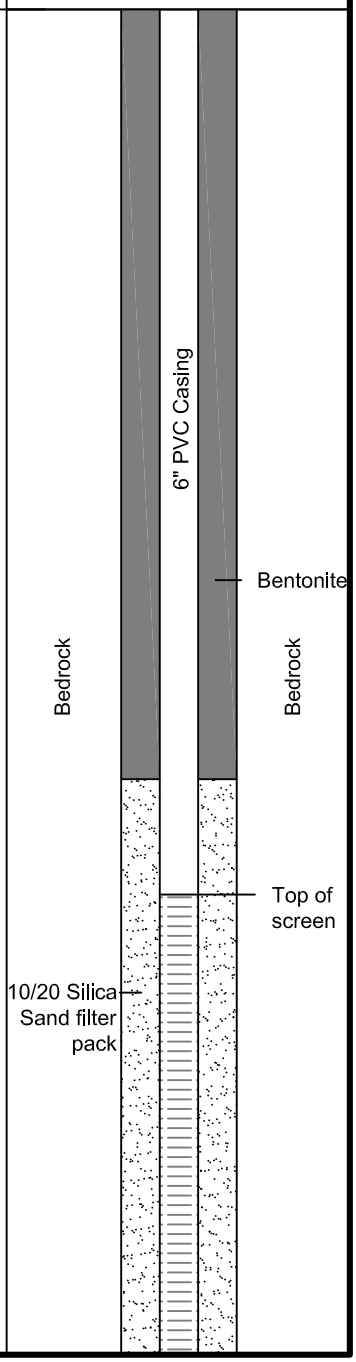
MONITORING WELL NUMBER LOB - MW02

PROJECT NUMBER 10098
PROJECT NAME LOB TO 18
LOCATION Lilly/Orphan Boy Mine
DRILLING METHOD Air hammer drill (10" bit)
SAMPLING METHOD Collect drill cuttings
GROUND ELEVATION
TOP OF CASING 6867.50
LOGGED BY JWM
REMARKS Chip samples obtained on five-foot intervals

DATE STARTED 9/23/2010
DATE COMPLETED 9/24/2010
CASING TYPE/DIAMETER PVC, 6" diameter
SCREEN TYPE/SLOT/LENGTH PVC, 20-slot, 20'
GRAVEL PACK TYPE 10/20 Colorado Silica Sand
GROUT TYPE/QUANTITY Bentonite chips
DEPTH TO WATER 69.5' AD 9/24/2010, 70.82' on 9/29/2010
GROUNDWATER ELEVATION 6796.68'

SAMPLE ID.	% RECOVERY	SPT	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
				70			58-92' - Oxidized Zone - Quartz Monzonite, with iron staining, brown and dark yellowish-brown, difficult drilling	
75				75				
80				80				
85				85			-- drilling becomes difficult @ ~85'	
90				90				
							92' - Quartz Monzonite, gray, difficult drilling	
95				95				
100				100				
105								

WELL DIAGRAM



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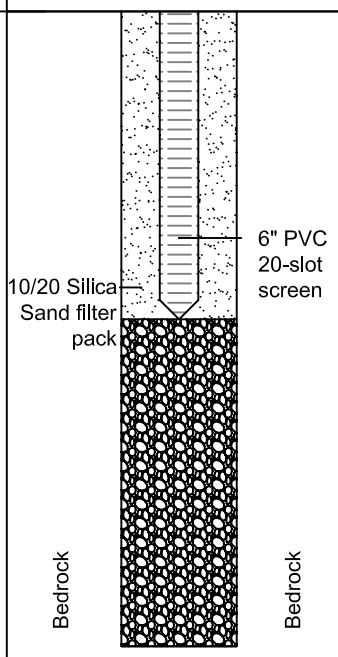
MONITORING WELL NUMBER LOB - MW02

PROJECT NUMBER 10098
PROJECT NAME LOB TO 18
LOCATION Lilly/Orphan Boy Mine
DRILLING METHOD Air hammer drill (10" bit)
SAMPLING METHOD Collect drill cuttings
GROUND ELEVATION
TOP OF CASING 6867.50
LOGGED BY JWM
REMARKS Chip samples obtained on five-foot intervals

DATE STARTED 9/23/2010
DATE COMPLETED 9/24/2010
CASING TYPE/DIAMETER PVC, 6" diameter
SCREEN TYPE/SLOT/LENGTH PVC, 20-slot, 20'
GRAVEL PACK TYPE 10/20 Colorado Silica Sand
GROUT TYPE/QUANTITY Bentonite chips
DEPTH TO WATER 69.5' AD 9/24/2010, 70.82' on 9/29/2010
GROUNDWATER ELEVATION 6796.68'

SAMPLE ID.	% RECOVERY	SPT	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
				105			92' - Weathered Quartz Monzonite, gray, difficult drilling	
110				110				
							-- boring caved from 113-121.5' while removing drill pipe on 9/24/2010, bottom of well set to 113'	
115				115				
120				120				
							Bottom of boring @ ~121.5'	
				125				
				130				
				135				

WELL DIAGRAM



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MONITORING WELL NUMBER LOB - MW03

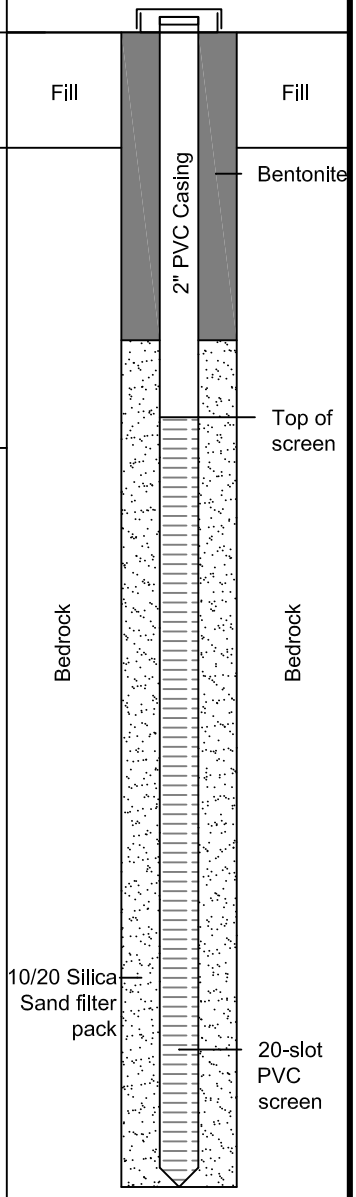
PROJECT NUMBER 10098
PROJECT NAME LOB TO 18
LOCATION Lilly/Orphan Boy Mine
DRILLING METHOD Air hammer drill
SAMPLING METHOD Collect drill cuttings
GROUND ELEVATION
TOP OF CASING 6804.48
LOGGED BY JWM

DATE STARTED 9/24/2010
DATE COMPLETED 9/25/2010
CASING TYPE/DIAMETER PVC, 2" diameter
SCREEN TYPE/SLOT/LENGTH PVC, 20-slot, 20'
GRAVEL PACK TYPE 10/20 Colorado Silica Sand
GROUT TYPE/QUANTITY Bentonite chips
DEPTH TO WATER 28' WD; 10.8' 9/25/2010, 8.11' on 9/29/2010
GROUNDWATER ELEVATION 6796.37'

REMARKS Chip samples obtained on five-foot intervals, flush mount in road; offset from staked location as was too steep for drill rig to setup

SAMPLE ID.	% RECOVERY	SPT	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							0-3' - Fill - Waste Rock mixed with Glacial Till	
				5			3-22' - Weathered Quartz Monzonite, trace iron staining, brown, difficult drilling	
				10				
				15			-- color becomes light brown @ ~18'	
				20				
							22' - Quartz Monzonite, gray, difficult drilling	
				25				
				30			Bottom of boring @ ~30'	

WELL DIAGRAM



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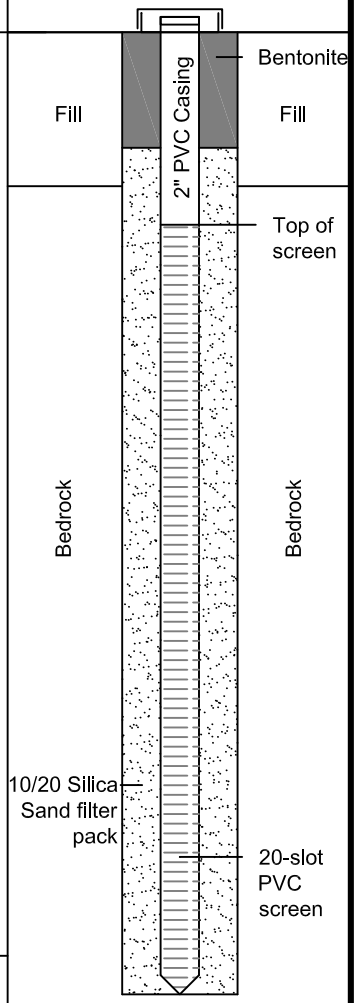
MONITORING WELL NUMBER LOB - MW04

PROJECT NUMBER 10098
PROJECT NAME LOB TO 18
LOCATION Lilly/Orphan Boy Mine
DRILLING METHOD Air hammer drill/Tricone
SAMPLING METHOD Collect drill cuttings
GROUND ELEVATION
TOP OF CASING 6782.63
LOGGED BY JWM
DATE STARTED 9/25/2010
DATE COMPLETED 9/25/2010
CASING TYPE/DIAMETER PVC, 2" diameter
SCREEN TYPE/SLOT/LENGTH PVC, 20-slot, 2"
GRAVEL PACK TYPE 10/20 Colorado Silica Sand
GROUT TYPE/QUANTITY Bentonite chips
DEPTH TO WATER 24', 8.31' on 9/29/2010
GROUNDWATER ELEVATION 6774.32'
REMARKS Chip samples obtained on five-foot intervals, flush mount in road

SAMPLE ID.	% RECOVERY	SPT	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							0-4' - Colluvium and Fill	
5				5			4-21' - Highly Weathered Quartz Monzonite, with iron staining, gray and dark yellowish-brown, easy drilling	
10				10				
15				15				
20				20				
							21' - Weathered Quartz Monzonite, mottled dark gray, gray and dark yellowish-brown, difficult drilling	
25				25			Bottom of boring @ ~25'	
				30				

WELL DIAGRAM



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Environmental Engineering, Inc.

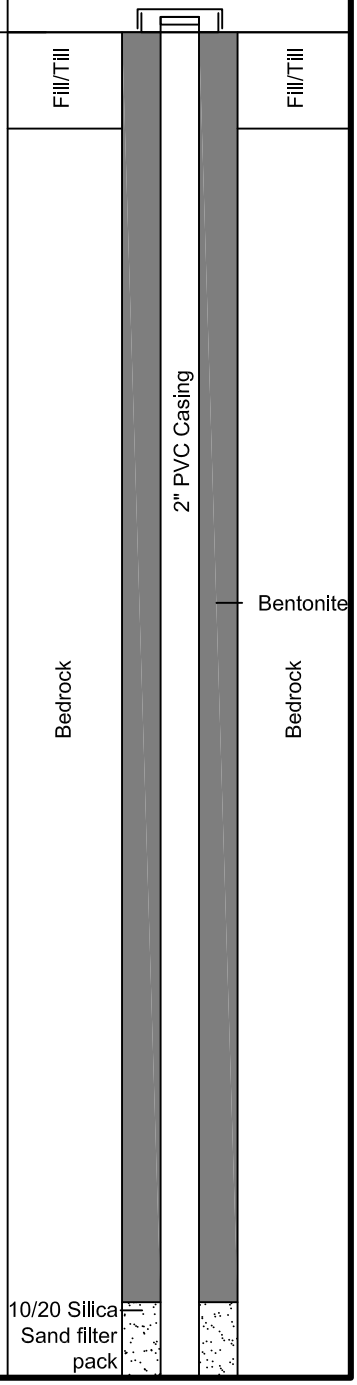
MONITORING WELL NUMBER LOB - MW05

PROJECT NUMBER 10098
PROJECT NAME LOB TO 18
LOCATION Lilly/Orphan Boy Mine
DRILLING METHOD Air hammer drill
SAMPLING METHOD Collect drill cuttings
GROUND ELEVATION
TOP OF CASING 6840.14
LOGGED BY JWM
REMARKS Chip samples obtained on five-foot intervals, flush mount

DATE STARTED 9/24/2010
DATE COMPLETED 9/24/2010
CASING TYPE/DIAMETER PVC, 2" diameter
SCREEN TYPE/SLOT/LENGTH PVC, 20-slot, 20'
GRAVEL PACK TYPE 10/20 Colorado Silica Sand
GROUT TYPE/QUANTITY Bentonite chips
DEPTH TO WATER 55', 27.36' on 9/29/2010
GROUNDWATER ELEVATION 6812.78'

SAMPLE ID.	% RECOVERY	SPT	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
							0-2.5' - Mix of Waste Rock and Glacial Till, dark brown	
							2.5-19' - Oxidized zone - Quartz Monzonite, with iron staining, dark yellowish-brown, difficult drilling	
5				5				
10				10				
15				15			-- drilling becomes moderately difficult @ ~15'	
19								
				20			19' - Highly Weathered Quartz Monzonite, trace iron staining, brown, easy drilling	
25				25			-- drilling becomes moderately difficult @ ~25'	
30				30				
35							-- color becomes gray @ ~35'	

WELL DIAGRAM



Y:\09210 - Lilly-Orphan Boy Mine\E. Deliverables\a. Reports\Ph II R1\Drawings\LOB Well Log Sheet.dwg

TerraGraphics
Environmental Engineering, Inc.

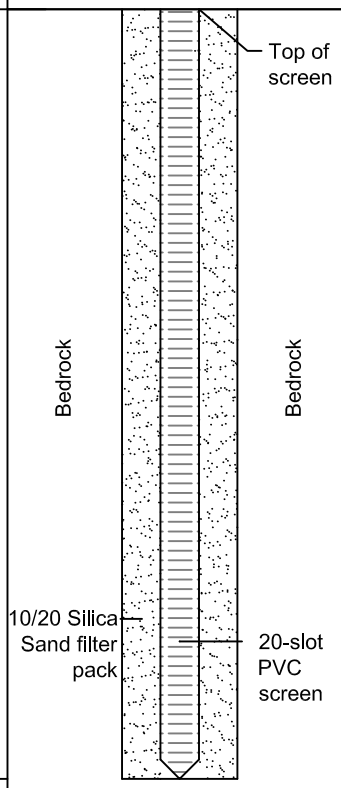
MONITORING WELL NUMBER LOB - MW05

PROJECT NUMBER 10098
PROJECT NAME LOB TO 18
LOCATION Lilly/Orphan Boy Mine
DRILLING METHOD Air hammer drill
SAMPLING METHOD Collect drill cuttings
GROUND ELEVATION
TOP OF CASING 6840.14
LOGGED BY JWM
REMARKS Chip samples obtained on five-foot intervals, flush mount

DATE STARTED 9/24/2010
DATE COMPLETED 9/24/2010
CASING TYPE/DIAMETER PVC, 2" diameter
SCREEN TYPE/SLOT/LENGTH PVC, 20-slot, 20'
GRAVEL PACK TYPE 10/20 Colorado Silica Sand
GROUT TYPE/QUANTITY Bentonite chips
DEPTH TO WATER 55', 27.36' on 9/29/2010
GROUNDWATER ELEVATION 6812.78'

SAMPLE ID.	% RECOVERY	SPT	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
				35			19' - Highly Weathered Quartz Monzonite, trace iron staining, gray, easy drilling	
40				40			-- color becomes brown @ ~40'	
45				45				
50				50				
55				55			Bottom of boring @ ~55'	▽
				60				
				65				

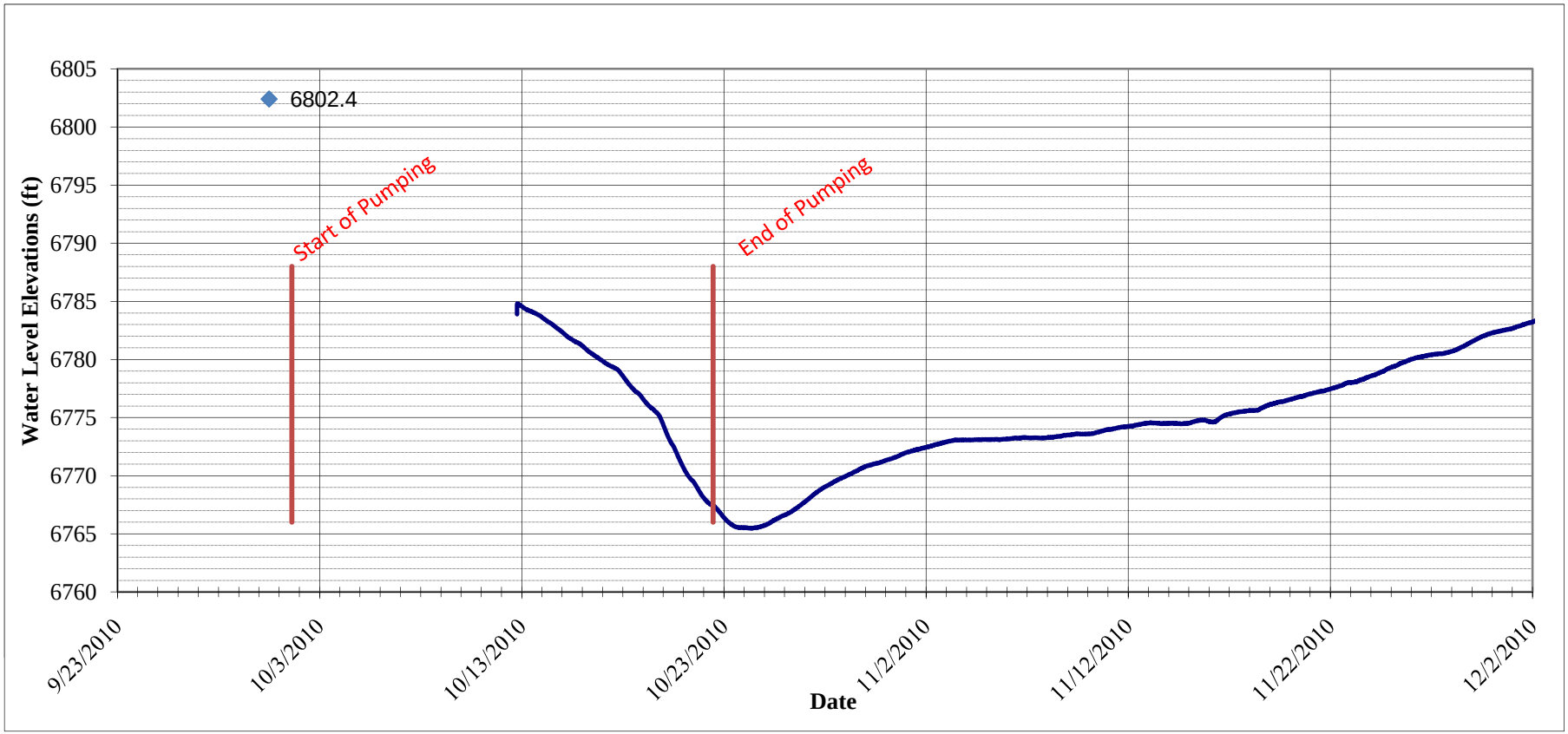
WELL DIAGRAM



Y:\09210 - Lilly-Orphan Boy Mine\E. Deliverables\a. Reports\Ph II RI\Drawings\LOB Well Log Sheet.dwg

Appendix E

Transducer Data Graphs

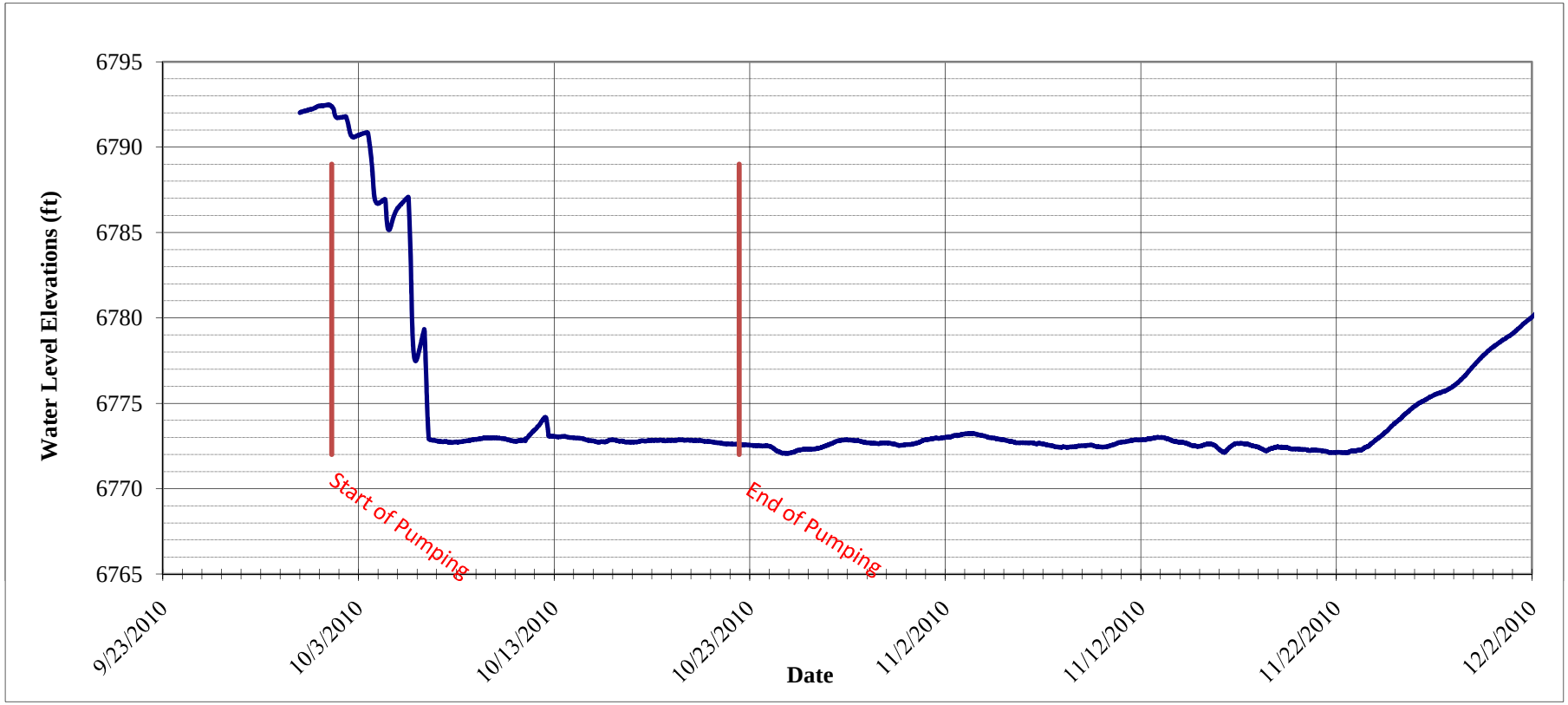


Notes:

9/30/2010	12:00:00	6802.4	Static water level
10/22/2010	11:20:00	6767.4	End of pumping
12/2/2010	12:00:00	6783.5	Transducers removed

No transducer data from 9/30 to 10/12 as transducer failed and was replaced on 10/12.

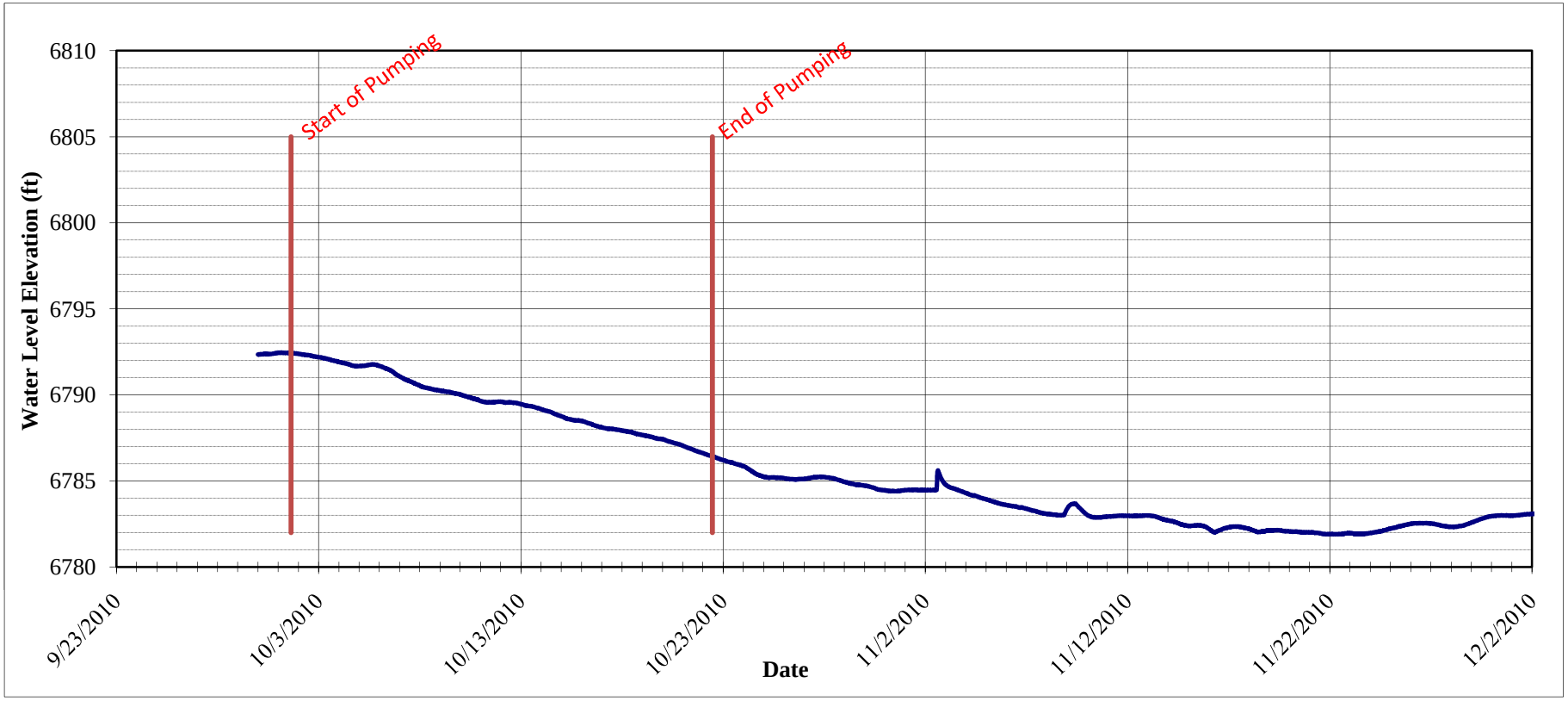
Figure E1. LOB-MW01 Water Level Measurements



Notes:

9/30/2010	12:00:00	6792.20	Static water level
10/22/2010	11:20:00	6772.62	End of pumping
12/2/2010	12:00:00	6780.53	Transducers removed

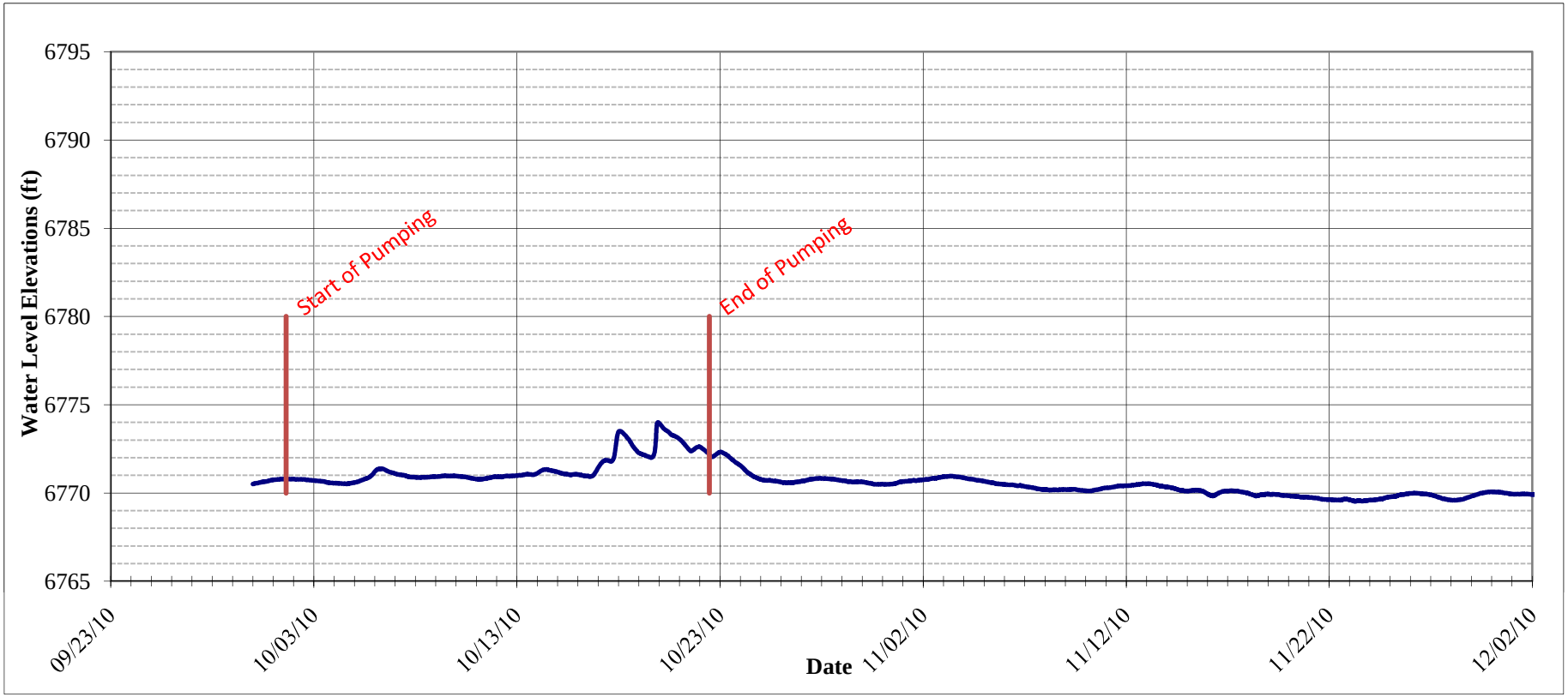
Figure E2. LOB-MW02 Water Level Measurements



Notes:

9/30/2010	12:00:00	6792.39	Static water level
10/22/2010	11:20:00	6786.44	End of pumping
12/2/2010	12:00:00	6783.12	Transducers removed

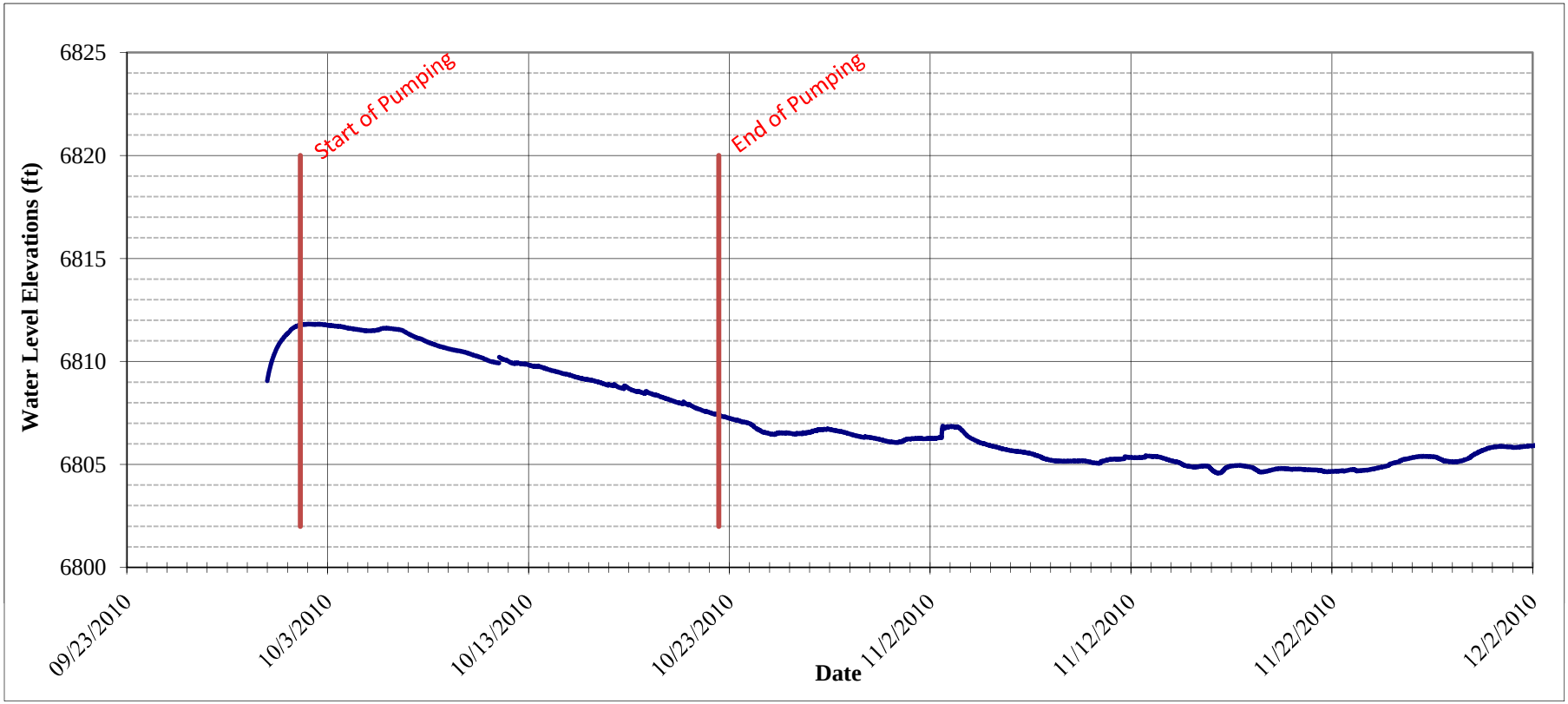
Figure E3. LOB-MW03 Water Level Measurements



Notes:

9/30/2010	12:00:00	6770.63	Static water level
10/22/2010	11:20:00	6772.18	End of pumping
12/2/2010	12:00:00	6769.89	Transducers removed

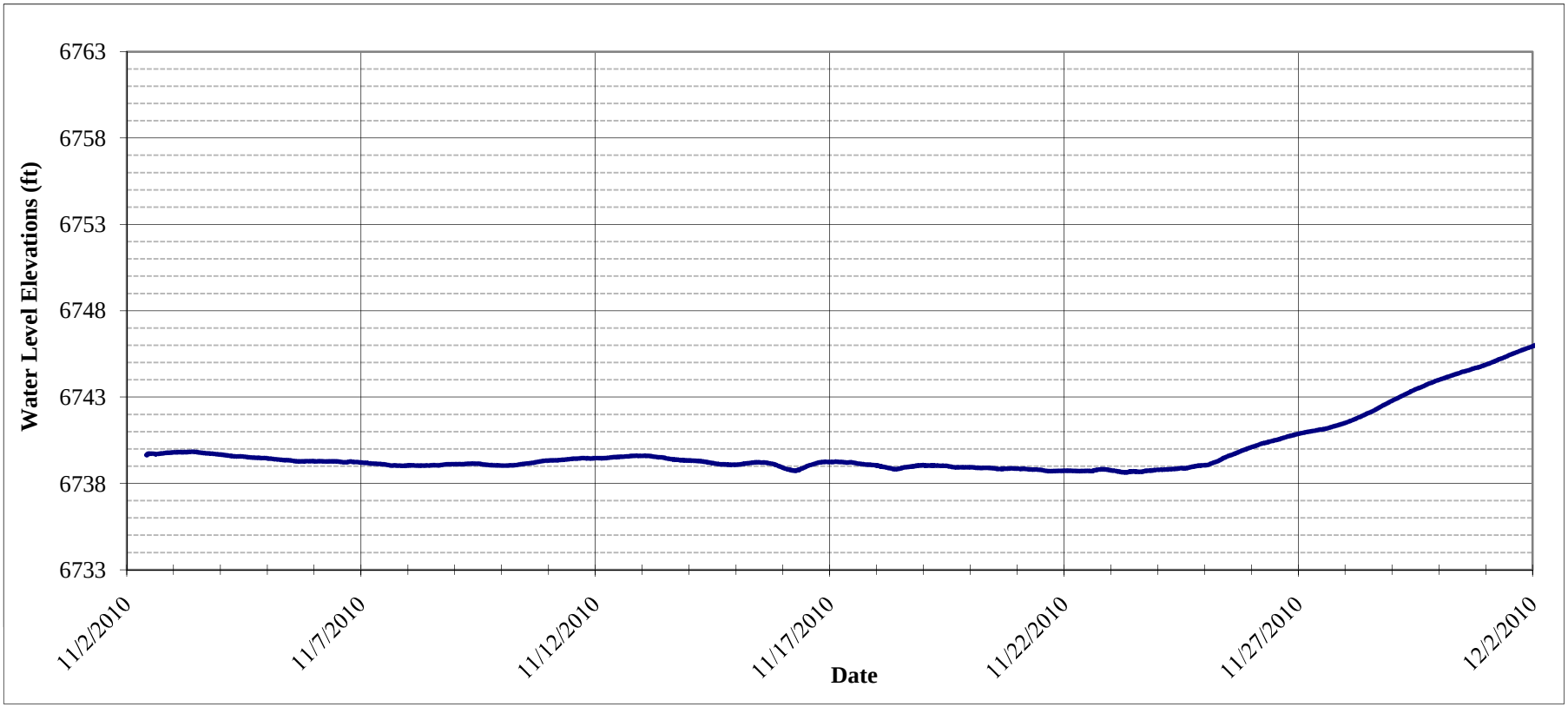
Figure E4. LOB-MW04 Water Level Measurements



Notes:

9/30/2010	12:00:00	6810.69	Static water level
10/22/2010	11:20:00	6807.40	End of pumping
12/2/2010	12:00:00	6805.92	Transducers removed

Figure E5. LOB-MW05 Water Level Measurements



Notes:

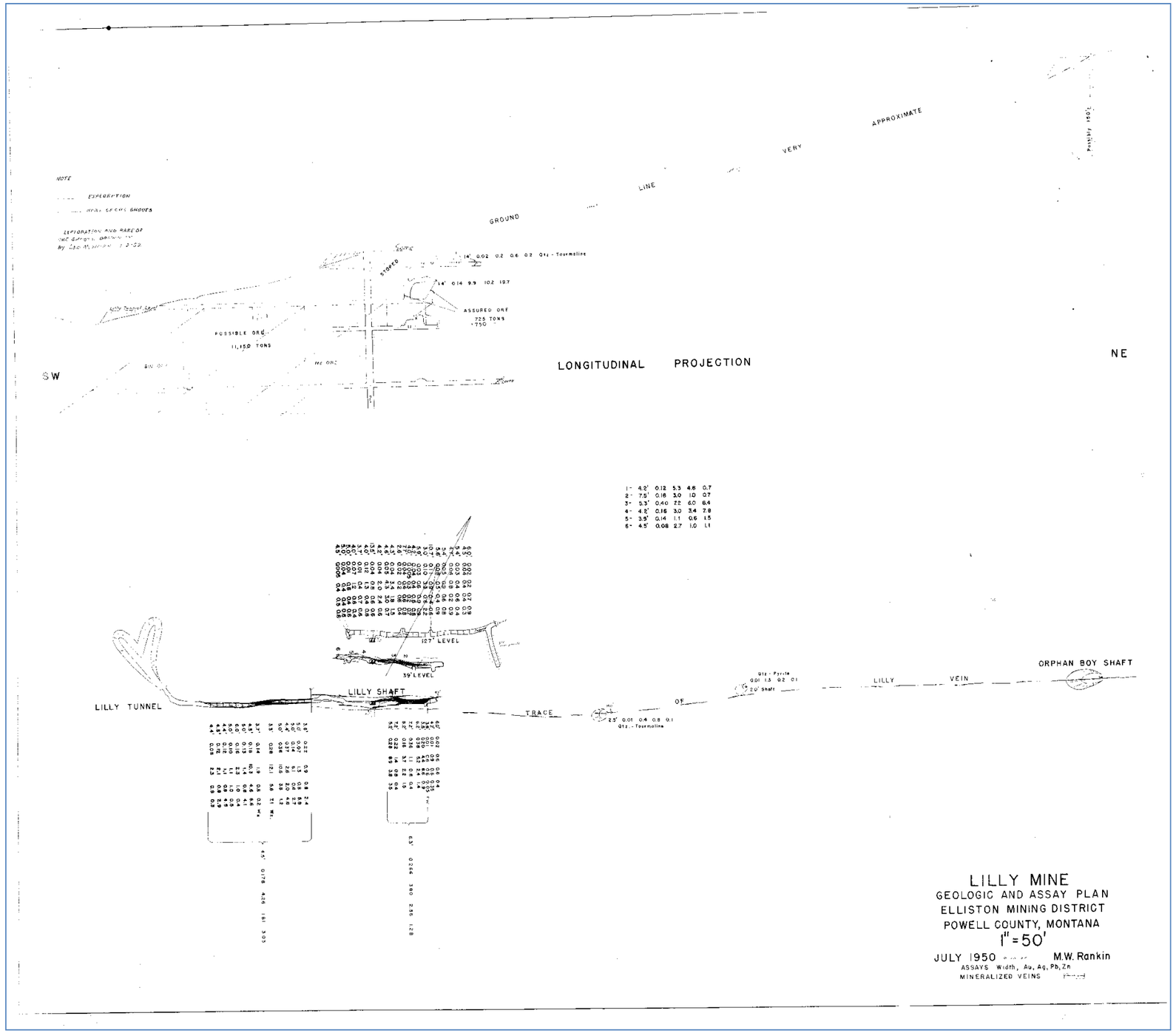
10/1/2010	15:15	6,794.70	Static water level
10/21/2010	10:10	6,722.15	Nearest reading to the end of pumping
12/2/2010	12:00:00	6746.447	Transducers removed

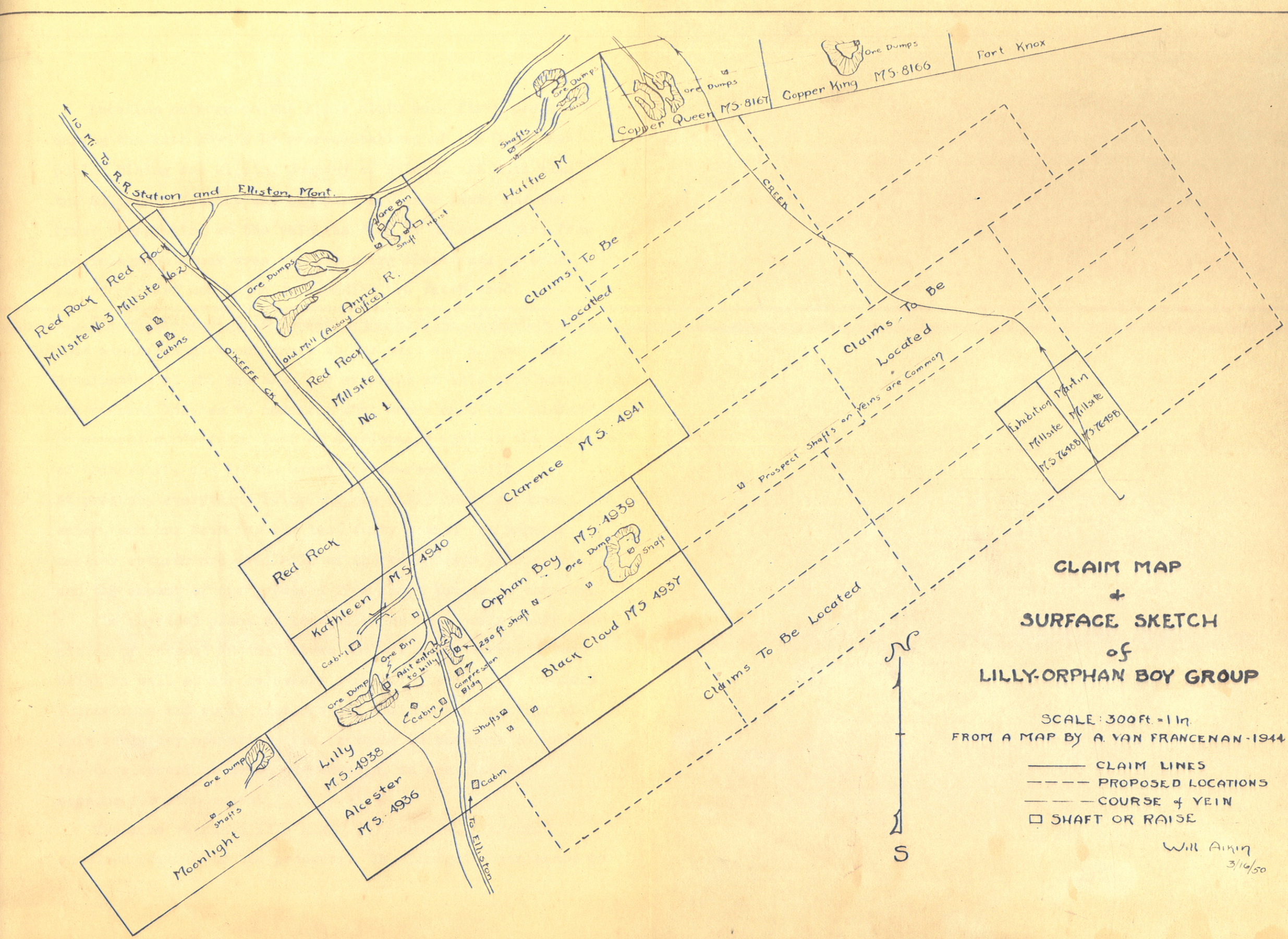
Figure 6. Shaft Water Level Recovery Measurements

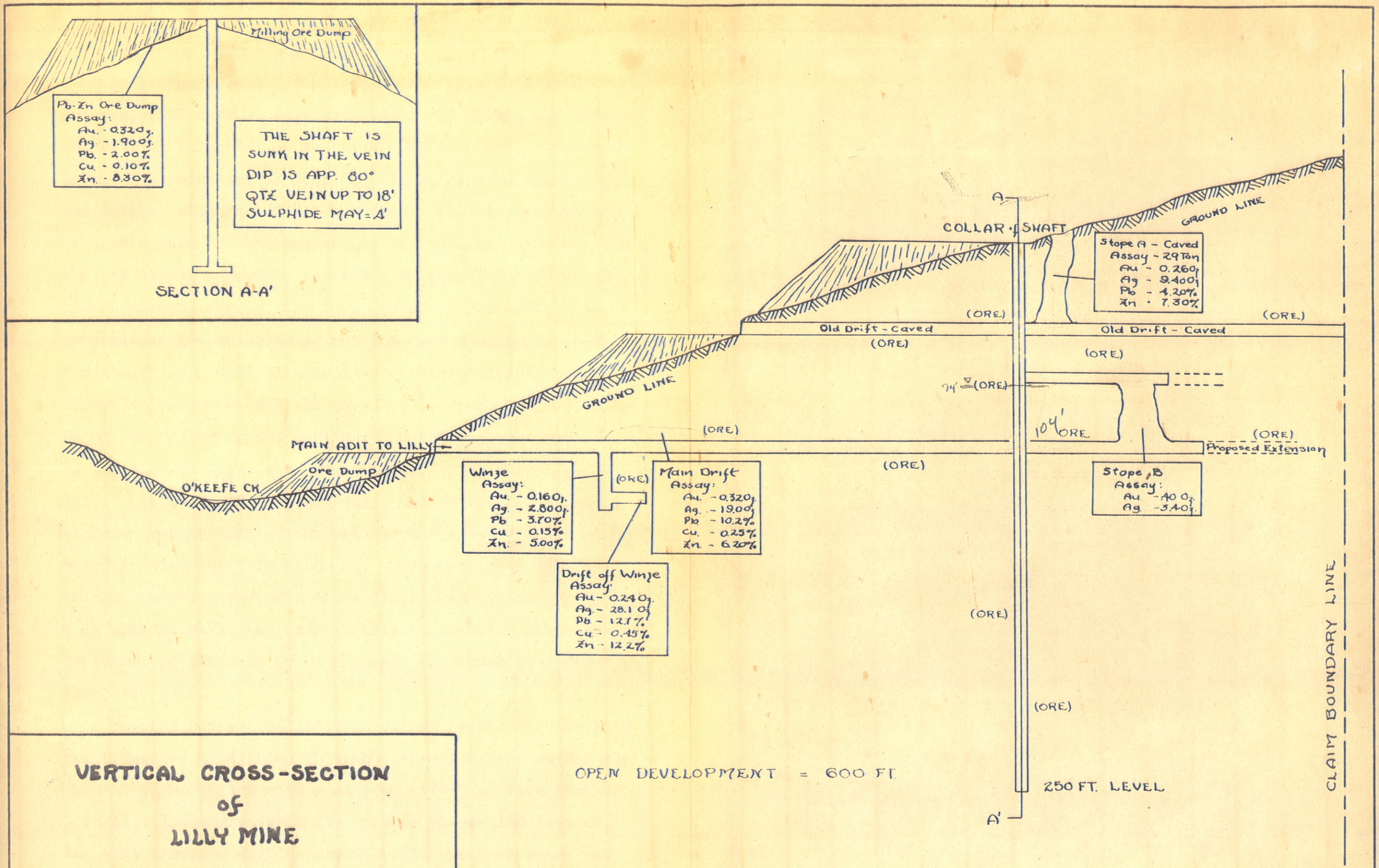
Appendix F

Mine Maps from Rankin and Aikin

Copy of Original Rankin Mine Map




CLAIM MAP
+
SURFACE SKETCH
of
LILLY-ORPHAN BOY GROUP
SCALE: 300 ft. = 1 in.
FROM A MAP BY A. VAN FRANCENAN - 1944
CLAIM LINES
PROPOSED LOCATIONS
COURSE of VEIN
SHAFT OR RAISE
Will Aikin
3/16/50
N
S
10 Mi. To R.R. Station and Elliston, Mont.
Red Rock Millsite No. 3
Red Rock Millsite No. 2
Cabins
O'KEEFE CR.
Ore Dumps
Old Mill (Assay Office)
Ore Bin
Snaff
Hoist
Anna R.
Shafts
Ore Dumps
Hattie M
Ore Dumps
Copper Queen MS. 8167
Ore Dumps
Copper King MS. 8166
Fort Knox
CREEK
Claims To Be Located
Claims To Be Located
Claims To Be Located
Prospect Shafts on Veins are Common
Exhibition Millsite MS 7648B
Martin Millsite MS 7648B
Red Rock Millsite No. 1
Clarence MS. 4941
Red Rock
Kathleen MS. 4940
Cabin
Orphan Boy MS. 4939
Ore Dump
Shaft
290 ft. shaft
Ore Bin
Adit entrance to Lilly
Compression Bldg
Ore Dump
Cabin
Black Cloud MS 4937
Shafts
Cabin
Lilly MS. 4938
Alcester MS. 4936
Ore Dump
Shafts
Moonlight
To Elliston



VERTICAL CROSS-SECTION of LILLY MINE

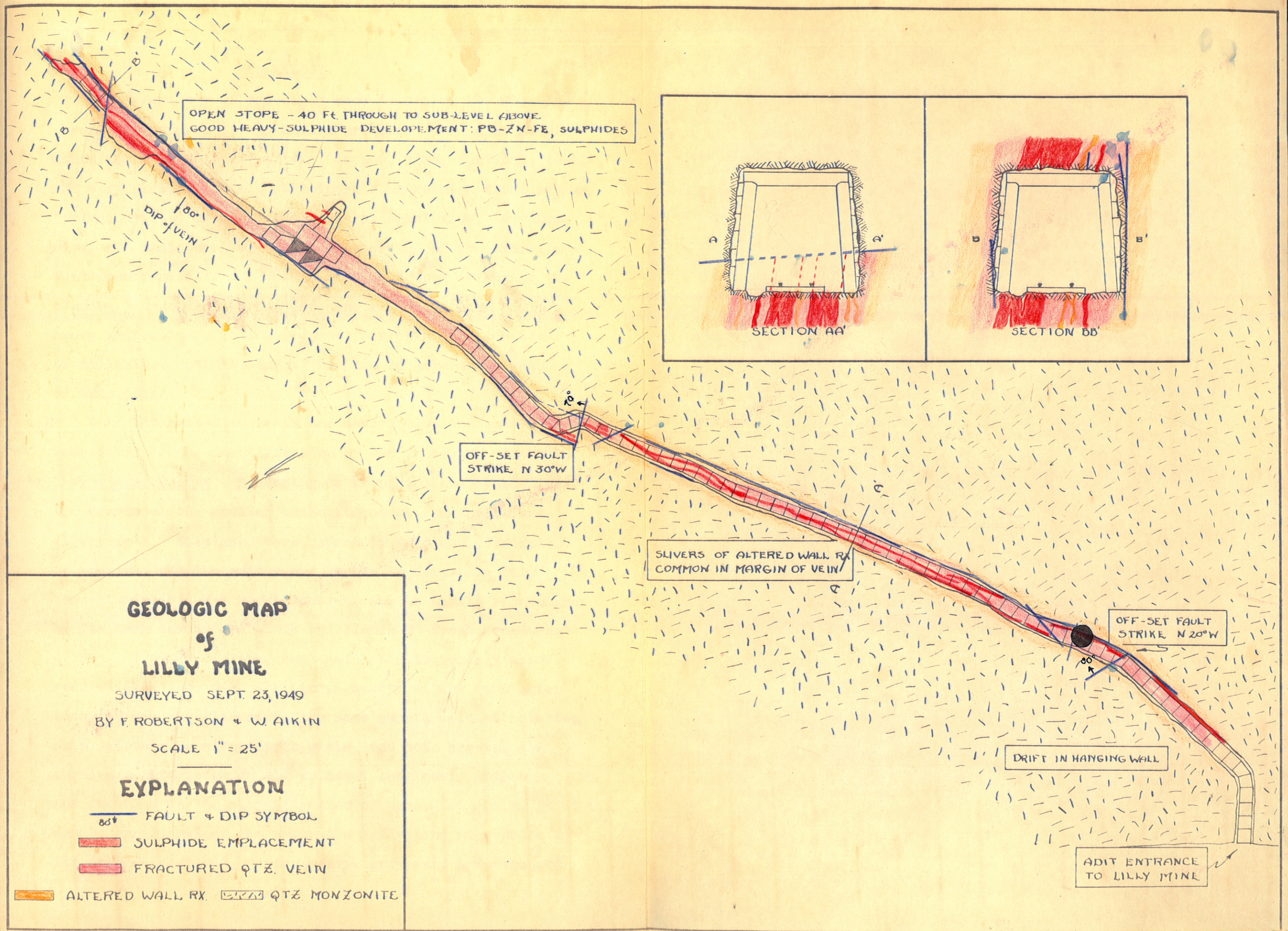
SCALE 1" = 50'

DRAWING BY A.V. VAN FRANCENEN

REVISED: 1944 & 1950

Will Aikin
4/5/50

OPEN DEVELOPMENT = 600 FT.


OPEN STOPE - 40 Ft. THROUGH TO SUB-LEVEL ABOVE
GOOD HEAVY-SULPHIDE DEVELOPEMENT: PB-ZN-FE, SULPHIDES
B
B'
80°
DIP of VEIN
OFF-SET FAULT
STRIKE N 30°W
SLIVERS OF ALTERED WALL RX
COMMON IN MARGIN OF VEIN
OFF-SET FAULT
STRIKE N 20°W
DRIFT IN HANGING WALL
ADIT ENTRANCE
TO LILLY MINE
A
A'
SECTION AA'
B
B'
SECTION BB'
GEOLOGIC MAP
of
LILLY MINE
SURVEYED SEPT. 23, 1949
BY F. ROBERTSON & W. AIKIN
SCALE 1" = 25'
EXPLANATION
80°
FAULT & DIP SYMBOL
SULPHIDE EMPLACEMENT
FRACTURED QTZ. VEIN
ALTERED WALL RX.
QTZ. MONZONITE

Appendix G

Injection Well Depth Calculations

Appendix G

Calculations to estimate the elevation of the floor of the Lilly Drift relative to the bottom elevation of the MSE injection wells (MW-Injection 1 and MW-Injection 2).

Elevation of the 74-foot level (Lilly Drift)

The elevation of the shaft collar is approximately 6868 feet above mean sea level (amsl). Subtracting 74 feet from the shaft collar elevation yields a floor elevation of the Lilly Drift at the shaft of approximately 6794 feet above mean sea level (amsl). The elevation of the drift at the toe of the adit is approximately 6785 feet amsl. Estimating the length of the drift to be 340 feet, the floor of the drift has an average grade of approximately 2.5 percent. In the vicinity of the wells, the floor of the drift is at an elevation of approximately 6791 feet. Table 1 summarizes the well details.

To estimate if the wells were drilled to a depth sufficient to encounter the 74-foot level, the slope of the drift was calculated to estimate of the floor elevation in the vicinity of the well locations. Using an approximate shaft collar elevation of 6868 feet amsl (above mean sea level) and the measured depth of 74 feet to the floor of this level, the floor elevation at the shaft is approximately 6794 feet amsl. The estimated elevation of the toe of the adit is 6785 feet amsl. The elevation difference between these two points is approximately 9 feet. The approximate distance between the shaft collar and the toe of the adit is 340 feet. Dividing the elevation difference by the length of the drift west of the shaft provides an average grade of approximately 2½ percent for the drift. By interpolating this slope in the vicinity of the injection wells, the floor elevation of the Lilly Drift is estimated to be approximately 6791 feet amsl in proximity to the wells.

The table below summarizes calculations to estimate the elevation of the bottom of the two injection wells and their vertical position relative to the floor of the drift:

Table 1: Monitoring well calculations

Well	Location	Elevation (ft amsl)	Total Depth (feet)	Elevation of Bottom of Well (ft amsl)	Well TD relative to floor elevation of Lilly Drift
MW-Injection 1	Approximately 73 feet southwest of shaft	6843.8	49.0	6794.8	The bottom of the well is approximately 3 feet above the floor of the drift.
MW-Injection 2	Approximately 91 feet southwest of shaft	6843.8	52.4	6791.4	The bottom of the well is approximately 0.5 foot above the floor of drift.

Appendix H

Data Validation Report

TerraGraphics Environmental Engineering, Inc.

DATA VALIDATION REPORT

1. Introduction

This memo addresses the quality assurance and quality control (QA/QC) review of 71 samples analyzed by Pace Analytical Services, Inc. as part of the Phase II Reclamation Investigation at the Lilly/Orphan Boy Mine site, Powell County, Montana. Sampling occurred from September through December 2010. This data validation includes the following Pace Analytical lab report numbers:

10140782	10140984	10141507	10141792
10140918	10141012	10141753	10144942
10140973	10141502	10141790	

Table 1 summarizes all collected samples by type. At least one field duplicate sample, one field blank, and one rinsate blank were collected for each of the sampling events. The analytical methods used for each analyte are presented in Table 2.

Table 1 Samples Collected for the Phase II Reclamation Investigation of Lilly/Orphan Boy Mine

	Groundwater	Surface and Mine Water	Soil
Number of Samples	5	41	13
Duplicate Samples	1	2	1
Field Blanks	1	2	1
Rinsate Blanks	1	2	1

Table 2 Water Sample Analytes and Analytical Methods

Analyte	Analytical Method
Aluminum	EPA 200.8, 6010
Aluminum, Dissolved	EPA 200.8
Arsenic	EPA 200.8, 6010
Arsenic, Dissolved	EPA 200.8
Cadmium	EPA 200.8, 6010
Cadmium, Dissolved	EPA 200.8
Calcium, Dissolved	EPA 200.7/200.8
Copper	EPA 200.8, 6010
Copper, Dissolved	EPA 200.8
Iron	EPA 200.8, 6010
Iron, Dissolved	EPA 200.7/200.8
Lead	EPA 200.8, 6010
Lead, Dissolved	EPA 200.8
Magnesium, Dissolved	EPA 200.7/200.8
Manganese	EPA 200.8, 6010
Manganese, Dissolved	EPA 200.8
Potassium, Dissolved	EPA 200.8

Table 2 Water Sample Analytes and Analytical Methods

Analyte	Analytical Method
Sodium, Dissolved	EPA 200.8
Hardness (total as CaCO3)	EPA 200.8
Zinc	EPA 200.8, 6010
Zinc, Dissolved	EPA 200.8
Chloride, total and dissolved	EPA 300.0
Sulfate, total and dissolved	EPA 300.0
Acidity	2320
Alkalinity, Carbonate (CaCO3)	SM 2320B
Alkalinity, Total as CaCO3	SM 2320B
Alkalinity, Bicarbonate (CaCO3)	SM 2320B
Specific Conductance	SM 2510B
Total Dissolved Solids (TDS)	SM 2540C
Total Suspended Solids (TSS)	SM 2540D
pH at 25 Degrees C	SM 4500-HB
Acid Potential w/ Sulfur forms	Sobek Modified
Acid/Base Potential	Sobek Modified
Neutralization Potential	Sobek Modified

- Validation procedures used are consistent with the US Environmental Protection Agency (USEPA) *Contract Laboratory Program (CLP) National Functional Guidelines for Inorganic Superfund Data Review* (USEPA 2010) and the *Final Sampling and Analysis Plan(SAP) / Quality Assurance Project Plan (QAPP) for Phase II Reclamation Investigation of Lilly/Orphan Boy Mine, Powell County, Montana* (TerraGraphics 2010), hereinafter referred to as the SAP/QAPP. Data qualifiers that were assigned include:
    - J = estimated concentration
    - J+ = estimated high concentration
    - J- = estimated low concentration
    - U = concentration is below the reporting limit

- Overall level of validation:
  ___ Contract Laboratory Program (CLP)
  _X_ Standard
  ___ Visual
  Data were reviewed in accordance with the SAP/QAPP.

2. Deliverables

- All laboratory document deliverables were present as specified in the *USEPA Contract Laboratory Program Statement of Work for Inorganic Analysis: Multi-Media, Multi-Concentration (ILM05.4)* (USEPA 2007a), USEPA publication *SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (USEPA 2007b), and/or the project contract.
  _X_ Yes
  ___ No

- All documentation of field procedures was provided as required.
  _X_ Yes
  ___ No

3. Condition of Samples Upon Receipt

- There were no concerns with the condition of samples upon receipt, with the exception of report numbers 10140984 and 10141502. In report 10140984, the lab noted that two bottles were listed for HNO_3 (nitric acid), but only one was received. In report 10141502, sample 10141502007 was received without a lid.

4. Field Quality Control Samples

- **Blanks**

  DI, trip, rinsate, or any other field blanks have been carried out at the proper frequency.
  _X_ Yes.
  ___ No.

  - Rinsate and field blanks were carried out at the proper frequency for the sampling event (one per event or one per 20 samples). The rinsate and field blanks taken with the soil sampling event were only analyzed for total metals, so only those analytes could be evaluated.

  Reported results on the field blanks are less than the contract required detection limits (CRDLs) or the project required detection limits (PRDL) if project detection limits have been specified.
  ___ Yes
  _X_ No

  - Reported results on the field blanks were less than PRDLs for all analytes except for a rinsate blank that had a total zinc concentration of 0.011 mg/L. Ten associated samples that had total zinc results less than ten times the detected blank concentration were qualified with "J+." A field blank had a total dissolved solids concentration of 37 mg/L. Three associated samples that had total dissolved solids (TDS) concentrations less than ten times the detected blank concentrations were qualified with "J+."

- **Field duplicates**
  Field duplicates have been collected at the proper frequency.
  _X_ Yes
  ___ No
  - Field duplicates were collected at the proper frequency (one per sampling event or one every 20 samples).

Field duplicate relative percent differences (RPDs) were within the required control limits (i.e., RPD of 20% or less).
___ Yes
___ No
_X_ NA

- There were no project specified control limits for field duplicate RPDs. Field duplicate RPDs were evaluated, but no results were qualified due to high RPDs.

5. Laboratory Procedures

- **Laboratory procedures followed**

___ CLP-SOW
_X_ SW-846
___ Methods for Chemical Analysis of Water and Wastes
___ XRF Standard Operating Procedures
_X_ Other

Table 2 details the analytical methods used.

- **Holding times met**

___ Yes
_X_ No

- Samples did not meet holding times in the following reports. No results were qualified due to holding times.

Report Number	Analyte
10141753	Alkalinity, pH
10140918	TDS, TSS, acidity, alkalinity, pH
10141502	pH, TDS, TSS
10141790	pH, TDS, TSS
10141792	pH, TDS, TSS
10140973	pH
10140984	pH
10141012	pH
10141507	pH
10144942	pH

- **Consistency with project requirements**

Analyses were carried out as requested.
_X_ Yes
___ No

Project specified methods were used.
_X_ Yes
___ No
___ NA

6. Detection Limits

- Reporting detection limits met PRDLs.
  _X_ Yes
  ___ No

  - Reporting detection limits met PRDLs, except for sample 10141502008, which required a high dilution rate.

7. Laboratory Blanks

- **Preparation blanks**
  Preparation blanks were prepared and analyzed at the required frequency.
  _X_ Yes
  ___ No

  All the analytes in the preparation blank were less than the CRDL (or the PRDL if a project detection limit has been specified).
  ___ Yes
  _X_ No

  - Any detected analytes in preparation blanks were less than the project required detection limits except for iron, which was detected at 5.1 mg/L in report 10140782. Associated samples were more than ten times the amount detected in the blanks; therefore, they were not qualified.

8. Laboratory Matrix Spikes

- A matrix spike (MS) sample (pre-digestion) was prepared and analyzed at the required frequency.
  _X_ Yes
  ___ No

- Samples were spiked at levels appropriate to the sample concentrations.
  _X_ Yes
  ___ No

- MS recoveries were within the required control limits (75-125%).
  ___ Yes
  _X_ No

- MS recoveries were calculated when the spiked amount was within four times the parent sample concentration. MS recoveries were reviewed when they were conducted on samples collected for this project; data were not qualified due to matrix spikes done on samples from other projects. MS recoveries were within the required control limits for all analyses and batch numbers, except the following:

  - Report number 10140918: An MS had a high percent recovery for iron. Associated detected iron results were qualified with a J+.
  - Report number 10140973: An MS had a high percent recovery for alkalinity. Associated detected alkalinity results were qualified with a J+.
  - Report number 10140984: An MS had a high percent recovery for aluminum. Associated detected aluminum results were qualified with a J+. An MS had a low percent recovery for dissolved aluminum. Associated detected dissolved aluminum results were qualified with a J-, and nondetected dissolved aluminum results were qualified with a UJ.
  - Report number 10141012: An MS had a high percent recovery for aluminum. Associated detected aluminum results were qualified with a J+.
  - Report number 10141502: An MS had high percent recoveries for cadmium and dissolved zinc. Associated detected cadmium and dissolved zinc results were qualified with a J+.
  - Report number 10144942: An MS had high percent recoveries for aluminum and dissolved zinc. Associated detected aluminum and dissolved zinc results were qualified with a J+.

9. Laboratory Duplicates

- Laboratory duplicate samples were analyzed at the proper frequency.
  _X_ Yes
  ___ No

- The laboratory duplicate RPDs were within the required control limits (i.e., RPD of 20% or less).
  ___ Yes
  _X_ No

  - Laboratory duplicate RPDs were within the required control limits, except for acidity in reports 10141790 and 1014792. Associated acidity results were qualified with a J.

10. Laboratory Control Standards

- The reference material used was of the correct matrix and concentration, according to Pace Analytical.
  _X_ Yes
  ___ No

- Laboratory control samples (LCSs) were prepared and analyzed at the proper frequency.
  _X_ Yes
  ___ No

- LCSs were prepared in the same way as the associated samples, according to Pace Analytical.
  _X_ Yes
  ___ No

- LCS recoveries were within the required control limits.
  _X_ Yes
  ___ No

11. Additional Data Evaluation

- There were insufficient sample volumes to analyze for TSS for sample 10141507009; TDS, TSS, alkalinity, and dissolved inorganics for sample 10141507008; and TSS and dissolved inorganics for 10141507007.
- Sample 10141502007 was analyzed for metals only, as one of the bottles had opened during sample transport.
- Samples in batch 10144942 were not analyzed for chloride and sulfate as had been specified on the chain-of-custody.
- Sample 10140918021 was incorrectly entered on the chain of custody (COC) as LOB-MW10-A-020100929. The correct field ID is LOB-MW01-A-020100929.
- Sample 10140918017 was incorrectly entered on the COC as LOB-MW2-A-20100927. The correct field ID is LOB-MW02-A-20100929.
- Other sample IDs that did not follow the naming conventions outlined in the SAP/QAPP were updated for data summary purposes. The tables and references to samples in this data validation report use the IDs that were written on the COCs and reported by the laboratory.

12. Data Quality Objectives

- Project data quality objectives (DQOs) were met.
  _X_ Yes
  ___ No
  ___ NA

  - QC criteria for precision and accuracy were used to assess and qualify data. Based on this assessment, the data are acceptable and usable. No results were rejected, meeting the target goal of 95% completeness for the project. Table 3 provides a summary of the rationale for all assigned data qualifiers.

DATA VALIDATION REPORT

Prepared by: Mara Moscato

Reviewed by: Jeremy Mickey

References

TerraGraphics Environmental Engineering, Inc. (TerraGraphics). 2010. *Final Sampling and Analysis Plan (SAP)/Quality Assurance Project Plan (QAPP) for Phase II Reclamation Investigation of Lilly/Orphan Boy Mine, Powell County, Montana.* Prepared for Montana Department of Environmental Quality (DEQ). August.

US Environmental Protection Agency (USEPA). 2007a. *USEPA Contract Laboratory Program Statement of Work for Inorganic Analysis: Multi-Media, Multi-Concentration (ILM05.4)*. USEPA 540-FS-07-004. January.

USEPA. 2007b. *Third Edition of SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, as amended by Final Updates I, II, IIA, IIB, III, IIIA, IIIB, and IV; February.

USEPA. 2010. *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review*. OSWER 9240.1-51; USEPA 540-R-10-011. January.

Table 3. Qualifier Assignment Summary

LabID	FieldID	Parameter	Result	Units	Assigned Qualifier
Results Qualified Due to MS Percent Recovery					
10140973001	LOB-SW07-A-20101013	Alkalinity, Total as CaCO3	11.2	mg/L	J+
10140973002	LOB-SW07-A-20101013 DISSOLVED	Alkalinity, Total as CaCO3	11.6	mg/L	J+
10141012005	LOB-SHAFT WATER 20101016	Aluminum	31.8	mg/L	J+
10144942001	LOB-SW01-A-20101206	Aluminum	0.12	mg/L	J+
10140984001	LOB-SW03-A-20101013	Aluminum	0.27	mg/L	J+
10141012007	LOB-SW03-A-20101015	Aluminum	0.28	mg/L	J+
10144942002	LOB-SW03-A-20101206	Aluminum	0.25	mg/L	J+
10140984005	LOB-SW05-A-20101007	Aluminum	0.079	mg/L	J+
10144942003	LOB-SW05-A-20101206	Aluminum	0.20	mg/L	J+
10144942004	LOB-SW05-D-20101206	Aluminum	0.068	mg/L	J+
10144942005	LOB-SW06-A-20101206	Aluminum	0.29	mg/L	J+
10141012003	LOB-SW07-A-20101015	Aluminum	0.21	mg/L	J+
10141012001	LOB-SW07-A-20101017	Aluminum	0.21	mg/L	J+
10140984003	SHAFT WATER - RAW 181,800 GAL	Aluminum	4.3	mg/L	J+
10140984001	LOB-SW03-A-20101013	Aluminum, Dissolved	0.11	mg/L	J-
10140984005	LOB-SW05-A-20101007	Aluminum, Dissolved	0.046	mg/L	J-
10141502007	LOB-SEEP 1-5' E	Cadmium	0.19	mg/L	J+
10141502010	LOB-SEEP 58' W	Cadmium	0.14	mg/L	J+
10141502008	LOB-SEEP 75' E	Cadmium	3.9	mg/L	J+
10141502005	LOB-SHAFT RAW WATER 20101018	Cadmium	0.026	mg/L	J+
10141502003	LOB-SW03-A-20101018	Cadmium	0.0054	mg/L	J+
10141502001	LOB-SW07-A-20101018	Cadmium	0.0057	mg/L	J+
10140918021	LOB-MW01-A-020100929	Iron	2.3	mg/L	J+
10140918017	LOB-MW2-A-20100927	Iron	26.9	mg/L	J+
10140918019	LOB-MW2-D-20100929	Iron	27.0	mg/L	J+
10140918027	LOB-MW3-A-20100929	Iron	0.76	mg/L	J+
10140918031	LOB-MW4-A-20100929	Iron	0.22	mg/L	J+
10140918029	LOB-MW5-A-20100929	Iron	2.4	mg/L	J+
10140918013	LOB-SW01-A-20100929	Iron	0.50	mg/L	J+
10140918007	LOB-SW03-A-20100929	Iron	0.71	mg/L	J+
10140918011	LOB-SW05-A-20100929	Iron	0.19	mg/L	J+
10140918009	LOB-SW06-A-20100929	Iron	0.55	mg/L	J+
10140918005	LOB-SW06-D-20100929	Iron	0.65	mg/L	J+
10140918001	LOB-SW07-A-20101001	Iron	0.54	mg/L	J+
10144942008	LOB-SW01-A-20101206 DISSOLVED	Zinc, Dissolved	0.048	mg/L	J+

Table 3. Qualifier Assignment Summary

LabID	FieldID	Parameter	Result	Units	Assigned Qualifier
10144942007	LOB-SW01-C-20101206	Zinc, Dissolved	0.046	mg/L	J+
10141502003	LOB-SW03-A-20101018	Zinc, Dissolved	0.68	mg/L	J+
10144942009	LOB-SW03-A-20101206 DISSOLVED	Zinc, Dissolved	0.063	mg/L	J+
10144942010	LOB-SW05-A-20101206 DISSOLVED	Zinc, Dissolved	0.025	mg/L	J+
10144942011	LOB-SW05-D-20101206 DISSOLVED	Zinc, Dissolved	0.032	mg/L	J+
10144942012	LOB-SW06-A-20101206 DISSOLVED	Zinc, Dissolved	0.085	mg/L	J+
10141502001	LOB-SW07-A-20101018	Zinc, Dissolved	0.8	mg/L	J+
Results Qualified Due to RPD					
10141792011	LOB-RAW SHAFT-20101019	Acidity	101	mg/L	J
10141792002	LOB-RAW SHAFT-20101020	Acidity	61.5	mg/L	J
10141792012	LOB-SHAFT RAW-20101021	Acidity	49.9	mg/L	J
10141792001	LOB-SW03-20101019	Acidity	37.3	mg/L	J
10141792003	LOB-SW03-20101020	Acidity	18.8	mg/L	J
10141790001	LOB-SW03-20101021	Acidity	30.5	mg/L	J
10141792013	LOB-SW07-20101019	Acidity	24.7	mg/L	J
10141792004	LOB-SW07-20101020	Acidity	28.5	mg/L	J
10141792010	LOB-SW07-20101021	Acidity	32.4	mg/L	J
Results Qualified Due to Field Blank/Rinsate Blank Results					
10140918025	LOB-MW2-C-20100929	Total Dissolved Solids	17.0	mg/L	J
10144942001	LOB-SW01-A-20101206	Total Dissolved Solids	17.0	mg/L	J
10144942003	LOB-SW05-A-20101206	Total Dissolved Solids	22.0	mg/L	J
10140918029	LOB-MW5-A-20100929	Zinc	0.054	mg/L	J+
10140918013	LOB-SW01-A-20100929	Zinc	0.022	mg/L	J+
10144942001	LOB-SW01-A-20101206	Zinc	0.080	mg/L	J+
10144942006	LOB-SW01-B-20101206	Zinc	0.012	mg/L	J+
10144942002	LOB-SW03-A-20101206	Zinc	0.092	mg/L	J+
10140918011	LOB-SW05-A-20100929	Zinc	0.016	mg/L	J+
10140984005	LOB-SW05-A-20101007	Zinc	0.015	mg/L	J+
10144942003	LOB-SW05-A-20101206	Zinc	0.065	mg/L	J+
10144942004	LOB-SW05-D-20101206	Zinc	0.083	mg/L	J+
10144942005	LOB-SW06-A-20101206	Zinc	0.084	mg/L	J+

Appendix I

Mine Water Turbidity Data

Lilly/Orphan Boy Mine Water Dewatering

Rain for Rent water quality monitoring box data export
Influent & Effluent Mine Water Turbidity Monitoring Data

Serial Number: 000001141366 **Effluent Mine Water Turbidity**
Device ID: 104 **Monitoring Data (after pH adjustment & holding in tank)**
Manufacture ID: 1 FNU is the ISO system for measuring turbidity, roughly equivalent to NTU.

Nephelometric turbidity unit (NTU): A measure of turbidity in a water sample, roughly equivalent to (JTU).
Formazin turbidity unit (FTU) and Jackson turbidity unit
ISO refers to its units as FNU (Formazin Nephelometric Units).

Date & Time	INFLUENT TURBIDITY (FNU)	Date & Time	EFFLUENT TURBIDITY (FNU)	PUMPED & TREATED VOLUME (gallons)	NOTES
9/28/2010 9:10	1	9/28/2010 9:50	0		Fine tuning & preparing system
9/28/2010 10:00	0	9/28/2010 10:00	0		
9/28/2010 10:10	0	9/28/2010 10:10	0		
9/28/2010 10:20	0	9/28/2010 10:20	0		
9/28/2010 10:00	0	9/28/2010 10:00	1		
9/28/2010 13:30	0	9/28/2010 13:30	1		
9/28/2010 13:40	0	9/28/2010 13:40	1		
9/28/2010 13:50	0	9/28/2010 13:50	1		
9/28/2010 14:00	0	9/28/2010 14:00	1		
9/28/2010 14:50	0	9/28/2010 14:50	0		
9/28/2010 15:40	0	9/28/2010 15:40	0		
9/28/2010 15:50	0	9/28/2010 15:50	0		
9/28/2010 16:00	39	9/28/2010 16:00	0		
9/28/2010 16:10	31	9/28/2010 16:10	0		
9/28/2010 16:20	29	9/28/2010 16:20	45		
9/28/2010 16:30	23	9/28/2010 16:30	67		
9/28/2010 16:40	24	9/28/2010 16:40	61		
9/28/2010 16:50	17	9/28/2010 16:50	53		
9/28/2010 17:00	14	9/28/2010 17:00	53		
9/28/2010 17:10	40	9/28/2010 17:10	43		
9/28/2010 17:20	16	9/28/2010 17:20	43		
9/28/2010 17:30	15	9/28/2010 17:30	40		
9/28/2010 17:40	13	9/28/2010 17:40	24		
9/28/2010 17:50	12	9/28/2010 17:50	18		
9/28/2010 18:00	27	9/28/2010 18:00	19		
9/28/2010 18:10	45	9/28/2010 18:10	21		
9/28/2010 18:20	13	9/28/2010 18:20	18		
9/28/2010 18:30	9	9/28/2010 18:30	15		
9/28/2010 18:40	9	9/28/2010 18:40	14		
9/28/2010 18:50	8	9/28/2010 18:50	14		
9/28/2010 19:00	10	9/28/2010 19:00	13		
9/28/2010 19:10	8	9/28/2010 19:10	12		
9/29/2010 9:20	19	9/29/2010 9:20	21		Fine tuning & preparing system
9/29/2010 9:30	17	9/29/2010 9:30	22		
9/29/2010 9:40	18	9/29/2010 9:40	25		
9/29/2010 9:50	18	9/29/2010 9:50	24		
9/29/2010 10:00	18	9/29/2010 10:00	25		
9/29/2010 10:10	36	9/29/2010 10:10	26		
9/29/2010 10:20	18	9/29/2010 10:20	26		
9/29/2010 10:30	20	9/29/2010 10:30	30		
9/29/2010 10:40	20	9/29/2010 10:40	28		
9/29/2010 10:50	20	9/29/2010 10:50	29		
9/29/2010 11:00	35	9/29/2010 11:00	29		
9/29/2010 11:10	19	9/29/2010 11:10	29		
9/29/2010 11:20	26	9/29/2010 11:20	47		
9/29/2010 11:30	19	9/29/2010 11:30	49		
9/29/2010 11:40	22	9/29/2010 11:40	60		
9/29/2010 11:50	19	9/29/2010 11:50	63		
9/29/2010 12:00	20	9/29/2010 12:00	78		
9/29/2010 12:10	22	9/29/2010 12:10	82		
9/29/2010 12:20	23	9/29/2010 12:20	77		
9/29/2010 12:30	22	9/29/2010 12:30	75		

Date & Time	INFLUENT TURBIDITY (FNU)	Date & Time	EFFLUENT TURBIDITY (FNU)	PUMPED & TREATED VOLUME (gallons)	NOTES
9/29/2010 12:40	22	9/29/2010 12:40	78		
9/29/2010 12:50	22	9/29/2010 12:50	94		
9/29/2010 13:00	27	9/29/2010 13:00	73		
9/29/2010 13:10	37	9/29/2010 13:10	65		
9/29/2010 13:40	23	9/29/2010 13:40	80		
9/29/2010 13:50	21	9/29/2010 13:50	57		
9/29/2010 14:00	21	9/29/2010 14:00	57		
9/29/2010 14:10	21	9/29/2010 14:10	57		
9/29/2010 14:20	21	9/29/2010 14:20	57		
9/29/2010 14:30	21	9/29/2010 14:30	58		
9/29/2010 14:40	21	9/29/2010 14:40	58		
9/29/2010 14:50	23	9/29/2010 14:50	58		
9/29/2010 15:00	23	9/29/2010 15:00	59		
9/30/2010 10:30	24	9/30/2010 10:30	80		Fine tuning & preparing system
9/30/2010 10:40	16	9/30/2010 10:40	80		
9/30/2010 10:50	24	9/30/2010 10:50	80		
9/30/2010 11:00	10	9/30/2010 11:00	79		
9/30/2010 11:10	29	9/30/2010 11:10	65		
9/30/2010 11:20	42	9/30/2010 11:20	68		
9/30/2010 11:30	32	9/30/2010 11:30	62		
9/30/2010 11:40	31	9/30/2010 11:40	62		
9/30/2010 11:50	30	9/30/2010 11:50	62		
9/30/2010 12:00	25	9/30/2010 12:00	61		
9/30/2010 12:10	23	9/30/2010 12:10	39		
9/30/2010 12:20	20	9/30/2010 12:20	33		
9/30/2010 12:30	17	9/30/2010 12:30	29		
9/30/2010 12:40	17	9/30/2010 12:40	28		
9/30/2010 12:50	17	9/30/2010 12:50	25		
9/30/2010 13:00	19	9/30/2010 13:00	25		
9/30/2010 13:10	17	9/30/2010 13:10	24		
9/30/2010 13:20	17	9/30/2010 13:20	23		
9/30/2010 13:30	16	9/30/2010 13:30	23		
9/30/2010 13:40	16	9/30/2010 13:40	23		
9/30/2010 13:50	16	9/30/2010 13:50	23		
9/30/2010 14:00	17	9/30/2010 14:00	22		
9/30/2010 14:10	17	9/30/2010 14:10	28		
9/30/2010 14:20	17	9/30/2010 14:20	25		
9/30/2010 14:30	17	9/30/2010 14:30	24		
9/30/2010 14:40	20	9/30/2010 14:40	24		
9/30/2010 14:50	19	9/30/2010 14:50	25		
9/30/2010 15:00	21	9/30/2010 15:00	25		
9/30/2010 15:10	21	9/30/2010 15:10	25		
9/30/2010 15:20	22	9/30/2010 15:20	25		
9/30/2010 15:30	21	9/30/2010 15:30	25		
9/30/2010 15:40	17	9/30/2010 15:40	25		
9/30/2010 15:50	25	9/30/2010 15:50	22		
9/30/2010 16:00	24	9/30/2010 16:00	28		
9/30/2010 16:10	23	9/30/2010 16:10	29		
9/30/2010 16:20	22	9/30/2010 16:20	32		
9/30/2010 16:30	29	9/30/2010 16:30	32		
9/30/2010 16:40	42	9/30/2010 16:40	40		
9/30/2010 16:50	55	9/30/2010 16:50	51		
9/30/2010 17:00	59	9/30/2010 17:00	62		
9/30/2010 17:10	62	9/30/2010 17:10	67		
9/30/2010 17:20	72	9/30/2010 17:20	78		
9/30/2010 17:30	72	9/30/2010 17:30	85		
9/30/2010 17:40	79	9/30/2010 17:40	92		
9/30/2010 17:50	77	9/30/2010 17:50	96		
9/30/2010 18:00	76	9/30/2010 18:00	94		
9/30/2010 18:10	72	9/30/2010 18:10	93		
9/30/2010 18:20	117	9/30/2010 18:20	109		
9/30/2010 18:30	127	9/30/2010 18:30	132		
9/30/2010 18:40	224	9/30/2010 18:40	160		

Date & Time	INFLUENT TURBIDITY (FNU)	Date & Time	EFFLUENT TURBIDITY (FNU)	PUMPED & TREATED VOLUME (gallons)	NOTES
10/1/2010 8:40	16	10/1/2010 8:40	5		Start of pumping & treatment
10/1/2010 8:50	267	10/1/2010 8:50	194		Dewatering Lilly Tunnel
10/1/2010 9:00	177	10/1/2010 9:00	221		DTW = 74.3'
10/1/2010 9:10	175	10/1/2010 9:10	219		
10/1/2010 9:20	103	10/1/2010 9:20	176		
10/1/2010 9:30	65	10/1/2010 9:30	126		
10/1/2010 9:40	45	10/1/2010 9:40	97		
10/1/2010 9:50	57	10/1/2010 9:50	77		
10/1/2010 10:00	81	10/1/2010 10:00	91		
10/1/2010 10:10	133	10/1/2010 10:10	95		
10/1/2010 10:20	177	10/1/2010 10:20	137		
10/1/2010 10:30	176	10/1/2010 10:30	92		
10/1/2010 10:40	156	10/1/2010 10:40	65		
10/1/2010 10:50	182	10/1/2010 10:50	145		
10/1/2010 11:00	169	10/1/2010 11:00	144		
10/1/2010 11:10	108	10/1/2010 11:10	143		
10/1/2010 11:20	90	10/1/2010 11:20	118	16,000	
10/2/2010 13:30	209	10/2/2010 13:30	155		DTW = 74.8'
10/2/2010 13:40	110	10/2/2010 13:40	184		
10/2/2010 13:50	64	10/2/2010 13:50	140		
10/2/2010 14:00	43	10/2/2010 14:00	106		
10/2/2010 14:10	33	10/2/2010 14:10	81		
10/2/2010 14:20	36	10/2/2010 14:20	73		
10/2/2010 14:30	257	10/2/2010 14:30	180		
10/2/2010 14:40	252	10/2/2010 14:40	127		
10/2/2010 14:50	257	10/2/2010 14:50	170		
10/2/2010 15:00	603	10/2/2010 15:00	391		
10/2/2010 15:10	680	10/2/2010 15:10	280		
10/2/2010 15:20	665	10/2/2010 15:20	157		
10/2/2010 15:30	735	10/2/2010 15:30	702		
10/2/2010 15:40	624	10/2/2010 15:40	616		
10/2/2010 15:50	676	10/2/2010 15:50	820		
10/2/2010 16:00	644	10/2/2010 16:00	349		
10/2/2010 16:10	650	10/2/2010 16:10	212		
10/2/2010 16:20	436	10/2/2010 16:20	722		
10/2/2010 16:30	343	10/2/2010 16:30	696		
10/2/2010 16:40	275	10/2/2010 16:40	575		
10/2/2010 16:50	240	10/2/2010 16:50	491		
10/2/2010 17:00	200	10/2/2010 17:00	421		
10/2/2010 17:10	213	10/2/2010 17:10	373		
10/2/2010 17:20	200	10/2/2010 17:20	371		
10/2/2010 17:40	182	10/2/2010 17:40	336		
10/2/2010 17:50	143	10/2/2010 17:50	290		
10/2/2010 18:00	139	10/2/2010 18:00	277	17,100	
10/3/2010 9:10	220	10/3/2010 9:10	319		DTW = 74.39'
10/3/2010 9:20	95	10/3/2010 9:20	207		
10/3/2010 9:30	61	10/3/2010 9:30	157		
10/3/2010 9:40	44	10/3/2010 9:40	118		
10/3/2010 9:50	35	10/3/2010 9:50	90		
10/3/2010 10:00	30	10/3/2010 10:00	81		
10/3/2010 10:10	31	10/3/2010 10:10	63		
10/3/2010 10:20	28	10/3/2010 10:20	53		
10/3/2010 10:30	30	10/3/2010 10:30	49		
10/3/2010 10:40	29	10/3/2010 10:40	47		
10/3/2010 10:50	30	10/3/2010 10:50	46		
10/3/2010 11:00	29	10/3/2010 11:00	54		
10/3/2010 11:10	30	10/3/2010 11:10	53		
10/3/2010 11:20	44	10/3/2010 11:20	56		
10/3/2010 11:30	49	10/3/2010 11:30	65		
10/3/2010 11:40	52	10/3/2010 11:40	71		
10/3/2010 11:50	76	10/3/2010 11:50	90		
10/3/2010 12:00	85	10/3/2010 12:00	110		
10/3/2010 12:10	95	10/3/2010 12:10	126		

Date & Time	INFLUENT TURBIDITY (FNU)	Date & Time	EFFLUENT TURBIDITY (FNU)	PUMPED & TREATED VOLUME (gallons)	NOTES
10/3/2010 12:20	105	10/3/2010 12:20	136		
10/3/2010 12:30	113	10/3/2010 12:30	152		
10/3/2010 13:50	130	10/3/2010 13:50	131		
10/3/2010 14:00	110	10/3/2010 14:00	167		
10/3/2010 14:10	97	10/3/2010 14:10	163		
10/3/2010 14:20	111	10/3/2010 14:20	159		
10/3/2010 14:30	122	10/3/2010 14:30	170		
10/3/2010 14:40	144	10/3/2010 14:40	191		
10/3/2010 14:50	136	10/3/2010 14:50	205		
10/3/2010 15:00	130	10/3/2010 15:00	198		
10/3/2010 15:10	137	10/3/2010 15:10	181		
10/3/2010 15:20	137	10/3/2010 15:20	120		
10/3/2010 15:30	133	10/3/2010 15:30	204		
10/3/2010 15:40	134	10/3/2010 15:40	202		
10/3/2010 15:50	141	10/3/2010 15:50	209		
10/3/2010 16:00	148	10/3/2010 16:00	217		
10/3/2010 16:10	172	10/3/2010 16:10	234		
10/3/2010 16:20	209	10/3/2010 16:20	271		
10/3/2010 16:30	246	10/3/2010 16:30	287		
10/3/2010 16:40	278	10/3/2010 16:40	305		
10/3/2010 16:50	236	10/3/2010 16:50	363	63,200	DTW = 79.3'
10/3/2010 17:00	224	10/4/2010 12:50	466		DTW = 82.59'
10/4/2010 12:50	126	10/4/2010 13:00	222		
10/4/2010 13:00	86	10/4/2010 13:10	188		
10/4/2010 13:10	64	10/4/2010 13:20	130		
10/4/2010 13:20	51	10/4/2010 13:30	101		
10/4/2010 13:30	40	10/4/2010 13:40	88		
10/4/2010 13:40	34	10/4/2010 13:50	70		
10/4/2010 13:50	35	10/4/2010 14:00	63		
10/4/2010 14:00	30	10/4/2010 14:10	80		
10/4/2010 14:10	35	10/4/2010 14:20	58		
10/4/2010 14:20	33	10/4/2010 14:30	51		
10/4/2010 14:30	34	10/4/2010 14:40	53		
10/4/2010 14:40	39	10/4/2010 14:50	61		
10/4/2010 14:50	47	10/4/2010 15:00	71		
10/4/2010 15:00	46	10/4/2010 15:10	72		
10/4/2010 15:10	51	10/4/2010 15:20	79		
10/4/2010 15:20	63	10/4/2010 15:30	97		
10/4/2010 15:30	78	10/4/2010 15:40	111		
10/4/2010 15:40	81	10/4/2010 15:50	124		
10/4/2010 15:50	79	10/4/2010 16:00	128		
10/4/2010 16:00	77	10/4/2010 16:10	133		
10/4/2010 16:10	88	10/4/2010 16:20	134		
10/4/2010 16:20	83	10/4/2010 16:30	115		
10/4/2010 16:30	78	10/4/2010 16:40	125		
10/4/2010 16:40	75	10/4/2010 16:50	126		
10/4/2010 16:50	75	10/4/2010 16:50	19		
10/4/2010 16:50	9	10/4/2010 17:00	171		
10/4/2010 17:00	191	10/4/2010 18:20	85		
10/4/2010 18:30	95	10/4/2010 18:30	188		
10/4/2010 18:40	51	10/4/2010 18:40	134		
10/4/2010 18:50	36	10/4/2010 18:50	97		
10/4/2010 19:00	25	10/4/2010 19:00	83		
10/4/2010 19:10	25	10/4/2010 19:10	73		
10/4/2010 19:20	24	10/4/2010 19:20	55		
10/4/2010 19:30	23	10/4/2010 19:30	44		
10/4/2010 19:40	21	10/4/2010 19:40	37		
10/4/2010 19:50	23	10/4/2010 19:50	30		
10/4/2010 20:00	22	10/4/2010 20:00	18		
10/4/2010 20:10	23	10/4/2010 20:10	71		
10/4/2010 20:20	16	10/4/2010 20:20	50		
10/4/2010 20:30	9	10/4/2010 20:30	41		
10/4/2010 20:40	10	10/4/2010 20:40	34		

Date & Time	INFLUENT TURBIDITY (FNU)	Date & Time	EFFLUENT TURBIDITY (FNU)	PUMPED & TREATED VOLUME (gallons)	NOTES
10/4/2010 20:50	13	10/4/2010 20:50	25		
10/4/2010 21:00	10	10/4/2010 21:00	20		
10/4/2010 21:10	9	10/4/2010 21:10	17		
10/4/2010 21:20	8	10/4/2010 21:20	15		
10/4/2010 21:30	7	10/4/2010 21:30	14		
10/4/2010 21:40	8	10/4/2010 21:40	13		
10/4/2010 21:50	8	10/4/2010 21:50	14		
10/4/2010 22:00	5	10/4/2010 22:00	14		
10/4/2010 22:10	6	10/4/2010 22:10	13	71,400	Out of filters
10/5/2010 19:10	16	10/5/2010 19:10	18		DTW = 89.1'
10/5/2010 19:20	11	10/5/2010 19:20	18		
10/5/2010 19:30	9	10/5/2010 19:30	17		
10/5/2010 20:30	7	10/5/2010 20:30	17		
10/5/2010 20:40	12	10/5/2010 20:40	16		
10/5/2010 22:10	8	10/5/2010 22:10	9		
10/5/2010 22:20	12	10/5/2010 22:20	17		
10/5/2010 22:30	9	10/5/2010 22:30	17		
10/5/2010 22:40	5	10/5/2010 22:40	16		
10/5/2010 22:50	9	10/5/2010 22:50	14		
10/5/2010 23:00	7	10/5/2010 23:00	14		
10/5/2010 23:10	6	10/5/2010 23:10	13	92,700	Changed filters 4x
10/6/2010 14:10	12	10/6/2010 14:10	17		
10/6/2010 14:20	8	10/6/2010 14:20	17		
10/6/2010 14:30	6	10/6/2010 14:30	15		
10/6/2010 14:40	3	10/6/2010 14:40	14		
10/6/2010 14:50	5	10/6/2010 14:50	12		DTW = 99.1'
10/6/2010 15:00	4	10/6/2010 15:00	11		
10/6/2010 21:20	16	10/6/2010 21:20	12		
10/6/2010 21:30	33	10/6/2010 21:30	34		
10/6/2010 21:40	31	10/6/2010 21:40	50		
10/6/2010 21:50	25	10/6/2010 21:50	57		
10/6/2010 22:00	19	10/6/2010 22:00	55		
10/6/2010 22:10	16	10/6/2010 22:10	50		
10/6/2010 22:20	13	10/6/2010 22:20	45		
10/6/2010 22:30	11	10/6/2010 22:30	40		
10/6/2010 22:40	12	10/6/2010 22:40	38		
10/6/2010 22:50	14	10/6/2010 22:50	38		
10/6/2010 23:00	20	10/6/2010 23:00	49		
10/6/2010 23:10	28	10/6/2010 23:10	70		
10/6/2010 23:20	34	10/6/2010 23:20	93		
10/6/2010 23:30	37	10/6/2010 23:30	110		
10/6/2010 23:40	36	10/6/2010 23:40	98		DTW = 102.81'
10/6/2010 23:50	40	10/6/2010 23:50	103	130,200	Changed filters 3x, lowered pump
10/7/2010 0:00	39				
10/7/2010 0:10	43	10/7/2010 0:10	153		DTW = 97.94'
10/7/2010 0:20	43	10/7/2010 0:20	169		
10/7/2010 13:10	11	10/7/2010 13:10	6		
10/7/2010 13:20	34	10/7/2010 13:20	149		
10/7/2010 13:30	19	10/7/2010 13:30	117		
10/7/2010 13:40	13	10/7/2010 13:40	84		
10/7/2010 13:50	9	10/7/2010 13:50	62		
10/7/2010 14:00	7	10/7/2010 14:00	47		
10/7/2010 14:10	7	10/7/2010 14:10	39		
10/7/2010 14:20	9	10/7/2010 14:20	38		
10/7/2010 14:30	13	10/7/2010 14:30	45		
10/7/2010 14:40	17	10/7/2010 14:40	59		
10/7/2010 14:50	20	10/7/2010 14:50	76		
10/7/2010 17:10	20	10/7/2010 17:10	68	156,200	DTW = 106.2'
10/7/2010 17:20	15	10/7/2010 17:20	83		
10/7/2010 17:30	12	10/7/2010 17:30	81		
10/7/2010 17:40	11	10/7/2010 17:40	75		
10/7/2010 17:50	10	10/7/2010 17:50	73		
10/7/2010 18:00	11	10/7/2010 18:00	69		

Date & Time	INFLUENT TURBIDITY (FNU)	Date & Time	EFFLUENT TURBIDITY (FNU)	PUMPED & TREATED VOLUME (gallons)	NOTES
10/7/2010 18:10	12	10/7/2010 18:10	69		
10/7/2010 18:20	12	10/7/2010 18:20	70		
10/7/2010 18:30	14	10/7/2010 18:30	74		
10/7/2010 18:40	14	10/7/2010 18:40	82		
10/7/2010 18:50	14	10/7/2010 18:50	88		
10/7/2010 19:00	13	10/7/2010 19:00	93		
10/7/2010 19:10	15	10/7/2010 19:10	96		
10/7/2010 19:20	14	10/7/2010 19:20	98		
10/7/2010 19:30	13	10/7/2010 19:30	98		
10/7/2010 19:40	12	10/7/2010 19:40	98		
10/7/2010 19:50	12	10/7/2010 19:50	97		
10/7/2010 20:00	11	10/7/2010 20:00	97		
10/7/2010 20:10	12	10/7/2010 20:10	97		
10/7/2010 20:20	11	10/7/2010 20:20	97		
10/7/2010 20:30	10	10/7/2010 20:30	93		
10/7/2010 20:40	9	10/7/2010 20:40	89		
10/7/2010 20:50	8	10/7/2010 20:50	83		
10/7/2010 21:00	7	10/7/2010 21:00	79		
10/7/2010 21:10	8	10/7/2010 21:10	76		
10/7/2010 21:20	7	10/7/2010 21:20	73		
10/7/2010 21:30	7	10/7/2010 21:30	71		
10/7/2010 21:40	7	10/7/2010 21:40	72		
10/7/2010 21:50	7	10/7/2010 21:50	76		
10/7/2010 22:00	10	10/7/2010 22:00	93		
10/7/2010 22:10	21	10/7/2010 22:10	130		
10/7/2010 22:20	32	10/7/2010 22:20	200	156,200	
10/8/2010 15:50	44	10/8/2010 15:50	294		DTW = 103.21'
10/8/2010 16:00	27	10/8/2010 16:00	236		
10/8/2010 16:10	19	10/8/2010 16:10	174		
10/8/2010 16:20	11	10/8/2010 16:20	130		
10/8/2010 16:30	8	10/8/2010 16:30	99		
10/8/2010 16:40	6	10/8/2010 16:40	70		
10/8/2010 16:50	5	10/8/2010 16:50	52		
10/8/2010 17:00	4	10/8/2010 17:00	42		
10/8/2010 17:10	16	10/8/2010 17:10	44		
10/8/2010 17:20	56	10/8/2010 17:20	111		
10/8/2010 17:30	32	10/8/2010 17:30	57		
10/8/2010 17:40	49	10/8/2010 17:40	141		
10/8/2010 17:50	82	10/8/2010 17:50	208		
10/8/2010 18:00	100	10/8/2010 18:00	254		
10/8/2010 18:10	124	10/8/2010 18:10	123		
10/8/2010 18:20	123	10/8/2010 18:20	99		
10/8/2010 18:30	121	10/8/2010 18:30	101		
10/8/2010 18:40	97	10/8/2010 18:40	353		
10/8/2010 18:50	176	10/8/2010 18:50	489		
10/8/2010 19:00	172	10/8/2010 19:00	159		
10/8/2010 19:10	194	10/8/2010 19:10	137		
10/8/2010 19:20	183	10/8/2010 19:20	129		
10/8/2010 19:30	138	10/8/2010 19:30	110		
10/8/2010 19:40	219	10/8/2010 19:40	561		
10/8/2010 19:50	306	10/8/2010 19:50	1,032		
10/8/2010 20:00	391	10/8/2010 20:00	974		
10/8/2010 20:10	244	10/8/2010 20:10	263		
10/8/2010 20:20	474	10/8/2010 20:20	1,843		Start of muck through system as
10/8/2010 20:30	483	10/8/2010 20:30	1,211		starting to dewater the 114' level.
10/8/2010 20:40	141	10/8/2010 20:40	330		
10/8/2010 20:50	475	10/8/2010 20:50	3,918		
10/8/2010 21:00	321	10/8/2010 21:00	3,918		
10/8/2010 21:10	240	10/8/2010 21:10	2,884		
10/8/2010 21:20	288	10/8/2010 21:20	3,304	156,200	
10/9/2010 15:50	1,304	10/9/2010 15:50	3,918		Larger pump delivered & installed
10/9/2010 16:00	875	10/9/2010 16:00	3,918		DTW = 99.8'
10/9/2010 16:10	519	10/9/2010 16:10	3,918		

Date & Time	INFLUENT TURBIDITY (FNU)	Date & Time	EFFLUENT TURBIDITY (FNU)	PUMPED & TREATED VOLUME (gallons)	NOTES
10/9/2010 16:20	283	10/9/2010 16:20	3,918		
10/9/2010 16:30	177	10/9/2010 16:30	2,320		
10/9/2010 16:40	208	10/9/2010 16:40	1,533		
10/9/2010 16:50	243	10/9/2010 16:50	1,302		
10/9/2010 17:00	237	10/9/2010 17:00	1,202		
10/9/2010 17:10	287	10/9/2010 17:10	1,146		
10/9/2010 17:20	287	10/9/2010 17:20	313		
10/9/2010 17:30	326	10/9/2010 17:30	1,251		
10/9/2010 17:40	256	10/9/2010 17:40	1,001		
10/9/2010 17:50	291	10/9/2010 17:50	1,054		
10/9/2010 18:00	276	10/9/2010 18:00	474		
10/9/2010 18:10	331	10/9/2010 18:10	266		
10/9/2010 18:20	432	10/9/2010 18:20	1,455		
10/9/2010 18:30	380	10/9/2010 18:30	1,361		
10/9/2010 18:40	309	10/9/2010 18:40	1,499		
10/9/2010 18:50	301	10/9/2010 18:50	341		
10/9/2010 19:00	268	10/9/2010 19:00	1,152		
10/9/2010 19:10	191	10/9/2010 19:10	1,100		
10/9/2010 19:20	150	10/9/2010 19:20	959		
10/9/2010 19:30	136	10/9/2010 19:30	850		
10/9/2010 19:40	143	10/9/2010 19:40	315		
10/9/2010 19:50	141	10/9/2010 19:50	193		
10/9/2010 20:00	152	10/9/2010 20:00	785		
10/9/2010 20:10	179	10/9/2010 20:10	826		
10/9/2010 20:20	281	10/9/2010 20:20	1,315		
10/9/2010 20:30	299	10/9/2010 20:30	2,256		
10/9/2010 20:40	287	10/9/2010 20:40	2,734		
10/9/2010 20:50	287	10/9/2010 20:50	3,918		
10/9/2010 21:00	278	10/9/2010 21:00	2,224		
10/9/2010 22:20	260	10/9/2010 22:20	3,918	156,200	
10/10/2010 19:40	331	10/10/2010 19:40	1,425		
10/10/2010 19:50	142	10/10/2010 19:50	841		
10/10/2010 20:00	66	10/10/2010 20:00	502		
10/10/2010 20:10	34	10/10/2010 20:10	329		
10/10/2010 20:20	20	10/10/2010 20:20	213		
10/10/2010 20:30	13	10/10/2010 20:30	140		
10/10/2010 20:40	10	10/10/2010 20:40	101		
10/10/2010 20:50	8	10/10/2010 20:50	82		
10/10/2010 21:00	6	10/10/2010 21:00	74		
10/10/2010 21:10	7	10/10/2010 21:10	62		
10/10/2010 21:20	8	10/10/2010 21:20	58		
10/10/2010 21:30	9	10/10/2010 21:30	58	156,200	
10/11/2010 13:50	14	10/11/2010 13:50	36		Trouble lowering aluminum pipe
10/11/2010 14:00	13	10/11/2010 14:00	183		in shaft as shaft is angled
10/11/2010 14:10	8	10/11/2010 14:10	121		DTW = 96'
10/11/2010 14:20	5	10/11/2010 14:20	82		
10/11/2010 14:30	4	10/11/2010 14:30	59		
10/11/2010 14:40	3	10/11/2010 14:40	44		
10/11/2010 14:50	3	10/11/2010 14:50	35		
10/11/2010 15:00	4	10/11/2010 15:00	30		
10/11/2010 15:10	5	10/11/2010 15:10	34		
10/11/2010 17:50	6	10/11/2010 17:50	6		
10/11/2010 18:00	18	10/11/2010 18:00	209		
10/11/2010 18:10	14	10/11/2010 18:10	141		
10/11/2010 18:20	11	10/11/2010 18:20	122		
10/11/2010 18:30	18	10/11/2010 18:30	127		
10/11/2010 18:40	23	10/11/2010 18:40	167		
10/11/2010 18:50	25	10/11/2010 18:50	221		
10/11/2010 19:00	24	10/11/2010 19:00	91		
10/11/2010 19:10	28	10/11/2010 19:10	73		
10/11/2010 19:20	47	10/11/2010 19:20	267		
10/11/2010 19:30	42	10/11/2010 19:30	361		
10/11/2010 19:40	38	10/11/2010 19:40	414		

Date & Time	INFLUENT TURBIDITY (FNU)	Date & Time	EFFLUENT TURBIDITY (FNU)	PUMPED & TREATED VOLUME (gallons)	NOTES
10/11/2010 19:50	35	10/11/2010 19:50	173		
10/11/2010 20:00	35	10/11/2010 20:00	124		
10/11/2010 20:10	31	10/11/2010 20:10	383		
10/11/2010 20:20	26	10/11/2010 20:20	378		
10/11/2010 20:30	25	10/11/2010 20:30	155		
10/11/2010 20:40	25	10/11/2010 20:40	118		
10/11/2010 20:50	23	10/11/2010 20:50	352		
10/11/2010 21:00	18	10/11/2010 21:00	324		
10/11/2010 21:10	22	10/11/2010 21:10	309		
10/11/2010 21:20	28	10/11/2010 21:20	344		
10/11/2010 21:30	26	10/11/2010 21:30	134		
10/11/2010 21:40	26	10/11/2010 21:40	91		
10/11/2010 21:50	24	10/11/2010 21:50	130		
10/11/2010 22:00	28	10/11/2010 22:00	383		
10/11/2010 22:10	26	10/11/2010 22:10	396		
10/11/2010 22:20	28	10/11/2010 22:20	422		
10/11/2010 22:30	18	10/11/2010 22:30	134		
10/11/2010 22:40	24	10/11/2010 22:40	626		
10/11/2010 22:50	18	10/11/2010 22:50	493		
10/11/2010 23:00	20	10/11/2010 23:00	431	156,200	
10/12/2010 14:00	15	10/12/2010 14:00	116	156,200	DTW = 94.35'
10/12/2010 14:10	14	10/12/2010 14:10	313		
10/12/2010 14:20	6	10/12/2010 14:20	221		
10/12/2010 14:30	3	10/12/2010 14:30	142		
10/12/2010 14:40	2	10/12/2010 14:40	93		
10/12/2010 14:50	1	10/12/2010 14:50	61		
10/12/2010 15:00	1	10/12/2010 15:00	42		
10/12/2010 15:10	1	10/12/2010 15:10	32		
10/12/2010 15:20	0	10/12/2010 15:20	27		
10/12/2010 15:30	0	10/12/2010 15:30	25		
10/12/2010 15:40	0	10/12/2010 15:40	26		
10/12/2010 15:50	0	10/12/2010 15:50	28		DTW = 96.71'
10/12/2010 16:00	1	10/12/2010 16:00	37	173,800	Need to lower pump
10/13/2010 13:30	6	10/13/2010 13:30	43		
10/13/2010 13:40	3	10/13/2010 13:40	99		
10/13/2010 13:50	2	10/13/2010 13:50	60		
10/13/2010 14:00	1	10/13/2010 14:00	38		
10/13/2010 14:10	1	10/13/2010 14:10	50		
10/13/2010 14:20	0	10/13/2010 14:20	28		
10/13/2010 14:30	0	10/13/2010 14:30	20		
10/13/2010 14:40	0	10/13/2010 14:40	16		
10/13/2010 14:50	0	10/13/2010 14:50	15		
10/13/2010 15:00	0	10/13/2010 15:00	15		
10/13/2010 15:10	0	10/13/2010 15:10	15	187,100	DTW = 102.5'
		10/14/2010 13:50	2		DTW = 102.2'
10/14/2010 14:00	2	10/14/2010 14:00	29		
10/14/2010 14:10	2	10/14/2010 14:10	30		
10/14/2010 14:20	1	10/14/2010 14:20	25		
10/14/2010 14:30	1	10/14/2010 14:30	24		
10/14/2010 14:40	1	10/14/2010 14:40	20		
10/14/2010 14:50	1	10/14/2010 14:50	20		
10/14/2010 15:00	1	10/14/2010 15:00	19		
10/14/2010 15:10	1	10/14/2010 15:10	19		
10/14/2010 15:20	1	10/14/2010 15:20	22		
10/14/2010 15:30	1	10/14/2010 15:30	23		
10/14/2010 15:40	1	10/14/2010 15:40	25		
10/14/2010 14:00	5	10/14/2010 14:00	4		
10/14/2010 14:10	5	10/14/2010 14:10	3		
10/14/2010 14:20	5	10/14/2010 14:20	3		
10/14/2010 14:30	5	10/14/2010 14:30	3		
10/14/2010 14:40	5	10/14/2010 14:40	3		
10/14/2010 14:50	5	10/14/2010 14:50	3		
10/14/2010 15:00	5	10/14/2010 15:00	3		

Date & Time	INFLUENT TURBIDITY (FNU)	Date & Time	EFFLUENT TURBIDITY (FNU)	PUMPED & TREATED VOLUME (gallons)	NOTES
10/14/2010 15:10	5	10/14/2010 15:10	3		
10/14/2010 15:20	5	10/14/2010 15:20	3		
10/14/2010 15:30	5	10/14/2010 15:30	3		
10/14/2010 15:40	5	10/14/2010 15:40	3		
10/14/2010 15:50	5	10/14/2010 15:50	3		
10/14/2010 16:00	5	10/14/2010 16:00	3		
10/14/2010 16:10	5	10/14/2010 16:10	3		
10/14/2010 16:20	5	10/14/2010 16:20	3		
10/14/2010 16:30	5	10/14/2010 16:30	3		
10/14/2010 16:40	5	10/14/2010 16:40	3		
10/14/2010 16:50	5	10/14/2010 16:50	3		
10/14/2010 17:00	5	10/14/2010 17:00	3		
10/14/2010 17:10	5	10/14/2010 17:10	3		
10/14/2010 17:20	5	10/14/2010 17:20	3		
10/14/2010 17:30	5	10/14/2010 17:30	3		
10/14/2010 17:40	5	10/14/2010 17:40	3		
10/14/2010 17:50	5	10/14/2010 17:50	3		
10/14/2010 18:00	5	10/14/2010 18:00	3		
10/14/2010 18:10	5	10/14/2010 18:10	3		
10/14/2010 18:20	5	10/14/2010 18:20	3		
10/14/2010 18:30	5	10/14/2010 18:30	3		
10/14/2010 18:40	5	10/14/2010 18:40	3		
10/14/2010 18:00	2	10/14/2010 18:00	1		
10/14/2010 18:10	3	10/14/2010 18:10	1		
10/14/2010 18:20	3	10/14/2010 18:20	1		
10/14/2010 18:30	4	10/14/2010 18:30	1		
10/14/2010 18:40	4	10/14/2010 18:40	1		
10/14/2010 18:50	4	10/14/2010 18:50	1		
10/14/2010 19:00	4	10/14/2010 19:00	1		Filter change
10/14/2010 19:10	5	10/14/2010 19:10	1		
10/14/2010 19:20	5	10/14/2010 19:20	1		
10/14/2010 19:30	5	10/14/2010 19:30	1		
10/14/2010 19:40	5	10/14/2010 19:40	2		
10/14/2010 19:50	5	10/14/2010 19:50	2		
10/14/2010 20:00	5	10/14/2010 20:00	2		
10/14/2010 20:10	5	10/14/2010 20:10	2		
10/14/2010 20:20	5	10/14/2010 20:20	2		
10/14/2010 20:30	5	10/14/2010 20:30	2	214,000	

Appendix J

Surface Water Standards Adjusted For Hardness

Appendix F - Hardness-dependant Surface Water Standards

Sample ID	Hardness (mg/L)[a]	Cadmium		Copper		Lead		Zinc	
		Acute Standard (mg/L)	Chronic Standard (mg/L)	Acute Standard (mg/L)	Chronic Standard (mg/L)	Acute Standard (mg/L)	Chronic Standard (mg/L)	Acute Standard (mg/L)	Chronic Standard (mg/L)
LOB-SH01-A-20101013	25.00	0.0005	0.0001	0.0038	0.0029	0.0140	0.0005	0.0370	0.0370
LOB-SH01-A-20101016	25.00	0.0005	0.0001	0.0038	0.0029	0.0140	0.0005	0.0370	0.0370
LOB-SH01-A-20101018	25.00	0.0005	0.0001	0.0038	0.0029	0.0140	0.0005	0.0370	0.0370
LOB-SH01-A-20101019	25.00	0.0005	0.0001	0.0038	0.0029	0.0140	0.0005	0.0370	0.0370
LOB-SH01-A-20101020	25.00	0.0005	0.0001	0.0038	0.0029	0.0140	0.0005	0.0370	0.0370
LOB-SH01-A-20101021	25.00	0.0005	0.0001	0.0038	0.0029	0.0140	0.0005	0.0370	0.0370
LOB-SH01-A-20101022	157	0.0034	0.0004	0.0214	0.0137	0.1450	0.0056	0.1756	0.1756
LOB-SH01-A-20101026	25.00	0.0005	0.0001	0.0038	0.0029	0.0140	0.0005	0.0370	0.0370
LOB-SP01-A-20101018	25.00	0.0005	0.0001	0.0038	0.0029	0.0140	0.0005	0.0370	0.0370
LOB-SP02-A-20101021	25.00	0.0005	0.0001	0.0038	0.0029	0.0140	0.0005	0.0370	0.0370
LOB-SP03-A-20101018	25.00	0.0005	0.0001	0.0038	0.0029	0.0140	0.0005	0.0370	0.0370
LOB-SP04-A-20101021	25.00	0.0005	0.0001	0.0038	0.0029	0.0140	0.0005	0.0370	0.0370
LOB-SP05-A-20101021	25.00	0.0005	0.0001	0.0038	0.0029	0.0140	0.0005	0.0370	0.0370
LOB-SP06-A-20101021	25.00	0.0005	0.0001	0.0038	0.0029	0.0140	0.0005	0.0370	0.0370
LOB-SW01-A-20100929	16.9	0.0004	0.0001	0.0026	0.0020	0.0085	0.0003	0.0266	0.0266
LOB-SW01-A-20101206	17.8	0.0004	0.0001	0.0028	0.0021	0.0091	0.0004	0.0278	0.0278
LOB-SW03-A-20100929	22.9	0.0005	0.0001	0.0035	0.0026	0.0125	0.0005	0.0344	0.0344
LOB-SW03-A-20101013	21.9	0.0005	0.0001	0.0033	0.0025	0.0118	0.0005	0.0331	0.0331
LOB-SW03-A-20101015	33.5	0.0007	0.0001	0.0050	0.0037	0.0203	0.0008	0.0474	0.0474
LOB-SW03-A-20101017	23.4	0.0005	0.0001	0.0036	0.0027	0.0129	0.0005	0.0350	0.0350
LOB-SW03-A-20101018	26.1	0.0005	0.0001	0.0039	0.0030	0.0148	0.0006	0.0384	0.0384
LOB-SW03-A-20101019	35.5	0.0007	0.0001	0.0053	0.0039	0.0218	0.0009	0.0498	0.0498
LOB-SW03-A-20101020	31.3	0.0007	0.0001	0.0047	0.0035	0.0186	0.0007	0.0448	0.0448
LOB-SW03-A-20101021	35.8	0.0008	0.0001	0.0053	0.0039	0.0221	0.0009	0.0502	0.0502
LOB-SW03-A-20101022	28.9	0.0006	0.0001	0.0043	0.0032	0.0168	0.0007	0.0419	0.0419
LOB-SW03-A-20101206	18.1	0.0004	0.0001	0.0028	0.0022	0.0093	0.0004	0.0282	0.0282
LOB-SW05-A-20100929	16.4	0.0003	0.0001	0.0025	0.0020	0.0082	0.0003	0.0259	0.0259
LOB-SW05-A-20101007	17.6	0.0004	0.0001	0.0027	0.0021	0.0089	0.0003	0.0275	0.0275
LOB-SW05-A-20101206	17.8	0.0004	0.0001	0.0028	0.0021	0.0091	0.0004	0.0278	0.0278
LOB-SW06-A-20100929	20.5	0.0004	0.0001	0.0031	0.0024	0.0109	0.0004	0.0313	0.0313
LOB-SW06-A-20101206	31.9	0.0007	0.0001	0.0048	0.0035	0.0191	0.0007	0.0455	0.0455
LOB-SW07-A-20101001	24.1	0.0005	0.0001	0.0037	0.0028	0.0133	0.0005	0.0359	0.0359
LOB-SW07-A-20101007	28.6	0.0006	0.0001	0.0043	0.0032	0.0166	0.0006	0.0415	0.0415
LOB-SW07-A-20101013	24.9	0.0005	0.0001	0.0038	0.0028	0.0139	0.0005	0.0369	0.0369
LOB-SW07-A-20101015	34.7	0.0007	0.0001	0.0052	0.0038	0.0212	0.0008	0.0489	0.0489
LOB-SW07-A-20101017	30.5	0.0006	0.0001	0.0046	0.0034	0.0180	0.0007	0.0438	0.0438
LOB-SW07-A-20101018	31.6	0.0007	0.0001	0.0047	0.0035	0.0188	0.0007	0.0451	0.0451
LOB-SW07-A-20101019	37.6	0.0008	0.0001	0.0056	0.0040	0.0235	0.0009	0.0523	0.0523
LOB-SW07-A-20101020	38.6	0.0008	0.0001	0.0057	0.0041	0.0243	0.0009	0.0535	0.0535
LOB-SW07-A-20101021	33	0.0007	0.0001	0.0049	0.0036	0.0199	0.0008	0.0468	0.0468
LOB-SW07-A-20101022	34.1	0.0007	0.0001	0.0051	0.0037	0.0208	0.0008	0.0482	0.0482

Appendix K

2009 RI Data

CONCENTRATION OF METALS FROM 2009 RECLAIMATION INVESTIGATION
LILLY/ORPHAN BOY MINE SITE

Sample	Description		Arsenic (µg/L)		Cadmium (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Manganese (µg/L)	Nickel (µg/L)	Zinc (µg/L)
LOB-SW-01	T.C. Upgradient		<5		<1	<10	370	<10	180	<10	30
LOB-SW-02	Adit Discharge/Flow		874		163	40	29,600	70	5,640	30	17,700
LOB-SW-03	T.C. Downgradient		14		3	<10	610	<10	740	<10	610
LOB-SW-04	N side WR pile 3		854		67	100	8,280	50	5,250	20	9,310

Sample	Description	Antimony (mg/kg)	Arsenic (mg/kg)	Barium (mg/kg)	Cadmium (mg/kg)	Copper (mg/kg)	Iron (mg/kg)	Lead (mg/kg)	Manganese (mg/kg)	Nickel (mg/kg)	Zinc (mg/kg)
LOB-SD-01	T.C. Upgradient	5UJ	327	80	1	9	24,600	34	1,670		362
LOB-SD-02	Adit Sediment	11	19,300	6	4	27	113,000	298	29		140
LOB-SD-03	T.C. Downgradient	<5	294	48	21	52	11,300	50	5,930		823
LOB-SD-04	N side WR pile 3	31	24,400	<5	13	42	106,000	562	55		554
LOB-SD-05	Pond Sediment	<5	160	47	6	14	12,300	13	768		967
LOB-SS-01	Soil, S WR pile 1	5UJ	140	68	<1	29	11,900	117	579	<5	123
LOB-SS-02	Waste, WR pile 1	177	6,420	70	6	116	33,300	7,840	764	43	322
LOB-SS-03	Waste, WR pile 1	972	36,600	17	15	267	66,900	43,800	13	302	1,250
LOB-SS-04	Soil, SW WR pile 1	14	444	44	3	45	14,200	501	838	<5	241
LOB-SS-05	Soil, E WR pile 2	21	1,370	78	3	60	15,800	1,190	234	<5	143
LOB-SS-06	Soil, NE WR pile 1	5UJ	188	46	2	29	11,800	244	389	<5	186
LOB-SS-07	Soil, NW WR pile 1	21	11,600	36	3	48	28,600	2,300	164	8	218
LOB-SS-08	Soil, N WR pile 2	5UJ	793	31	3	61	15,200	608	202	<5	254
LOB-SS-09	Waste, WR pile 2	95	8,180	31	4	91	19,300	19,900	9	97	220
LOB-SS-10	Soil, S WR pile 2	23	734	40	<1	75	12,400	909	247	<5	137
LOB-SS-10 (Duplicate)	Soil, S WR pile 3	13	833	35	2	63	12,300	902	137	<5	130
LOB-SS-11	Soil, W WR pile 2	19	6,640	33	1	58	2,700	622	624	<5	172
LOB-SS-12	Waste, WR pile 3	30	5,060	43	4	107	34,900	6,040	22	6	386
LOB-SS-13	Waste, WR pile 3	456	74,100	7	35	94	171,000	7,440	<5	66	453
LOB-SS-14	Soil, S WR pile 3	31	5,120	81	7	103	24,100	1,610	277	7	757
LOB-SS-15	Soil, E WR pile 3	15	31,200	54	3	38	185,000	1,320	44	<5	129
LOB-SS-16	Soil, Road by T.C.	12	725	34	<1	28	9,910	534	197	<5	142
LOB-SS-17	Soil, Road by T.C.	<5	641	24	1	78	16,800	834	130	<5	326