phelps dodge Tyrone, Inc. P. O. Drawer 571, Tyrone, New Mexico 88065 • (505) 538-5331

October 29, 2004

FedEx Tracking #840946637234 & 840946637267
Return Receipt Requested

Ms. Mary Ann Menetrey
Program Manager
New Mexico Environment Department
Mining Environmental Compliance Section
P. O. Box 26110
Santa Fe, New Mexico 87502

Mr. Holland Shepherd
Program Manager
Mining Act Reclamation Program
1220 South St. Francis Drive
Santa Fe, New Mexico 87505

Dear Ms. Menetrey and Mr. Shepherd:

Re: **Supplemental Characterization Study of the Leached Ore Stockpiles and Waste Rock Stockpiles Interim Report for NMED DP-1341, Condition 80, and MMD Permit Revision 01-1 to Permit GR010RE.**

As per the commitment made in the October 3, 2003 submittal to the New Mexico Environment Department (NMED) of the Supplemental Characterization study of the Leached Ore Stockpiles and Waste Rock Stockpiles Work Plan and in compliance with the Mining and Minerals Division (MMD) Permit Revision 01-1 to Permit GR010RE Condition 9.L.6, Phelps Dodge Tyrone, Inc. (Tyrone), hereby submits the Interim Report for the Supplemental Characterization study of the Leached Ore Stockpiles and Waste Rock Stockpiles.

Tyrone is aware that the NMED has not approved the original Work Plan. However, in order to comply with the schedule presented in the Work Plan, Tyrone has committed to meeting the various deadlines outlined in the Work Plan (Figure 2, Study Implementation and Reporting Schedule).

If you have any questions regarding this issue, please contact Mr. Chuck Thompson at (505) 538-7181.

Very truly yours,

C C Thompson for

Thomas L. Shelley, Manager
Strategic Environmental Projects
New Mexico Operations

TLS:ct
Attachment(s)
~~20041028-100~~ 20041029-101

xc: Mike Jaworski, MMD
Keith Ehlert, NMED

SUPPLEMENTAL MATERIALS CHARACTERIZATION STUDY OF THE LEACHED ORE STOCKPILES AND WASTE ROCK STOCKPILES - INTERIM REPORT FOR DP-1341, CONDITION 80

TYRONE MINE

Prepared for:

Phelps Dodge Tyrone Inc.
Tyrone, New Mexico

Prepared by:

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5231 South Quebec Street
Greenwood Village, Colorado 80111

October 29, 2004

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APPENDICES

1.0 INTRODUCTION

The New Mexico Environment Department (NMED) issued a Supplemental Discharge Permit for Closure DP-1341, hereafter referred to as DP-1341 (April 8, 2003) to Phelps Dodge Tyrone Inc. (PDTI) for the Tyrone Mine (Tyrone) (Figure 1). Section III of the permit requires PDTI to conduct scientific studies of the Tyrone Mine (Tyrone) and mine closure and closeout actions as a condition for acquiring the permit. A work plan describing PDTI's proposed supplemental study, fulfilling the requirements of Condition 80 of the permit was submitted to the NMED on October 3, 2003. Condition 80 of the DP-1341 permit is restated below:

> 80. Tyrone shall perform a supplemental materials characterization study of the Leach Ore Stockpiles and Waste Rock Piles located at the Tyrone Mine Facility. In accordance with the schedule approved under Condition 74, Tyrone shall submit to NMED for approval a work plan, including an implementation schedule for the supplemental materials characterization study of the Leach Ore Stockpiles and Waste Rock Piles located at the Tyrone Mine Facility. The study shall include instrumentation of the Leach Ore Stockpiles and Waste Rock Piles, which may be accomplished by using representative stockpiles, and shall be designed to consider the data needs for the studies described in Conditions 50, 78, 81, 82, and 83. The evaluation shall include, but not be limited to, the collection of an adequate number of samples to establish the geotechnical and geochemical characteristics of each individual Leach Ore Stockpile or Waste Rock Pile as necessary to refine closure designs.

The work plan described the stockpile characterization study that PDTI will conduct to fulfill these requirements and other related conditions in Permit DP-1341. This interim report is submitted according to the work plan schedule (Figure 2), and describes the work conducted to date. This report also provides updated plans for ongoing investigations. The objectives scope and purpose of this study are presented in sections 1.1, 1.2 and 1.3 below, respectively.

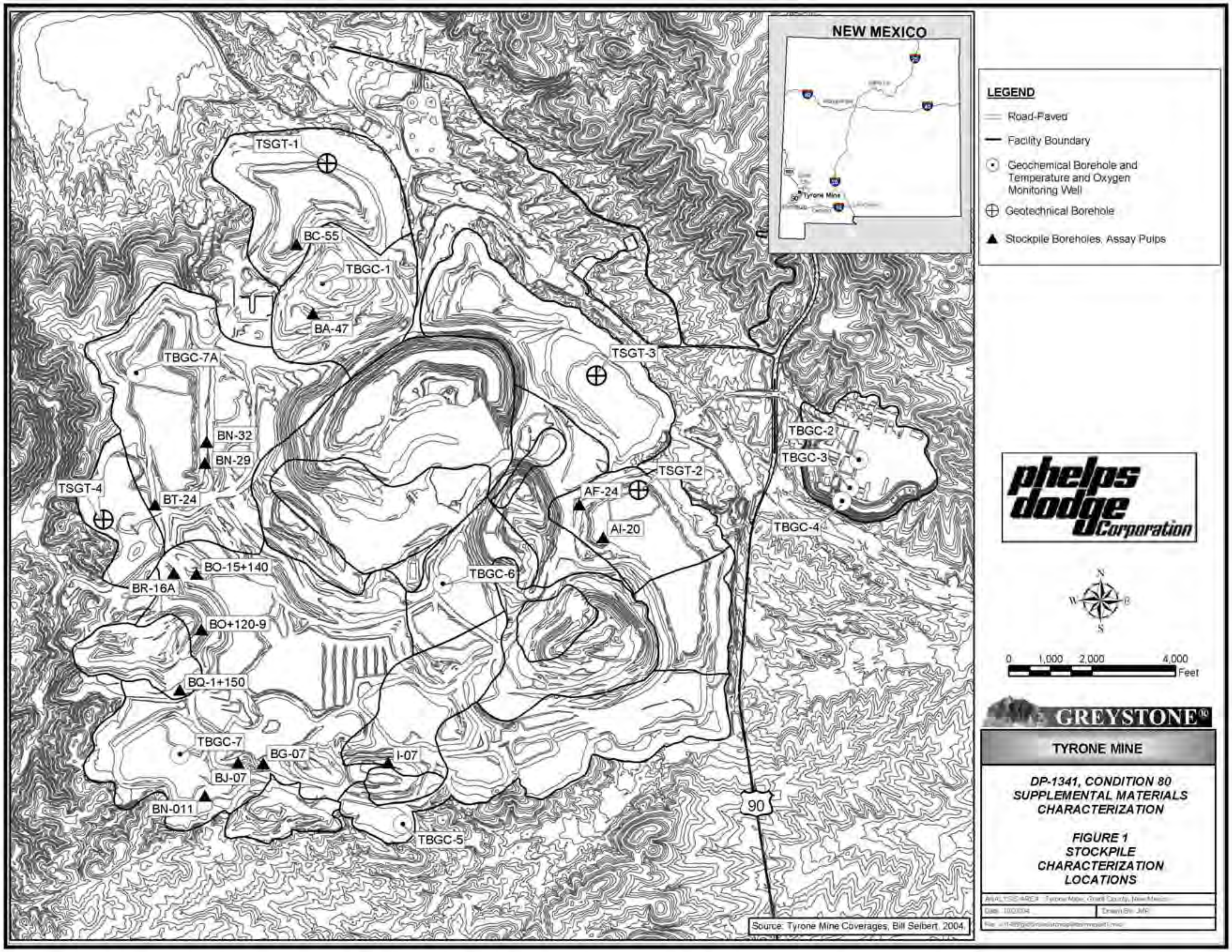
1.1 OBJECTIVES

There are two primary objectives of this study. They are:

- Characterize the internal composition and geochemistry of the leach ore stockpiles and waste rock stockpiles by collecting an adequate number of samples.

- Collect other physical and chemical data to support conditions 50, 78, 81, 82, and 83 of DP-1341.

Supplemental materials characterization is being conducted on stockpile samples collected by PDTI through stockpile drilling open cut, and surface sampling, in order to determine the potential for acidity and constituents of concern (COCs) to be leached from the mine materials contained within the stockpiles at Tyrone. In addition, Condition 50 of DP-1341requires PDTI to monitor temperature and oxygen concentrations in pore gases within the stockpiles. Therefore, monitoring wells are being drilled in leached ore and waste rock stockpiles in order to perform the monitoring required by the permit.

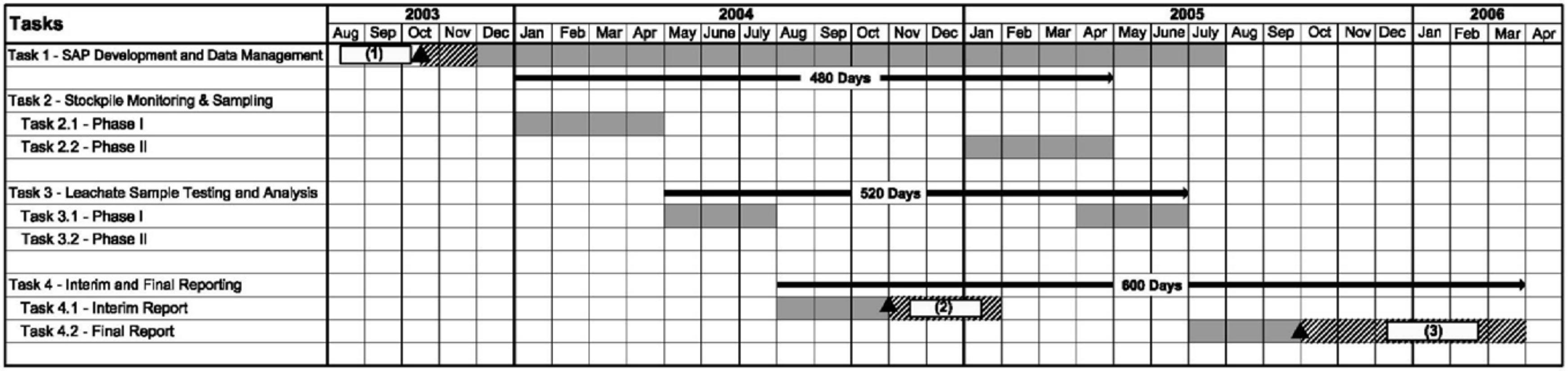


TYRONE MINE

DP-1341, CONDITION 80
SUPPLEMENTAL MATERIALS
CHARACTERIZATION

FIGURE 1
STOCKPILE
CHARACTERIZATION
LOCATIONS

Source: Tyrone Mine Coverages, Bill Seibert, 2004.



LABELS:

(1) Workplan Submittal
(2) Interim Report Review and Address Comments
(3) Report Review and Address Comments

LEGEND

▩ Scheduled Task
▨ Submit and Review
▲ Report Due

PHELPS DODGE, TYRONE MINE

FIGURE 2
Study Schedule

Study:
DP - 1341, Condition 80, Supplemental Materials Characterization

File:
<Project Root>\SuppMatlCharTyrone_InterimRpt04\1341Cond80Schedule.pdf

Date: 10/19/2004	Layout: Greystone	Drawn By: JC

GREYSTONE®

Work plans have been submitted for other related studies required by other conditions in Supplemental Discharge Permit DP-1341. Physical conditions within the interiors of the stockpiles are also being evaluated as part of the Supplemental Stability Study in accordance with Condition 78 of the permit. Golder Associates Inc. developed the work plan for the stability study (Golder 2003). The data generated from these studies will be used in evaluations of stockpile seepage quantity and quality, and groundwater impacts from stockpile seepage according to work plans submitted for Conditions 81 (Greystone 2004) and Condition 82 (DBS&A 2003), respectively. The work plan for the Pit Lake Formation study (Condition 83) will also consider the contributions from stockpile seepage sources.

The stockpile characterization data collected as part of this study and seepage modeling conducted according to Condition 81 will also be used to refine the mass loading estimates presented in the Outslope Evaluation report (DBS&A 2001) for alternative stockpile reclamation designs. The post-closure alternatives will be identified in the feasibility study that will be conducted as part of permit Condition 89, including the closure and closeout alternative specified in DP-1341.

1.2 SCOPE

The scope of this study includes:

- Document review and database compilation
- Stockpile material characterization
- Stockpile monitoring
- Evaluation of stockpile composition, material distribution and reactivity

This interim report primarily provides the methods used for stockpile drilling, sampling, and monitoring. All existing waste rock and leach stockpiles at Tyrone will be evaluated. The stockpiles to be evaluated for closure and closeout planning are defined in the Tyrone Closure/Closeout Plan (M3 Engineering and Technology Corp. [M3] 2001) as follows:

- No. 1 Stockpile
- No. 1A, No. 1B, No. 1C, and No. 1D Stockpiles
- No. 3 Stockpile
- No. 2, No. 2A, and No. 2B Stockpiles

The existing boundaries of these facilities are shown in Figure 1. These stockpiles are located within the Tyrone Mine Stockpile Unit (M3, 2001 and contain the majority of stockpiled mine materials that will remain at the Tyrone Mine after closure.

In addition to the existing configurations of the stockpiles, selected reclamation alternatives will be evaluated in this study. These alternatives will be selected based on discussions between PDTI and NMED, and on the preliminary findings of the feasibility study (DP-1341, Condition 89).

1.3 PURPOSE

The purpose of this interim report is to:

- Present the refined objectives and scope for this study (Sections 1.1 and 1.2)
- Update the stockpile material sampling and analysis methods
- Report the current status of Phase I stockpile materials sampling, analysis, and testing

- Present plans for the Phase II materials characterization, and evaluation

The Supplemental Materials Characterization Study Work Plan (Greystone 2003) presented PDTI's preliminary objectives, scope, sampling and analysis methods, and implementation schedule developed to meet the requirements of Condition 80 (NMED 2003). At the time of this submittal, the Phase I boreholes have been completed and monitor wells have been installed. The borehole samples are currently being tested and analyzed. Therefore, PDTI anticipates that all Phase I work will be completed by the end of 2004. Phase II work will begin, and be refined if necessary, based on comments and guidance provided by the NMED on the Condition 80 study implementation and work progress provided in this report.

1.4 ORGANIZATION OF REPORT

Applicable background information on the existing stockpile characteristics and materials characterization studies at Tyrone and related guidance are presented in Section 2. Section 3 provides the methods for drilling and sampling of the stockpile materials, and details on the proposed characterization methods. This section also describes the development of a stockpile materials database and a geographic information system (GIS) to portray the composition and distribution of the mined materials. Section 4 describes the preliminary stockpile materials characterization results and stockpile cross sections. PDTI's plans for additional stockpile materials characterization and data evaluation is described in Section 5. Section 6 contains a bibliography of existing stockpile studies for Tyrone and other relevant documents cited in this document.

2.0 BACKGROUND

The Tyrone Mine is an open pit copper mine located along State Highway 90, approximately 10 miles southwest of Silver City in Grant County, New Mexico. The general layout of the existing stockpile facilities at the Tyrone Mine is shown in Figure 1, with respect to permit and Closure/Closeout Mine Unit boundaries (M3, 2001).

The following sections describe stockpile facility construction, operation, and closure methods employed at the Tyrone Mine (Section 2.1), and relevant studies previously conducted at the mine (Section 2.2).

2.1 STOCKPILE CONSTRUCTION AND OPERATION

Modern open pit copper mining involves the excavation of large volumes of overburden, waste rock, and ore, and these operations have been conducted at the Tyrone Mine since May of 1967 (M3 2001). Excavation and hauling are the most costly activities associated with developing hard rock metal reserves (Hartman 1987). Economic and engineering constraints require the efficient removal and stockpiling of the minimum volume of overburden and waste rock required to safely reach the underlying ore. The location of stockpiles is determined based on extensive planning to minimize both the horizontal and vertical haulage distances, to ensure that adequate space is available for leaching operations, and to allow access to future reserves. As shown on Figure 1, the permit area for Tyrone consists of several stockpiles located near and within the Main and Gettysburg pit areas. The leach ore stockpiles are used to extract copper from low-grade ore, and the waste rock and overburden stockpiles are used to dispose of excavated materials that have little or no contained copper value.

The character and designation of the materials contained within the stockpiles is an important determinant of their distribution and configuration. The geology of the Tyrone copper deposit and surrounding area was summarized in the Closure/Closeout Plan (CCP) from the original work conducted by DuHamel et al. (1993), Kolessar (1982), Trauger (1972) and Paige (1922), and from geologic maps that were prepared by Hedlund (1978) and PDTI's Geology Department. Data from these sources, as well as information obtained from PDTI's continued exploration activities, were used to develop a geologic map of the pre-mining surface and mine permit area (DBS&A 1999a).

The Tyrone ore and overburden materials have been thoroughly characterized for standard acid-base accounting (ABA) (Sobek et al. 1978), synthetic precipitation leachate procedure (SPLP), whole rock constituent concentrations, soil pH, mineralogy, and kinetic testing of sulfide oxidation using humidity cells (DBS&A 1997a and 1997b; SARB 1999) according to procedures recommended by the NMED (1996). The results of these geochemical analyses were used to further categorize the stockpile materials into two broad groups, A and B, through statistical analysis of variability (DBS&A 1997a and 1997b). Group A consists primarily of sulfide-bearing mineral assemblages (MA-3, -4, and -5) having significant acid-generation potential, with an average ABA of -43.3 equivalent tons of calcium carbonate (CaCO3) per kiloton of rock (t/kt). Group B comprises leached cap and oxide mineral assemblages (MA-0, -1, -2, and -8) that are approximately neutral, with an average ABA of 6.7 t/kt. These statistical groupings will not be used further in this supplemental materials characterization study because analysis of variability based on variables of a constant sum, such as whole rock compositions acid generating potential (AGP), acid neutralizing potential (ANP) and ABA, is not valid because of the well-known effect of induced correlations (Chayes and Kruskal 1966; Koch and Link 1971; Aitchison 1986; and Rollinson 1993).

This study will use the material assemblage classifications shown below, which were established by the geologists at the Tyrone Mine when the SMC was conducted. The mineral assemblage classification system used at Tyrone is summarized below:

MA-0	Gila Conglomerate
MA-1	Leached capping
MA-2	Oxide copper
MA-3	Mixed oxide and chalcocite
MA-4	Chalcocite and pyrite
MA-5	Mixed chalcocite and chalcopyrite
MA-6	Chalcopyrite and pyrite
MA-7	Mixed oxide and chalcopyrite
MA-8	Native copper and cuprite

In addition, the PDTI Geology Department has developed the following two new material types since the SMC based on continued exploration and ore processing studies:

MA-21	Black copper oxide
MA-51	Mixed chalcopyrite with chalcocite and covellite

This system is based on the mineralogical characteristics of primary and secondary porphyry copper ore deposit formation and associated host rock alteration. A general summary of the geology and alteration of porphyry copper ore deposits is provided in Titley (1983).

The primary waste and overburden stockpiles at the Tyrone Mine are the Nos. 1C, 1D, 3B, and portions of the Nos. 2, 2A, and 2B Stockpiles. These stockpiles are generally located near or within the perimeter of the pit (Figure 1). Individual lifts that compose the waste and overburden stockpiles at Tyrone were constructed during active periods of open pit mining (DBS&A 1997a and 1997b) so as to minimize haul distances and to reduce the land area occupied by the stockpiles. They are characterized by steep, planar slopes that are generally at or near the angle of repose for the run-of-mine rock. Current construction of stockpile outslopes follows the requirements of DP-1341.

The waste rock stockpiles contain a significant proportion of materials designated as leached capping (MA-1) and other materials types, which have a wide range of ABA characteristics. Individual lifts of these materials have been exposed to weathering for variable periods of time since the inception of open pit development in 1967. The Preliminary Materials Characterization (PMC) (DBS&A 1997a) and Supplemental Materials Characterization (SMC) (DBS&A 1997b) provide estimates of the locations and depositional ages of these materials based on available mine records for Tyrone.

The primary leach stockpiles at the Tyrone Mine that were not located in active pits are the Nos. 1, 1A, 1B, 3, and portions of the Nos. 2 and 2A stockpiles. These stockpiles are generally located outside of the current and projected future areas for the pit, waste rock, and overburden stockpiles, but as close to the pit area as possible (Figure 1). The stockpiles tend to have broad, flat tops and steep slopes to maximize the available leaching area and copper extraction efficiency. The leach stockpiles consist of leachable ore materials, primarily from material types MA-3, -4, and -5, and these materials generally have a relatively uniform and negative ABA (DBS&A 1997a and 1997b; SARB 1999). The location, configuration, and composition of the leach stockpiles are designed to maximize the collection of pregnant leach solution (PLS).

Individual lifts of stockpiled materials have been exposed to leach solutions and weathering for variable periods of time since the inception of limited leaching operations on the No. 1 Stockpile in 1972. More extensive leaching operations were conducted upon commissioning of the solution extraction/electrowinning (SX/EW) plant in 1984 (DBS&A 1999a,b). The concentrator closed in 1992, after which copper was produced solely through leaching and solution processing. Prior to 1992, most of the highest-grade copper ore was sent to the milling and concentrating circuits for copper recovery and the fine-grained residues were then deposited in the tailing ponds. The PMC and SMC provide estimates of the repositories and depositional ages of ore and spent ore materials based on available mine records for the Tyrone Mine.

Throughout the history of the Tyrone Mine, PDTI mine planners have used best available mining technologies and practices to develop and implement stockpile facility designs that conform to the site-specific economic and permitting constraints. Data on ore reserves, grades, and locations are used to develop production plans that ensure continuous feed (rate, grade, and mineralogy) to the leaching circuits. These data are also used to estimate stockpile capacities and to determine whether additional stockpile facilities are required. Historically, the stockpiles at Tyrone are constructed by end-dumping the materials excavated from the pits in 30- to 50-foot lifts that have nearly level top surfaces. This technique is commonly used in the open pit copper mining industry (Bartlett 1992). This construction method results in stockpile slope gradients that are at an approximate angle of repose between lift levels and on the stockpile outslopes. Current and future stockpile construction practices will adhere to the requirements of DP-1341 through integration with mine planning activities.

2.2 PREVIOUS STUDIES AND GUIDANCE

This section summarizes the materials characterization studies that have been conducted at Tyrone, and the regulatory guidance information that has been referred to in planning this supplemental materials characterization study.

2.2.1 Previous Materials Characterization Studies

The current mine setting and other background information regarding closure/closeout of the Tyrone Mine is provided in the CCP (M3 2001). To support the CCP, baseline and closure design-related studies were conducted to ensure that groundwater, surface water, and air quality standards are met after mining ceases. In addition, effective reclamation and use of disturbed land must be conducted in accordance with the requirements of the New Mexico Mining Act (NMMA) and Rules 69-36-1 to 69-36-20 (NMSA 1978). The intent of the baseline supporting studies needed to fulfill these requirements was described in the CCP (M3 2001). The supporting studies that will be relied upon in this study, and the types of data and information provided in these studies, are listed in Table 1.

This study will supplement information from the PMC and SMC (DBS&A 1997a,b), Geochemical Evaluation (SARB, 1999) and other references in these documents. These studies compiled materials characterization on core and stockpile surface samples, developed compositional models of the stockpiles. These studies showed that the primary sulfide-bearing materials in the Tyrone stockpiles are mineral assemblages MA-3, MA-4, and MA-5. The sulfide ore is hosted primarily by Tertiary quartz monzonite porphyry and Precambrian granite. Sulfide minerals are also present in other mineral assemblage types such as MA6 and MA7, but these materials occur in lesser quantities. The leached capping (MA-1) and oxide copper (MA-2) material types can also contain small amounts of remnant sulfides encapsulated in the rock matrix, but most sulfides have been oxidized by weathering of the ore deposit.

TABLE 1 SUMMARY OF RELEVANT STUDIES AND DATA USAGE

Report	Reference	Status (a)	Data Categories									
			Site Background	Hydrogeology	Hydraulic Parameters	Extent of Stockpiles	Stockpile Compositions	Geochemical Parameters	Physical Parameters	Predictive Modeling (Hydrology/ Geochemistry)	Existing Impacts	Containment Measures
Closure/Closeout Plan	M3 2001	√	X	X		X				X	X	X
Geochemical Evaluation of Tailings and Stockpiles	SARB, 1999	√				X	X	X		X		
Preliminary Materials Characterization	DBS&A, 1997a	√				X	X	X				
Supplemental Materials Characterization Study	DBS&A, 1997b	√				X	X	X				
Cover Design Study Status Report	DBS&A 1999b	√			X			X		X		
Summary of Long-term Stability Analyses for Stockpiles and Tailing Ponds at the Tyrone Mine	Golder 2001	√	X			X	X		X			

(a) √ = Complete; — = In progress; --- = Ongoing monitoring effort

CCP = Closure/Closeout plan
DBS&A = Daniel B. Stephens & Associates, Inc.
Golder = Golder & Associates, Inc
M3 = M3 Engineering & Technology Corp.

2.2.2 Mine Materials Characterization Guidance Documents

The technical guidance used to develop this supplemental materials characterization study includes the following documents:

- Plumlee and Logsdon (1999) The Environmental Geochemistry of Mineral Deposits
- NMED Ground Water Pollution Prevention Section, Discharge plan closure guidance for mining sites (Draft) (NMED 1996)
- Environmental Protection Agency, Technical document - acid mine drainage prediction (EPA 1994)
- Mine Environment Neutral Drainage Project (MEND) Acid mine drainage prediction manual. (MEND 1991)

and references therein.

According to the EPA's technical document on Acid Mine Drainage Prediction (EPA 1994), sample collection for prediction tests for both old and new mines should consider both geologic and environmental factors. Sample selection based on geologic factors requires a good understanding of the local geology, which has been developed at Tyrone over the past 3 decades of open pit mining and geologic resource evaluation efforts. The geologic database has been developed based on exploration core logs and assays, stockpile borehole logs, pit wall sampling, and mine operation records. This information has been synthesized and interpreted by the mine's geologists, and they have provided guidance on sample selection and characterization in the PMC, SMC, and Geochemical Evaluation (SARB 1999) studies. PDTI's geologists are also providing detailed guidance on sample selection and characterization for this supplemental materials characterization study. Environmental factors include consideration of the potential environmental constituents of concern in the rock and climatic variables.

The EPA (1994) states that there are many opinions concerning the number of samples that need to be collected in order to adequately characterize mine stockpiles. For fixed-frequency sampling, the recommendations range from one sample per million tons to 50 samples per million tons. However, there are reservations to prescribing a fixed number of samples for collection per volume (mass) of material and fixed-frequency sampling does not encourage the use of best judgment on the part of the sample collector, and does not necessarily incorporate the objectives of the sampling. It also does not provide the statistical basis to account for variability among the samples. The determination of how many samples should be taken at any one time depends on the variability of the site's geology and how the mine will be developed. At least eight to 12 samples should be collected from the mine for each major rock type, and it is also prudent to sample waste or material throughout the life of the mine as it develops (EPA 1994). It is also recommended that the samples are collected from different localities within the mined area and areas to be mined (MEND 1991).

The NMED's guidance document for mining sites (NMED 1996) recommends both static (i.e. ABA) and kinetic testing (humidity cells) on representative mine material samples. In addition, solid phase characterization can be used to extrapolate the rates of acid production and consumption beyond the timeframe of kinetic tests (EPA 1994).

3.0 METHODS

This section describes the methods that are being used to assemble the new and existing stockpile materials information into a relational database (Section 3.1), create a GIS for the Tyrone Mine Stockpile Unit (Section 3.2), characterize samples collected from the interior regions of the stockpile through borehole drilling and open cut sampling (Section 3.3), and to monitor temperature and oxygen in the stockpiles (Section 3.4).

3.1 MINE MATERIALS DATABASE

Existing Tyrone mine stockpile information reported in the documents listed in Table 1 are being compiled into an Access 2003 database. The analytical data was compiled from four main sources: 1) PMC 2) SMC; 3) Geochemical Evaluation (SARB, 1999); and 4) PDTI's Geology department

Table 2 below describes the number, sample type, type of testing, and lab name for analytical data from each of the described sources.

In addition, supplemental stockpile material sample data generated as part of this study and are being added to the database. The database currently includes supplemental data derived from analysis and testing of selected archived stockpile borehole samples provided by PDTI's geology department (see Appendix A). The method of selection and characterization of these samples is described in Section 3.3.1 below. The comprehensive assembly of data on rock core and stockpile materials of various compositions and depositional ages into one relational database will facilitate data evaluation, including a comparison of pre- and post-leaching and weathering chemistry and physical properties.

3.2 MINE STOCKPILE UNIT GIS

A GIS has been created for the Mine Stockpile Unit of the Tyrone mine in order to compile geographic data on the extent and volume of mined materials throughout the history of open pit mining at Tyrone. In addition, the GIS will incorporate the composition of the stockpile material sequences as presented in the PMC and SMC reports. The composition model was composed from mine plan maps and production records for waste rock and leach ore to reconstruct the materials deposited in each stockpile. The compositional model represents the amount and spatial distribution of material types within each stockpile.

Greystone assembled topographic data from three primary sources:

1) contour lines in AutoCAD files provided by PDTI Engineering representing stockpile surfaces from 1995 through the first quarter of 2004;
2) maps digitized and layered sequentially; and
3) historic stockpile lift polygons from the PMC and SMC reports, with polygons refined and elevations attributed from the stockpile development maps.

Table 3 describes the source and extent of topographic data assembled by Greystone.

TABLE 2 SOURCES AND TYPES OF MATERIALS CHARACTERIZATION DATA

Source	Type of Sample	No. Samples	Type of Testing	Lab
DBS&A - Preliminary Materials Characterization, 1997	archived drill cores & assay pulp, MA 0-6 & 8	88	Acid-base accounting (ABA)	SVL Analytical Labs (SVL)
		88	Whole Rock Analysis	SVL
		22	synthetic precipitation leachate procedure (SPLP)	SVL
		12	Petrography (thin sections)	New Mexico Institute of Mining and Technology (NMIMT)
		15	Mineralogy (X-ray diffraction [XRD])	New Mexico Bureau of Mines and Mineral Resources (NMBMMR)
DBS&A - Supplemental Materials Characterization, 1997	archived assay pulp, MA 1&2	36	ABA	SVL
		36	Whole Rock Analysis	SVL
		3	SPLP	SVL
		3	Mineralogy (XRD)	NMBMMR
	1997 stockpile surface samples	50	ABA	SVL
		50	Whole Rock Analysis	SVL
		18	SPLP	SVL
		25	Mineralogy (XRD)	NMBMMR
	archived unweathered drill core samples, MA 1-6	10	ABA	SVL
			Whole Rock Analysis	SVL
			Mineralogy (XRD)	NMBMMR
			Petrography (thin sections)	NMIMT
			Kinetic testing (humidity cell testing [HCT])	Daniel B. Stephens and Associates (DBS&A)
SARB Geochemical Evaluation of Tailings and Stockpiles - 1999	rock chips and powdered samples from 1C and Main Pit Stockpile	115	Whole Rock Analysis	Activation Laboratories Ltd. (ACTLABS)
		41	ABA	SVL
		13 (Main Pit)	Mineralogy (polished thin sections)	New Mexico School of Mines (NMSM)
		21 (1C)		U of Geneva
	rock chips from 2A Stockpile	10	ABA	SVL
			Mineralogy (XRD, polished thin sections)	U of Geneva
Phelps Dodge Geology Dept.	archived stockpile borehole samples	15 at different depths = 179	ABA, Whole Rock Analysis (in progress), Mineralogy (XRD) (in progress)	SVL

TABLE 3 MINE STOCKPILE UNIT TOPOGRAPHIC DATA SOURCES

Topography	Spatial Extent	Origin
Pre-Mine	Tyrone Mine full extent	1966 topography provided by PDTI Engineering (D. Benavidez, June 16, 2004).
Underdump	Tyrone Mine full extent	Bedrock topography beneath stockpiles as tracked by PDTI Engineering and updated to reflect changes resulting from (D. Benavidez, Mar 8, 2004).
1973, 1975, 1976, 1978, 1982, 1986, 1987, 1989, 1990, 1992	Main Pit Upper Main Pit Stockpile Valencia Pit East Main Stockpile and Pit Gettysburg In-Pit Stockpile and Pit Gettysburg Out-Pit Stockpile Copper Mountain Pit San Salvador Hill Pit South Rim Pit, Savanna Stockpile No 2 Leach Stockpile	PDTI "Pit maps", reflecting mine-wide changes in pits and stockpiles, developed quarterly by PDTI since 1973. Hard-copies of pit maps were provided by DBS&A (Earley, 2004) for the time periods shown in this table. Changes to pits and stockpiles were digitized from these maps by Greystone and DDS, Inc, and attributed with elevation values. Plateaus were attributed at their recorded elevation value. Toe, crest, and contour lines were digitized and attributed elevation values at 50-foot increments. The Pre-Mine topography was used as the foundation, and changes within individual time periods were layered on top sequentially to create topography for each time period.
1973, 1975, 1976, 1978, 1982, 1986, 1987, 1989, 1990, 1992	No 2B Stockpile, No 2A Leach Stockpile, No 3 Leach Stockpile No 3B Stockpile No 1A Leach Stockpile No 1B Leach Stockpile No 1C Stockpile No 1D Waste Stockpile No 1 Leach Stockpile	The PDTI Pit maps referenced above were used in combination with vector features in AutoCAD files from the PMC, Appendix E (DBS&A 1997a). The polygons in the AutoCAD files, which represent changes in topography, were further refined by Greystone (subdivided into more polygons). These refined polygons were attributed elevation values based on PMC Appendix E maps and the more detailed PDTI Pit maps.
1995 – 2004	Tyrone Mine full extent	PDTI Engineering topographic data in AutoCAD files (D. Benavidez, May 3, 2004). The mine has been surveyed by PDTI Engineering at least once each year starting in 1995. Aerial surveys were conducted from 2000 to 2004.

The topographic data for each time period consisted of stockpile toe, crest, and contour lines and, for the time periods indicated, polygons attributed with elevation values. The elevation values of these vector features were interpolated across the surface of the mine by developing a triangulated irregular network (TIN) of contour line and polygon vertices. These TINS were converted to raster grids with uniform cell spacing of 25 feet by 25 feet to perform topographic and volumetric analyses.

Cross-section lines are being created for all stockpiles and pits along a grid spaced 500 feet (north-south) by 500 feet (east-west). For each cross-section line, a profile graph containing surface elevation data for each time period, or paleosurfaces (i.e. buried stockpile lift surfaces), was generated. Elevation data points were taken from each time period's topographic raster grid data at 25-foot horizontal increments.

Example cross-sections for the 3A and 3B stockpiles are presented in Appendix B. For each cross-section, paleosurfaces are displayed as follows:

- Under-dump surface is displayed for all cross-sections.
- 2004 surface is displayed for all cross-sections.
- Pre-mine surface is displayed if it differs from the under-dump.
- For 1973 through 2002, all paleosurfaces are shown that differ from the prior time period (2002 must also differ from 2004 to be shown).

For a given paleosurface to be defined as different from another paleosurface, 10 percent of the data points along the horizontal axis must differ by 10 feet or more. This approach reduces the visual clutter in the profile graphs by removing insignificant “background noise” elevation changes in the paleosurfaces attributed to TIN interpolations.

3.3 SUPPLEMENTAL STOCKPILE MATERIALS CHARACTERIZATION

This section briefly describes the methods that PDTI is using to characterize the stockpile materials. Section 3.3.1 discusses the selection of existing stockpile borehole samples from the Tyrone archive for supplemental analysis. Section 3.3.2 describes recently completed Phase I (Figure 2) stockpile drilling, borehole sample collection and borehole logging tasks. In addition, stockpile surfaces and open bulldozer cuts into stockpile slopes have also been sampled. Section 3.3.3 presents the methods used from laboratory analysis and testing of stockpile samples. A detailed description of the Tyrone stockpile sampling and analysis plan is provided in Appendix C.

3.3.1 Analysis of Archived Stockpile Material Assay Pulp Samples

Since the development of the open pit and stockpiles at the Tyrone Mine, continued exploration for copper ore has necessitated the drilling of new exploration boreholes into and through leach ore and waste rock stockpiles. Samples from more than 670 boreholes through stockpiles have been collected for the purpose of conducting assays for copper resource evaluation (Seibert 2004). The assay pulps were archived after the copper assays were performed in the event that additional analyses were required. Fifteen boreholes were selected at random for supplemental materials characterization. Details of the selection method are provided in the Stockpile Sampling and Analysis Plan (Appendix C).

The 10-foot interval assay pulp samples collected from the stockpile boreholes shown in Figure 1 were reanalyzed for the following:

- Modified ABA,
- paste pH,
- paste electrical conductivity (E.C.),
- Whole rock composition by XRF, and
- XRD Mineralogy on selected samples

These analytical procedures are described briefly in section 3.3.3 below and in detail in the stockpile sampling and analysis plan provided in Appendix C.

3.3.2 Stockpile Drilling and Sampling and Borehole Logging

In addition to materials characterization of archived stockpile borehole samples as described in section 3.3.1, stockpile drilling and sampling has been conducted on leach ore and waste rock stockpiles to collect supplemental samples for materials characterization. The drilling was also conducted to install monitor wells as described in Section 3.4 below. The locations of eight newly completed borehole locations for geochemical testing and monitoring are shown on Figure 1. These boreholes were completed using a percussion hammer drilling technique. In addition, four boreholes were completed using sonic drilling methods for the collection of geotechnical samples, and some geochemical testing will be conducted on selected samples as part of that study, as shown on Figure 1. The sampling and analysis plan in Appendix C describes the borehole drilling and sampling methods in detail.

In addition to stockpile borehole samples, grab samples were collected from the surface of the No. 1 Stockpile, and along the bench faces of open bulldozer cuts into the No. 1C and No. 1A Stockpiles where the stratigraphy has been recently exposed by regarding activity.

During borehole and open cut sampling, and attempt was made to collect samples from representative material types, although their identification may be complicated by the development of weathering and leaching products. A qualified geologist logged each sample and described the sample's texture, lithology, mineralization, color, and degree of alteration.

Geochemical and geophysical logging was conducted in two geotechnical boreholes and in one geochemical borehole by Schlumberger wire-line logging and testing. The down-hole logging tools used include the following:

Elemental Capture Spectroscopy Sonde (ECS)

Down-hole neutron activation technique for Si, Ca, Fe, S, Ti, Gd, and Al, Cu (0.14 wt%) and Ni (0.04 wt%) for determination of:

- Mineralogy/lithology
- Specific gravity

Litho Density Tool (LDT)

Gamma-Gamma technique for measurement of electron density and transformation to bulk density, which can also be converted to porosity using grain and fluid density.

- Bulk density
- Porosity

Compensated Neutron Tool (CNT)

Epithermal neutron-neutron for moisture in vadose zone or porosity in saturated media that measures H2O and OH content for determination of:

- Formation moisture or porosity
- Lithology
- Clay content and stratigraphic correlation

Natural Gamma Ray Spectrometry Tool (NGT)

Gamma ray activity from K, U, and Th for:

- Mineralogy determination
- Shale and clay content
- Igneous rock recognition

Cased Hole Formation Resistivity (CHFR)

Resistivity measurement in steel-cased holes for detection of moisture and salinity

- Moisture content
- Salinity/total dissolved solids (TDS)

Nelson and Johnston describe the ECS (formerly Geochemical Logging Tool), LDT, CNT and NGT applications to down-hole logging of porphyry copper deposits (1994). The CHFR is a relatively new tool for testing resistivity of cased formations (Kelt, 2004), but is based on the same principals as open-hole resistivity logging. The nuclear and electromagnetic logging scans extend through the drill casing from a few inches to approximately 1 foot into the formation and provide a continuous profile of the stockpile's in situ chemical and physical properties.

3.3.3 Stockpile Sample Analysis and Testing

Stockpile borehole and bench samples collected for this supplemental study are being subjected to geochemical analysis and testing in order to determine the potential for COCs to be leached by infiltrating meteoric water and released to groundwater in seepage. Geochemical testing includes:

- Paste pH and E.C.,
- Modified ABA,
- Mineralogical analysis by x-ray diffraction (XRD) and reflectance spectroscopy,
- Petrographic analysis,
- Leach extraction by the Meteoric Water Mobility Procedure (MWMP), and
- Bulk material composition by x-ray fluorescence (XRF).

The EPA (1994) and MEND (1991) mine materials characterization guidance manuals describe the application of these methods for acid rock drainage (ARD) prediction. A detailed description of the analytical and testing procedures used in this study is provided in Appendix C. A summary of these analytical methods and the rationale for their selection are described below.

All stockpile samples are being analyzed for paste pH and electrical conductivity. The AGP and ANP will also be measured on all of the samples using the Modified ABA procedure (Sobek et al. 1978). The ABA is an internationally accepted standard ARD test that indicates the static acid production potential of a mine material sample by determining the sulfide content from a reactive sulfide mineral such as pyrite, and the ANP of alkaline minerals such as calcite.

Stockpile mineralogy and mineral alteration are being analyzed using quantitative XRD, clay fraction XRD and reflectance spectroscopy on selected samples (see Appendix C for details). The quantitative XRD analyses will assess the relative abundance of the major and minor mineralogical components in the stockpile samples that may contribute to quality of the leachate and the overall chemical and physical properties of the mined materials. This analysis provides a frame of reference for evaluating results from acid-base accounting or static leaching. In combination with the bulk chemical characteristics, the mineralogy of the sample will be used to assess stockpile lithology and infer the geochemical reactions occurring within the stockpile.

Reflectance spectroscopy is a way to rapidly characterize and monitor mineralogical properties and changes in mine wastes. Using field spectroscopy, spectra are collected in seconds and large dumps and waste piles mapped quickly and in detail. Spectroscopy detects the alteration and weathering minerals in dumps and waste piles, both those originally in the waste rock and those produced during residence in the piles. The various iron and copper sulfates and oxides found in these environments are highly diagnostic of the pH and fluid flow through the piles. Because many of them are amorphous, the infrared technique is highly successful because it can see these "species," whereas XRD cannot. However, it is more difficult to identify and quantify primary gangue and ore minerals through reflectance spectroscopy. Hence, quantitative XRD and reflectance spectroscopy are complementary tools for materials characterization.

Rock chips and particles from samples are being analyzed through petrographic analysis using light optical microscopy and scanning electron microscopy to determine the textural relationship of reactive minerals to potential leachate flow paths.

Samples are being analyzed using XRF or another bulk composition method to characterize the total chemical composition of a sample. Bulk material analysis measures the total elemental weight percent composition of a sample for the major rock-forming components and elemental concentrations for trace metals. The sample analyses will yield chemical signatures that can be used to confirm the field evaluation of material types in the stockpile and to evaluate the relative and absolute state of weathering and reactivity of the various materials.

Samples are being subjected to a static leach test using MWMP (Nevada Department of Environmental Protection [NDEP] 1990) at a water-to-rock ratio (by weight) of 2 to 1. These tests are designed to assess the mobility of chemical constituents by simulating interaction between natural precipitation and a solid material. The leach extracts and any pore waters collected from the boreholes will be measured for the following parameters or constituents: pH; EC; total dissolved solids (TDS); total alkalinity; HCO3-; CO3-2 acidity; SO4-2; and other COCs specified in Appendix C. In addition, kinetic testing will be conducted on selected samples using a 50-week humidity cell procedure.

3.4 STOCKPILE MONITORING

The internal temperature, oxygen, and moisture gradients in the stockpiles will be monitored using down-hole instrumentation per Condition 50 of the permit. The locations of the completed temperature and oxygen monitoring wells are shown in Figure 1. Temperature probes and oxygen monitoring tubes were installed in these eight wells to measure temperature and concentrations of oxygen in pore gases within the stockpiles at 4 to 6 depth intervals. Details of the well installations and monitoring techniques are provided in Appendix C.

4.0 PRELIMINARY PHASE I RESULTS

This section summarizes the status of the supplemental materials characterization study. It provides the status of the mine materials database construction (Section 4.1), and Mine Stockpile Unit GIS (Section 4.2), preliminary results of supplemental stockpile material characterization (Section 4.3), and the status of stockpile temperature and oxygen monitoring (Section 4.4).

4.1 MINE MATERIALS DATABASE

All of the materials characterization information listed in Table 2 has been entered into the database and reviewed for QA and QC. This includes the 144 rock core samples and 179 stockpile samples that were characterized for the PMC, SMC, and Geochemical Evaluation (SARB 1999) studies. Tyrone Mine material characteristics from approximately 500 samples are currently tracked in the database, including the stockpile borehole assay pulp samples described in Section 3.3.1.. Therefore, approximately 350 samples representing a majority of the stockpiles at the Tyrone Mine have been, or are currently being, analyzed as part of this study, including approximately 150 new samples that have been collected through stockpile drilling and open cut sampling. The forthcoming characterization data will be included in the Tyrone Mine materials database.

Representative samples have been collected from both primary host rock types (Tertiary intrusives and Precambrian granites) and each significant mineral assemblage types to determine the variability of material characteristics in each group. In addition, borehole and open cut samples have been collected from most leached ore and waste rock stockpiles shown in Figure 1, and these samples are distributed within these units. Therefore, these samples represent materials of different depositional histories. For example, samples were collected from the No 1 leach stockpile, which was constructed primarily from sulfide ore material prior to 1980, and from the southwestern portion of the No 1C waste rock stockpile, which was constructed primarily from leach cap material in the 1990s.

4.2 MINE STOCKPILE UNIT GIS

A GIS application has been developed in ArcView 8.3 to facilitate the construction of stockpile cross sections showing the age and thickness of material deposited throughout the history of the open pit development at the Tyrone Mine. An example of the GIS-generated cross sections for the No. 3 Leach and No. 3B Stockpiles is provided in Appendix B of this interim report. The appendix contains the stockpile maps, grids, and cross sections in both electronic HTML and in printed formats. The cross sections were created along a 500-foot grid spacing, which resulted in 16 cross sections for the No. 3 stockpile and 15 cross sections for the No. 3B stockpile. In addition, the cross sections are referenced to pie charts showing the material type compositions of the stockpile time-stratigraphic sequences. The compositions were derived from the estimates provided in the PMC and SMC reports.

The cross sections show that construction of the No.3 Stockpile began in 1983 in order to develop a copper sulfide leach pad for the SX/EW plant. Except for a small amount of Gila Conglomerate and barren leach cap material along the northern slope, the stockpile consists of approximately 80 percent of mineral assemblage 4 with the remainder made up of nearly equal amounts of assemblages 3 and 5. Most of this material has been derived from the Upper Main and Main Pits (DBS&A 1997a,b).

The No. 3B stockpile was constructed in 1973 and has been historically used as a waste stockpile. In the early life of this stockpile, the waste and leach material was not segregated and the material stockpiled was a mixture of all mineral assemblages mined. No. 3B stockpile waste material consists primarily of mineral assemblages 1, smaller amounts of mineral assemblages 0 and 2, and relatively minor amounts of mineral assemblage 6. No. 3B also received small percentages of leach material composed of mineral assemblage 3 and 4 between 1976 and 1978. Detailed mineral assemblage apportionment data are provided as pie charts in Appendix B.

Cross sections for the other stockpiles shown in Figure 1 are being constructed along a 500-foot grid spacing using the Tyrone Mine Stockpile GIS, and these cross sections will be included in the final report.

4.3 SUPPLEMENTAL STOCKPILE MATERIALS CHARACTERIZATION

This section describes the status of the Phase I characterization results, including the analysis and testing of archived stockpile assay pulp samples (Section 4.3.1), stockpile drilling and sampling and borehole logging (Section 4.3.2), stockpile sample testing and analysis (4.3.3), and stockpile temperature and oxygen monitoring (Section 4.4).

4.3.1 Analysis of Archived Stockpile Assay Pulp Samples

The preliminary results from ABA analysis of archived stockpile assay pulp samples are provided in Appendix A. Net neutralizing potentials (NNP) are shown for both pyritic sulfur and total sulfur bases. Because these samples are from stockpiles that have been leached and weathered, some of the sulfide minerals originally deposited on the stockpile have likely weathered and generated acidity and sulfate reaction products. A review of the depth profiles and ABA comparison plots indicates the following trends:

- Paste pH values are greater than 3.5 and less than 7.0 in most stockpile sequences.
- Paste pH values are generally lower for lower NNP values and higher for higher NNP.
- Total sulfate contents in the stockpiles are generally 0.5 weight percent or less.

In addition, plots of AGP versus ANP for both core and stockpile samples in the database show the following trends:

- The ANP for most stockpile samples is at or below the detection limit (0.3 t/kt).
- The range in AGP (both sulfide and total sulfur) and ANP values is smaller for the stockpile samples than for the rock core samples characterized for the PMC and SMC reports.
- The sulfate content for the stockpile samples tends to be higher than that of the core samples for the equivalent AGP values.

These trends are expected because oxidation of sulfides in the mined materials occurs as a result of leaching and weathering. This reaction generates acidity and sulfate reaction products, resulting in greater sulfate concentrations. The acid generation consumes the ANP in the mined materials.

As described in section 5.2 below, a more thorough evaluation of the materials characterization data will be conducted once all the stockpile samples have been characterized. This evaluation will be presented in the final materials characterization report.

4.3.2 Stockpile Drilling, Sampling and Borehole Logging

The eight geochemical characterization holes shown in Figure 1 have been completed, and approximately 150 samples have been shipped to the analytical and testing laboratories. Eight surface samples were collected from open cut benches by Golder and Associates (Wythes 2004) as part of the Supplemental Stability Study (Condition 78), and these samples have also been submitted for comprehensive laboratory analysis and testing. Additionally, 20 samples were collected from the No 1C stockpile benches and 29 samples collected from the No. 1 stockpile surface for reflectance spectroscopy.

Borehole logging using the ECS, CNT, and NGT tools was conducted in the geochemical characterization. Borehole TBGC-6, and ECS, LDT, CNT, NGT, and CHFR logs were collected in the geotechnical characterization holes TSGT-1 and TSGT-3. The LDT and CHFR tools were not run in the TBGC-6 because they do not provide reliable log measurements within the dual tube of the hammer drill casing. The data from the down-hole logging are being interpreted by Schlumberger, and the interpreted results will also be presented in the final report for this study and in the Supplemental Stability Study (Condition 78) report.

4.3.3 Stockpile Sample Analysis and Testing

The final stockpile sample laboratory analyses and testing results will be entered into the Tyrone Stockpile materials database included in the final report for this supplemental materials characterization study.

4.4 STOCKPILE MONITORING

Additional details of the well completions will be provided in an as-built report in late 2004, once baseline monitoring data is available. Oxygen, temperature, and moisture will be measured monthly for 1 year, or as deemed necessary, to provide the baseline data set for this study. After 1 year of monitoring has been completed, measurements will be scheduled according to the requirements in DP-1341, Condition 50 and Condition 58.

5.0 PHASE II MATERIALS CHARACTERIZATION AND EVALUATION PLANS

This section describes PDTI's future plans to continue this supplemental materials characterization through the following work:

- Conduct Phase II materials characterization and compile data with the results of Phase I investigations (Section 5.1).
- Conduct a comprehensive evaluation of the materials characterization data (Section 5.2).
- Report findings in accordance with the supplemental materials characterization schedule (Figure 2) and address NMED's comments on the investigations.

5.1 PHASE II MATERIALS CHARACTERIZATION

PDTI intends to conduct Phase II materials characterization based primarily on the NMED's comments on the results of Phase I investigations reported herein. The results of both the Phase I and Phase II activities will be compiled into the Tyrone Mine Stockpile Access database. In addition, the GIS will be completed for the Mine Stockpile Unit, which and used to generate cross sections at 500-foot grid spacing for all stockpiles in the same manner used to construct the cross sections for the No. 3 and 3B stockpiles (Appendix B). These cross sections will also be linked to information on age of material deposition and gross composition (i.e. percentages of mineral assemblage types) of material sequences mined from the pit and placed on the stockpiles.

5.2 STOCKPILE MATERIAL EVALUATION

The supplemental materials characterization results will be used to finalize the Tyrone Mine Stockpile GIS and render stockpile compositional models in terms of the distribution, age of deposition, lithology, mineralogy, and alteration of the mined materials. The Tyrone stockpile GIS and database build upon the materials characterization and stockpile compositional models presented in the PMC and SMC. The GIS will also be used to facilitate stockpile seepage model construction for Condition 81 of DP-1341.

The materials characterization database will also be used to determine the effects of leaching and weathering on material reactivity within the leach ore and waste rock stockpiles. The mineralogical and chemical composition of the bulk stockpile samples will be compared with those of core samples characterized as part of the PMC and SMC studies. For example, inert chemical markers, such as the bulk zirconium concentration, in the stockpile materials can be used to quantify the reactivity of constituents. Grant (1986) details the theoretical basis of conservative element analysis for quantification of the chemical alteration for rocks. This technique was also applied to the weathering of massive sulfide deposits by Boyle (1994). The method involves normalizing the results for chemical analyses of the leached ore and weathered waste rock samples to chemical analyses of "fresh" stockpile material or core samples in order to discern the effects of acid leaching and long-term weathering on the stockpile's chemical and physical properties.

Chemical and mineralogical characterization of samples from greater depths within the stockpile provides information on the progressive effects of leaching and weathering. Similarly, comparison of physical characteristics such as grain size and clay content of samples collected from the surface and deeper within the stockpiles will yield information on the physical effects of weathering. Methods for the physical analysis and testing have been described in the work plan for the supplemental slope stability study (Condition 78) (Golder 2003).

Data from static and kinetic tests and seepage monitoring were used in the mass loading model for the outslope evaluation (DBS&A 2001). Kinetic tests (i.e., HCT modified after the method of Sobek et al. 1978) were performed on sulfide-bearing, rock core materials that may produce acidic seepage (DBS&A 1997b and SARB 1999). The potential limitations of the kinetic testing data are (1) the test sample represents only one material type and a limited particle size range, (2) the laboratory tests are of relatively short duration, and (3) seepage monitoring data may not represent the post-closure prediction period. In addition, HCTs do not usually account for mixtures of distinct mining wastes in, and the physical configurations of, the stockpiles. Data from MWMP and supplemental HCT tests on the stockpile materials will provide additional information on the reactivity of leached and weathered material composites. As these samples have been leached and weathered for up to 3 decades, the stockpile materials represent mined materials that have been subjected to longer periods of leaching and weathering reaction than tests performed previously on core samples.

The supplemental materials characterization database and the temperature, oxygen concentration monitoring data will also be used to support the Revised Seepage Investigation per condition 81 of DP-1341. The water quantity and quality from toe seepage and samples of pore water from the stockpiles collected during field sampling and monitoring will provide data to calibrate and verify the models developed as part of the Revised Seepage Investigation and the Pit Lake Formation Model (DP-1341, Condition 83).

The results of the materials characterization will also provide information for the test plot study (DP-1341 Condition 82). The stockpile closure alternatives to be modeled will be developed in conjunction with the feasibility study under Condition 89 of the permit. The overall performance objectives and conceptual designs for closure and reclamation of the major facilities at Tyrone will be based on the outcome of the supplemental supporting studies required in Supplemental Permit DP-1341 (NMED 2003), including this study.

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APPENDIX A - ABA ANALYSIS OF ARCHIVED STOCKPILE ASSAY PULP SAMPLES

APPENDIX B - EXAMPLE STOCKPILE CROSS SECTIONS NO. 3A AND 3B STOCKPILES - 500 FT. GRID

APPENDIX C - STOCKPILE SAMPLING AND ANALYSIS PLAN

SVL ANALYTICAL, INC.
One Government Gulch ▪ P.O. Box 929 ▪ Kellogg, Idaho 83827-0929 ▪ Phone: (208)784-1258 ▪ Fax: (208)783-0891

REPORT OF ANALYTICAL RESULTS

CLIENT : PHELPS DODGE - TYRONE
PROJECT: 1490
Sample Receipt: 8/16/04
Report Date: 8/30/04
Page 1 of 2
SVL JOB: 112676

SVL ID	CLIENT SAMPLE ID	COND 120.1	ABP EPA600	AGP EPA600	ANP EPA600	pH Pst ASA M9
S405177	AF-24-0-7	419umhos/cm	-5.63TCaC03/k	5.63TCaC03/k	<0.30TCaC03/k	5.61
S405178	AF-24-37-47	I/Sumhos/cm	-16.9TCaC03/k	16.9TCaC03/k	<0.30TCaC03/k	4.65
S405179	AF-24-47-57	I/Sumhos/cm	-7.81TCaC03/k	7.81TCaC03/k	<0.30TCaC03/k	5.77
S405180	AF-24-57-67	I/Sumhos/cm	-33.8TCaC03/k	33.8TCaC03/k	<0.30TCaC03/k	4.32
S405181	AF-24-67-77	I/Sumhos/cm	-34.4TCaC03/k	34.4TCaC03/k	<0.30TCaC03/k	4.59
S405182	AF-24-77-87	I/Sumhos/cm	-58.1TCaC03/k	58.1TCaC03/k	<0.30TCaC03/k	4.24
S405183	AF-24-97-107	I/Sumhos/cm	-5.94TCaC03/k	5.94TCaC03/k	<0.30TCaC03/k	4.78
S405184	AI-20-0-7	1010umhos/cm	-62.2TCaC03/k	62.2TCaC03/k	<0.30TCaC03/k	4.45
S405185	AI-20-7-17	I/Sumhos/cm	-64.7TCaC03/k	64.7TCaC03/k	<0.30TCaC03/k	4.48
S405186	AI-20-17-27	I/Sumhos/cm	-69.7TCaC03/k	69.7TCaC03/k	<0.30TCaC03/k	4.36
S405187	AI-20-27-37	901umhos/cm	-59.4TCaC03/k	59.4TCaC03/k	<0.30TCaC03/k	4.43
S405188	AI-20-37-47	I/Sumhos/cm	-50.6TCaC03/k	50.6TCaC03/k	<0.30TCaC03/k	4.23
S405189	AI-20-47-57	I/Sumhos/cm	-52.2TCaC03/k	52.2TCaC03/k	<0.30TCaC03/k	4.29
S405190	AI-20-57-67	I/Sumhos/cm	-42.8TCaC03/k	42.8TCaC03/k	<0.30TCaC03/k	4.23
S405191	AI-20-67-77	I/Sumhos/cm	-28.8TCaC03/k	28.8TCaC03/k	<0.30TCaC03/k	4.16
S405192	AI-20-77-87	549umhos/cm	-29.7TCaC03/k	29.7TCaC03/k	<0.30TCaC03/k	3.70
S405193	AI-20-87-97	I/Sumhos/cm	-28.8TCaC03/k	28.8TCaC03/k	<0.30TCaC03/k	3.85
S405194	AI-20-97-107	I/Sumhos/cm	-27.2TCaC03/k	27.2TCaC03/k	<0.30TCaC03/k	4.18
S405195	AI-20-107-117	I/Sumhos/cm	-27.8TCaC03/k	27.8TCaC03/k	<0.30TCaC03/k	4.32
S405196	AI-20-117-127	594umhos/cm	-36.6TCaC03/k	36.6TCaC03/k	<0.30TCaC03/k	4.28

I/S: Insufficient sample.

Soil Samples: As Received Basis

ID ID00019

Reviewed By:____________ Date: 8/30/04

SVL ANALYTICAL, INC.

REPORT OF ANALYTICAL RESULTS

One Government Gulch ▪ P.O. Box 929 ▪ Kellogg, Idaho 83827-0929 ▪ Phone: (208)784-1258 ▪ Fax: (208)783-08

CLIENT : PHELPS DODGE - TYRONE
PROJECT: 1490

Sample Receipt: 8/16/04
Report Date: 8/30/04

Page 2 of 2
SVL JOB: 112676

SVL ID	CLIENT SAMPLE ID	S N-EX LECO	S-PYR LECO	S-S04 LECO	S-TOT LECO
S405177	AF-24-0-7	0.100%	0.180%	0.090%	0.370%
S405178	AF-24-37-47	0.060%	0.540%	0.290%	0.890%
S405179	AF-24-47-57	0.040%	0.250%	0.130%	0.420%
S405180	AF-24-57-67	0.050%	1.08%	0.300%	1.43%
S405181	AF-24-67-77	0.060%	1.10%	0.260%	1.42%
S405182	AF-24-77-87	0.110%	1.86%	0.360%	2.33%
S405183	AF-24-97-107	0.010%	0.190%	0.110%	0.310%
S405184	AI-20-0-7	0.040%	1.99%	0.590%	2.62%
S405185	AI-20-7-17	0.040%	2.07%	0.490%	2.60%
S405186	AI-20-17-27	0.050%	2.23%	0.520%	2.80%
S405187	AI-20-27-37	0.040%	1.90%	0.630%	2.57%
S405188	AI-20-37-47	0.040%	1.62%	0.600%	2.26%
S405189	AI-20-47-57	0.030%	1.67%	0.470%	2.17%
S405190	AI-20-57-67	0.030%	1.37%	0.330%	1.73%
S405191	AI-20-67-77	0.020%	0.920%	0.330%	1.27%
S405192	AI-20-77-87	0.020%	0.950%	0.540%	1.51%
S405193	AI-20-87-97	<0.010%	0.920%	0.320%	1.24%
S405194	AI-20-97-107	0.020%	0.870%	0.370%	1.26%
S405195	AI-20-107-117	0.040%	0.890%	0.280%	1.21%
S405196	AI-20-117-127	0.030%	1.17%	0.290%	1.49%

I/S: Insufficient sample.

Soil Samples: As Received Basis

Certificate: ID ID00019

Reviewed By:________________ Date: 8/30/04

SVL ANALYTICAL, INC.

Quality Control Report
Part I Prep Blank and Laboratory Control Sample

Client :PHELPS DODGE - TYRONE

SVL JOB No: 112676

Analyte	Method	Matrix	Units	Prep Blank	True—LCS	—Found	LCS %R	Analysis Date
Spec. Cond.	120.1	SOIL	umhos/cm	3.80	206	192	93.2	8/30/04
Acid Generating	EPA600	SOIL	TCaCO3/k	N/A	9.36	9.06	96.8	8/24/04
Acid Neut. Pot.	EPA600	SOIL	TCaCO3/k	N/A	52.0	53.5	102.9	8/24/04
pH Paste	ASA M9	SOIL		5.85	8.45	8.35	98.8	8/24/04
Non-Ext Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	8/24/04
Pyritic Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	8/24/04
Sulfate Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	8/24/04
Total Sulfur, S	LECO	SOIL	%	<0.010	0.298	0.290	97.3	8/24/04

LEGEND:

LCS = Laboratory Control Sample

LCS %R = LCS Percent Recovery

N/A = Not Applicable

8/30/04 14:21

SVL ANALYTICAL, INC.

Quality Control Report
Part II Duplicate and Spike Analysis

Client :PHELPS DODGE - TYRONE

SVL JOB No: 112676

Test	Method	Mtx	QC SAMPLE ID			Duplicate or MSD		Matrix Spike			Analysis
				Units	Result	Found	RPD%	Result	SPK ADD	%R	Date
COND	120.1	S	1			I/S	N/A	N/A	N/A	N/A	
ABP	EPA600	S	1	TCaCO3/	-5.63	-6.88	20.0	N/A	N/A	N/A	8/24/04
AGP	EPA600	S	1	TCaCO3/	5.63	6.88	20.0	N/A	N/A	N/A	8/24/04
ANP	EPA600	S	1	TCaCO3/	<0.30	<0.30	UDL	N/A	N/A	N/A	8/24/04
S N-EX	LECO	S	1	%	0.100	0.110	9.5	N/A	N/A	N/A	8/24/04
S-PYR	LECO	S	1	%	0.180	0.220	20.0	N/A	N/A	N/A	8/24/04
S-SO4	LECO	S	1	%	0.090	0.040	76.9	N/A	N/A	N/A	8/24/04
S-TOT	LECO	S	1	%	0.370	0.370	0.0	N/A	N/A	N/A	8/24/04

LEGEND:
RPD% = (|SAM - DUP|/((SAM + DUP)/2) * 100) UDL = Both SAM & DUP not detected. *Result or *Found: Interference required dilution.
RPD% = (|SPK - MSD|/((SPK + MSD)/2) * 100) M in Duplicate/MSD column indicates MSD.
SPIKE ADD column, A = Post Digest Spike; %R = Percent Recovery N/A = Not Analyzed; R > 4S = Result more than 4X the Spike Added
QC limits for MS recoveries apply only if the spike is at least 1/4 the concentration of the analyte in the sample.
Control limits for the RPD apply only if the concentration of the analyte in the sample is at least five times the reporting limit.
I/S: Insufficient sample for QC test.
QC Sample 1:   SVL SAM No.: 405177   Client Sample ID: AF-24-0-7

112676

SVL ANALYTICAL

CHAIN OF CUSTODY RECORD

Page 1 of 18

Client: Phelps Dodge Tyrone Inc.
Contact: William Seibert III
Address: P.O. Drawer 571
Tyrone, NM 88065
Phone Number: 505-538-7151
FAX Number: 505-388-5773

NOTES:
1) Ensure proper container packaging.
2) Ship samples promptly following collection.
* 3) **Designate Sample Reject Disposition**
4) **Indicate state of sample origination**

PO#:
Project Name: 1490

Table 1. -- Matrix Type
1 = Surface Water, 2 = Ground Water
3 = Soil/Sediment, 4 = Rinsate, 5 = Oil
6=Waste, 7=Other (Specify)

State: NM

Samplers Signature:

FOR SVL USE ONLY
SVL JOB #: 112676

Lab Name: **SVL Analytical, Inc.** **(208) 784-1258** **FAX (208) 783-0891**
Address: **One Government Gulch, Kellogg, ID 83837-0929**

		Collection				Miscellaneous			Preservative(s)						Analyses Required									
	Sample ID	Date	Time	24 hour grab?	Collected by: (Init.)	Matrix Type From Table 1	No. of Containers	Sample Filtered ? Y/N	Unpreserved (Ice Only)	HNO3	HCl	H2SO4	NaOH	Other (Specify) N/A	ABA*	paste pH	paste E.C.							Comments
1.	AF-24-0-7					3								X										* Full ABA
2.	AF-24-37-47																							with sulfur forms
3.	AF-24-47-57																							if enough sample is
4.	AF-24-57-67																							available. Otherwise
5.	AF-24-67-77																							run basic AGP and
6.	AF-24-77-87																							ANP to determine
7.	AF-24-97-107																							ABA on total
8.	A1-20-0-7																							sulfur.
9.	A1-20-7-17																							
10.	A1-20-17-27																							

Relinquished by: Ramon Sias	Date: 8/9/04	Time: 11:30	Received by:	Date: 8/16/04	Time: 12:00
Relinquished by:	Date:	Time:	Received by:	Date:	Time:

* Sample Reject: ☒ Return ☐ Dispose ☐ Other ________ White: LAB COPY Yellow: CUSTOMER COPY SVL-COC 4/03

112676

SVL ANALYTICAL

CHAIN OF CUSTODY RECORD

Page 2 of 18

Client: Phelps Dodge Tyrone Inc.
Contact: William Seibert III
Address: P.O. Drawer 571
Tyrone, NM 88065
Phone Number: 505-538-7151
FAX Number: 505-388-5773

NOTES:
1) Ensure proper container packaging.
2) Ship samples promptly following collection.
* 3) Designate Sample Reject Disposition
4) Indicate state of sample origination

Table 1. – Matrix Type
1 = Surface Water, 2 = Ground Water
3 = Soil/Sediment, 4 = Rinsate, 5 = Oil
6=Waste, 7=Other (Specify)

FOR SVL USE ONLY
SVL JOB #:

State: NM
PO#:
Project Name: 1490
Samplers Signature:

Lab Name: SVL Analytical, Inc. (208) 784-1258 FAX (208) 783-0891
Address: One Government Gulch, Kellogg, ID 83837-0929

	Sample ID	Collection				Miscellaneous			Preservative(s)						Analyses Required									Comments
		Date	Time	24 hour grab?	Collected by: (Init.)	Matrix Type From Table 1	No. of Containers	Sample Filtered ? Y/N	Unpreserved (Ice Only)	HNO3	HCl	H2SO4	NaOH	Other (Specify) N/A	ABA *	paste pH	paste E.C.							
1.	A1-20-27-37					3								X										* Full ABA
2.	A1-20-37-47																							with sulfur forms
3.	A1-20-47-57																							if enough sample is
4.	A1-20-57-67																							available. Otherwise
5.	A1-20-67-77																							run basic AGP and
6.	A1-20-77-87																							ANP to determine
7.	A1-20-87-97																							ABA on total
8.	A1-20-97-107																							sulfur.
9.	A1-20-107-117																							
10.	A1-20-117-127																							

Relinquished by: Ramon Seas	Date: 8/9/04	Time: 11:30	Received by: CRSewy	Date: 8/10/04	Time: 12:00
Relinquished by:	Date:	Time:	Received by:	Date:	Time:

* Sample Reject: ☒ Return ☐ Dispose ☐ Other ______

White: LAB COPY Yellow: CUSTOMER COPY SVL-COC 4/03

Sample ID	Footage	Criteria Not Met
AF-24	0-7	
AF-24	37-47	
AF-24	47-57	
AF-24	57-67	
AF-24	67-77	
AF-24	77-87	
AF-24	97-107	
AI-20	0-7	
AI-20	7-17	
AI-20	17-27	
AI-20	27-37	
AI-20	37-47	
AI-20	47-57	
AI-20	57-67	
AI-20	67-77	
AI-20	77-87	
AI-20	87-97	
AI-20	97-107	
AI-20	107-117	
AI-20	117-127	
AI-20	127-137	
AI-20	137-147	
AI-20	147-157	
BA-47	0-6	
BA-47	6-16	
BA-47	16-26	
BA-47	26-36	
BA-47	36-46	
BA-47	46-56	
BA-47	56-66	
BA-47	66-76	
BA-47	76-86	
BA-47	86-96	
BA-47	96-106	**XXXXX**
BA-47	106-116	
BA-47	116-126	
BA-47	126-136	
BA-47	136-146	
BA-47	146-156	
BA-47	156-166	
BA-47	166-176	
BA-47	176-186	
BA-47	186-196	
BA-47	196-206	
BA-47	216-226	
BA-47	226-236	
BA-47	236-246	

Page 1 of 1

SVL ANALYTICAL, INC.
vernment Gulch - Kellogg, ID 83837-0929

SAMPLE RECEIPT CONFIRMATION

SVL JOB No: 112676
Received: 8/16/04
Expected Due date: 8/30/04

By	Received	Sample Comments
	8/16/04	
	8/16/04	
	8/16/04	
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	8/16/04	
	8/16/04	
	8/16/04	

Container temp not measured upon receipt.

after job completion.
, then you will receive a letter requesting disposal options.

you have questions regarding the receipt of these samples. 8/16/04 14:31

TRANSMISSION VERIFICATION REPORT

TIME : 08/17/2004 09:18
NAME : SVL ANALYTICAL
FAX : 2087830891
TEL : 2087841258
SER.# : BROF3J496071

DATE,TIME	08/17 09:17
FAX NO./NAME	915053885773
DURATION	00:00:21
PAGE(S)	01
RESULT	OK
MODE	FINE ECM

SVL ANALYTICAL, INC.

REPORT OF ANALYTICAL RESULTS

One Government Gulch ▪ P.O. Box 929 ▪ Kellogg, Idaho 83827-0929 ▪ Phone: (208)784-1258 ▪ Fax: (208)783-0891

CLIENT : PHELPS DODGE - TYRONE
PROJECT: 1490

Sample Receipt: 8/16/04
Report Date: 8/30/04

Page 1 of 2
SVL JOB: 112677

SVL ID	CLIENT SAMPLE ID	COND 120.1	ABP EPA600	AGP EPA600	ANP EPA600	pH Pst ASA M9
S405199	AI-20-127-137	770umhos/cm	-15.0TCaC03/k	15.0TCaC03/k	<0.30TCaC03/k	4.41
S405200	AI-20-137-147	736umhos/cm	-17.2TCaC03/k	17.2TCaC03/k	<0.30TCaC03/k	4.30
S405201	AI-20-147-157	546umhos/cm	-13.1TCaC03/k	13.1TCaC03/k	<0.30TCaC03/k	4.46
S405202	BA-47-0-6	I/Sumhos/cm	-15.9TCaC03/k	15.9TCaC03/k	<0.30TCaC03/k	5.13
S405203	BA-47-6-16	I/Sumhos/cm	-24.7TCaC03/k	24.7TCaC03/k	<0.30TCaC03/k	5.22
S405204	BA-47-16-26	533umhos/cm	-23.1TCaC03/k	23.1TCaC03/k	<0.30TCaC03/k	5.46
S405205	BA-47-26-36	250umhos/cm	-15.3TCaC03/k	15.3TCaC03/k	<0.30TCaC03/k	5.25
S405206	BA-47-36-46	I/Sumhos/cm	-20.0TCaC03/k	20.0TCaC03/k	<0.30TCaC03/k	5.09
S405207	BA-47-46-56	I/Sumhos/cm	-34.4TCaC03/k	34.4TCaC03/k	<0.30TCaC03/k	4.84
S405208	BA-47-56-66	513umhos/cm	-31.9TCaC03/k	31.9TCaC03/k	<0.30TCaC03/k	5.07
S405209	BA-47-66-76	I/Sumhos/cm	-19.4TCaC03/k	19.4TCaC03/k	<0.30TCaC03/k	5.18
S405210	BA-47-76-86	I/Sumhos/cm	-25.3TCaC03/k	25.3TCaC03/k	<0.30TCaC03/k	5.42
S405211	BA-47-86-96	I/Sumhos/cm	-19.7TCaC03/k	19.7TCaC03/k	<0.30TCaC03/k	5.54
S405212	BA-47-106-116	321umhos/cm	-20.9TCaC03/k	20.9TCaC03/k	<0.30TCaC03/k	5.61
S405213	BA-47-116-126	I/Sumhos/cm	-8.75TCaC03/k	8.75TCaC03/k	<0.30TCaC03/k	5.97
S405214	BA-47-126-136	I/Sumhos/cm	-6.88TCaC03/k	6.88TCaC03/k	<0.30TCaC03/k	5.82
S405215	BA-47-136-146	I/Sumhos/cm	-13.4TCaC03/k	13.4TCaC03/k	<0.30TCaC03/k	5.25
S405216	BA-47-146-156	I/Sumhos/cm	-31.6TCaC03/k	31.6TCaC03/k	<0.30TCaC03/k	4.63
S405217	BA-47-156-166	I/Sumhos/cm	-26.9TCaC03/k	26.9TCaC03/k	<0.30TCaC03/k	4.42
S405218	BA-47-166-176	553umhos/cm	-64.7TCaC03/k	64.7TCaC03/k	<0.30TCaC03/k	4.35

I/S: Insufficient Sample.

Soil Samples: As Received Basis

ID ID00019

Reviewed By:____________ Date: 8/30/01

SVL ANALYTICAL, INC.

REPORT OF ANALYTICAL RESULTS

One Government Gulch ▪ P.O. Box 929 ▪ Kellogg, Idaho 83827-0929 ▪ Phone: (208)784-1258 ▪ Fax: (208)783-089

CLIENT : PHELPS DODGE - TYRONE	Sample Receipt: 8/16/04	Page 2 of 2
PROJECT: 1490	Report Date: 8/30/04	SVL JOB: 112677

SVL ID	CLIENT SAMPLE ID	S N-EX LECO	S-PYR LECO	S-SO4 LECO	S-TOT LECO
S405199	AI-20-127-137	<0.010%	0.480%	0.440%	0.920%
S405200	AI-20-137-147	<0.010%	0.550%	0.380%	0.930%
S405201	AI-20-147-157	<0.010%	0.420%	0.390%	0.810%
S405202	BA-47-0-6	0.060%	0.510%	0.130%	0.700%
S405203	BA-47-6-16	0.050%	0.790%	0.010%	0.850%
S405204	BA-47-16-26	0.050%	0.740%	0.090%	0.880%
S405205	BA-47-26-36	0.160%	0.490%	0.180%	0.830%
S405206	BA-47-36-46	0.210%	0.640%	0.220%	1.07%
S405207	BA-47-46-56	0.190%	1.10%	0.380%	1.67%
S405208	BA-47-56-66	0.250%	1.02%	0.320%	1.59%
S405209	BA-47-66-76	0.320%	0.620%	0.220%	1.16%
S405210	BA-47-76-86	0.270%	0.810%	0.330%	1.41%
S405211	BA-47-86-96	0.150%	0.630%	0.130%	0.910%
S405212	BA-47-106-116	0.140%	0.670%	0.040%	0.850%
S405213	BA-47-116-126	0.050%	0.280%	0.150%	0.480%
S405214	BA-47-126-136	0.040%	0.220%	0.210%	0.470%
S405215	BA-47-136-146	0.050%	0.430%	0.120%	0.600%
S405216	BA-47-146-156	0.020%	1.01%	0.060%	1.09%
S405217	BA-47-156-166	0.020%	0.860%	0.200%	1.08%
S405218	BA-47-166-176	0.060%	2.07%	0.410%	2.54%

I/S: Insufficient sample.

Soil Samples: As Received Basis

Certificate: ID ID00019

Reviewed By:__________ Date: 8/30/04

SVL ANALYTICAL, INC.

Quality Control Report
Part I Prep Blank and Laboratory Control Sample

Client :PHELPS DODGE - TYRONE

SVL JOB No: 112677

Analyte	Method	Matrix	Units	Prep Blank	LCS		LCS %R	Analysis Date
					True	Found		
Spec. Cond.	120.1	SOIL	umhos/cm	3.80	206	192	93.2	8/30/04
Acid Generating	EPA600	SOIL	TCaCO3/k	N/A	9.36	9.06	96.8	8/30/04
Acid Neut. Pot.	EPA600	SOIL	TCaCO3/k	N/A	52.0	53.5	102.9	8/30/04
pH Paste	ASA M9	SOIL		5.62	8.45	8.31	98.3	8/30/04
Non-Ext Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	8/30/04
Pyritic Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	8/30/04
Sulfate Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	8/30/04
Total Sulfur, S	LECO	SOIL	%	<0.010	0.298	0.290	97.3	8/30/04

LEGEND:

LCS = Laboratory Control Sample

LCS %R = LCS Percent Recovery

N/A = Not Applicable

8/30/04 14:52

SVL ANALYTICAL, INC.

Quality Control Report
Part II Duplicate and Spike Analysis

Client :PHELPS DODGE - TYRONE

SVL JOB No: 112677

Test	Method	Mtx	QC SAMPLE ID Units	Result	Duplicate or Found	MSD RPD%	Matrix Spike Result	SPK ADD	%R	Analysis Date
COND	120.1	S	1		I/S	N/A	N/A	N/A	N/A	
ABP	EPA600	S	1 TCaCO3/	-15.0	-17.2	13.7	N/A	N/A	N/A	8/30/04
AGP	EPA600	S	1 TCaCO3/	15.0	17.2	13.7	N/A	N/A	N/A	8/30/04
ANP	EPA600	S	1 TCaCO3/	<0.30	<0.30	UDL	N/A	N/A	N/A	8/30/04
S N-EX	LECO	S	1 %	<0.010	<0.010	UDL	N/A	N/A	N/A	8/30/04
S-PYR	LECO	S	1 %	0.480	0.550	13.6	N/A	N/A	N/A	8/30/04
S-SO4	LECO	S	1 %	0.440	0.380	14.6	N/A	N/A	N/A	8/30/04
S-TOT	LECO	S	1 %	0.920	0.930	1.1	N/A	N/A	N/A	8/30/04

LEGEND:
RPD% = (|SAM - DUP|/((SAM + DUP)/2) * 100) UDL = Both SAM & DUP not detected. *Result or *Found: Interference required dilution.
RPD% = (|SPK - MSD|/((SPK + MSD)/2) * 100) M in Duplicate/MSD column indicates MSD.
SPIKE ADD column, A = Post Digest Spike; %R = Percent Recovery N/A = Not Analyzed; R > 4S = Result more than 4X the Spike Added
QC limits for MS recoveries apply only if the spike is at least 1/4 the concentration of the analyte in the sample.
Control limits for the RPD apply only if the concentration of the analyte in the sample is at least five times the reporting limit.
I/S: Insufficient sample for QC test.
QC Sample 1: SVL SAM No.: 405199 Client Sample ID: AI-20-127-137

8/30/04 14:52

112677

SVL ANALYTICAL

CHAIN OF CUSTODY RECORD

Page 3 of 18

Client: Phelps Dodge Tyrone Inc.
Contact: William Seibert III
Address: P.O. Drawer 571
Tyrone, NM 88065
Phone Number: 505-538-7151
FAX Number: 505-388-5773

NOTES:
1) Ensure proper container packaging.
2) Ship samples promptly following collection.
* 3) Designate Sample Reject Disposition
4) Indicate state of sample origination

PO#:
Project Name: 1490

Table 1. – Matrix Type
1 = Surface Water, 2 = Ground Water
3 = Soil/Sediment, 4 = Rinsate, 5 = Oil
6=Waste, 7=Other (Specify)

State: NM

FOR SVL USE ONLY
SVL JOB #:

Samplers Signature:

Lab Name: SVL Analytical, Inc. (208) 784-1258 FAX (208) 783-0891
Address: One Government Gulch, Kellogg, ID 83837-0929

		Collection				Miscellaneous			Preservative(s)						Analyses Required									
	Sample ID	Date	Time	24 hour grab?	Collected by: (Init.)	Matrix Type From Table 1	No. of Containers	Sample Filtered ? Y/N	Unpreserved (Ice Only)	HNO3	HCl	H2SO4	NaOH	Other (Specify) N/A	ABA *	paste pH	paste E.C.							Comments
1.	A1-20-127-137					3								X										* Full ABA
2.	A1-20-137-147																							with sulfur forms
3.	A1-20-147-157																							if enough sample is
4.	BA-47-0-6																							available. Otherwise
5.	BA-47-6-16																							run basic AGP and
6.	BA-47-16-26																							ANP to determine
7.	BA-47-26-36																							ABA on total
8.	BA-47-36-46																							sulfur.
9.	BA-47-46-56																							
10.	BA-47-56-66					↓								↓										

Relinquished by:		Date: 8/9/04	Time: 11:30	Received by:		Date: 8/16/04	Time: 12:02
Relinquished by:		Date:	Time:	Received by:		Date:	Time:

* Sample Reject: ☒ Return ☐ Dispose ☐ Other

White: LAB COPY Yellow: CUSTOMER COPY SVL-COC 4/03

112677

SVL ANALYTICAL

CHAIN OF CUSTODY RECORD

Page 4 of 18

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FOR SVL USE ONLY
SVL JOB #:

State: NM

Samplers Signature:

Lab Name: **SVL Analytical, Inc.** (208) 784-1258 FAX (208) 783-0891
Address: **One Government Gulch, Kellogg, ID 83837-0929**

	Sample ID	Collection				Miscellaneous			Preservative(s)						Analyses Required									Comments
		Date	Time	24 hour grab?	Collected by: (Init.)	Matrix Type From Table 1	No. of Containers	Sample Filtered ? Y/N	Unpreserved (Ice Only)	HNO3	HCl	H2SO4	NaOH	Other (Specify) N/A	ABA *	paste pH	paste E.C.							
1.	BA-47-66-76					3.								X										* Full ABA
2.	BA-47-76-86																							with sulfur forms
3.	BA-47-86-96																							if enough sample is
4.	BA-47-106-116																							available. Otherwise
5.	BA-47-116-126																							run basic AGP and
6.	BA-47-126-136																							ANP to determine
7.	BA-47-136-146																							ABA on total
8.	BA-47-146-156																							sulfur.
9.	BA-47-156-166																							
10.	BA-47-166-176					↓								↓										

Relinquished by: Ramon Rios	Date: 8/9/04	Time: 11:30	Received by: CR Sewy	Date: 8/16/04	Time: 12:00
Relinquished by:	Date:	Time:	Received by:	Date:	Time:

* Sample Reject: ☒ Return ☐ Dispose ☐ Other ________

White: LAB COPY Yellow: CUSTOMER COPY SVL-COC 4/03

Sample ID	Footage	Criteria Not Met
AF-24	0-7	
AF-24	37-47	
AF-24	47-57	
AF-24	57-67	
AF-24	67-77	
AF-24	77-87	
AF-24	97-107	
AI-20	0-7	
AI-20	7-17	
AI-20	17-27	
AI-20	27-37	
AI-20	37-47	
AI-20	47-57	
AI-20	57-67	
AI-20	67-77	
AI-20	77-87	
AI-20	87-97	
AI-20	97-107	
AI-20	107-117	
AI-20	117-127	
AI-20	127-137	
AI-20	137-147	
AI-20	147-157	
BA-47	0-6	
BA-47	6-16	
BA-47	16-26	
BA-47	26-36	
BA-47	36-46	
BA-47	46-56	
BA-47	56-66	
BA-47	66-76	
BA-47	76-86	
BA-47	86-96	
BA-47	96-106	XXXXX
BA-47	106-116	
BA-47	116-126	
BA-47	126-136	
BA-47	136-146	
BA-47	146-156	
BA-47	156-166	
BA-47	166-176	
BA-47	176-186	
BA-47	186-196	
BA-47	196-206	
BA-47	216-226	
BA-47	226-236	
BA-47	236-246	

Page 1 of 1

SVL ANALYTICAL, INC.
ernment Gulch - Kellogg, ID 83837-0929

SAMPLE RECEIPT CONFIRMATION

SVL JOB No: 112677
Received: 8/16/04
Expected Due date: 8/30/04

By	Received	Sample Comments
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
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	8/16/04	
	8/16/04	

ontainer temp not measured upon receipt.

after job completion.
, then you will receive a letter requesting disposal options.

you have questions regarding the receipt of these samples. 8/16/04 15:25

TRANSMISSION VERIFICATION REPORT

TIME : 08/17/2004 09:17
NAME : SVL ANALYTICAL
FAX : 2087830891
TEL : 2087841258
SER.# : BROF3J496071

DATE,TIME	08/17 09:16
FAX NO./NAME	915053885773
DURATION	00:00:21
PAGE(S)	01
RESULT	OK
MODE	FINE ECM

SVL ANALYTICAL, INC.
One Government Gulch ▪ P.O. Box 929 ▪ Kellogg, Idaho 83827-0929 ▪ Phone: (208)784-1258 ▪ Fax: (208)783-0891

REPORT OF ANALYTICAL RESULTS

CLIENT : PHELPS DODGE - TYRONE
PROJECT: 1490

Sample Receipt: 8/16/04
Report Date: 8/31/04

Page 1 of 2
SVL JOB: 112678

SVL ID	CLIENT SAMPLE ID	COND 120.1	ABP EPA600	AGP EPA600	ANP EPA600	pH Pst ASA M9
S405221	BA-47-176-186	553umhos/cm	-19.4TCaC03/k	19.4TCaC03/k	<0.30TCaC03/k	5.24
S405222	BA-47-186-196	I/S	-1.56TCaC03/k	1.56TCaC03/k	<0.30TCaC03/k	6.51
S405223	BA-47-196-206	I/S	-0.63TCaC03/k	0.63TCaC03/k	<0.30TCaC03/k	6.53
S405224	BA-47-216-226	815umhos/cm	-10.9TCaC03/k	10.9TCaC03/k	<0.30TCaC03/k	5.28
S405225	BA-47-226-236	I/S	-6.25TCaC03/k	6.25TCaC03/k	<0.30TCaC03/k	5.66
S405226	BA-47-236-246	718umhos/cm	-14.7TCaC03/k	14.7TCaC03/k	<0.30TCaC03/k	5.36
S405227	BA-47-246-256	I/S	-2.50TCaC03/k	2.50TCaC03/k	<0.30TCaC03/k	6.95
S405228	BC-55-0-11	I/S	-59.1TCaC03/k	59.1TCaC03/k	<0.30TCaC03/k	4.96
S405229	BC-55-31-41	931umhos/cm	-66.9TCaC03/k	66.9TCaC03/k	<0.30TCaC03/k	4.16
S405230	BC-55-41-51	I/S	-50.9TCaC03/k	50.9TCaC03/k	<0.30TCaC03/k	4.96
S405231	BC-55-51-61	I/S	-57.8TCaC03/k	57.8TCaC03/k	<0.30TCaC03/k	4.95
S405232	BC-55-61-71	I/S	-59.4TCaC03/k	59.4TCaC03/k	<0.30TCaC03/k	5.33
S405233	BC-55-91-101	I/S	-67.5TCaC03/k	67.5TCaC03/k	<0.30TCaC03/k	4.86
S405234	BC-55-101-111	I/S	-31.3TCaC03/k	31.3TCaC03/k	<0.30TCaC03/k	5.45
S405235	BC-55-111-121	I/S	-49.7TCaC03/k	49.7TCaC03/k	<0.30TCaC03/k	4.80
S405236	BC-55-121-131	I/S	-47.5TCaC03/k	47.5TCaC03/k	<0.30TCaC03/k	5.17
S405237	BC-55-131-141	I/S	-47.5TCaC03/k	47.5TCaC03/k	<0.30TCaC03/k	5.05
S405238	BC-55-151-161	I/S	-46.3TCaC03/k	46.3TCaC03/k	<0.30TCaC03/k	4.99
S405239	BC-55-201-211	I/S	-23.8TCaC03/k	23.8TCaC03/k	<0.30TCaC03/k	5.14

I/S: Insufficient Sample

Soil Samples: As Received Basis

Certificate: ID ID00019

Reviewed By:____________________ Date: 8/31/04

CLIENT : PHELPS DODGE - TYRONE
PROJECT: 1490
Sample Receipt: 8/16/04
Report Date: 8/31/04
Page 2 of 2
SVL JOB: 112678

SVL ID	CLIENT SAMPLE ID	S N-EX LECO	S-PYR LECO	S-SO4 LECO	S-TOT LECO
S405221	BA-47-176-186	0.080%	0.620%	0.260%	0.960%
S405222	BA-47-186-196	0.040%	0.050%	0.130%	0.220%
S405223	BA-47-196-206	0.040%	0.020%	0.840%	0.900%
S405224	BA-47-216-226	0.010%	0.350%	0.220%	0.580%
S405225	BA-47-226-236	0.020%	0.200%	0.290%	0.510%
S405226	BA-47-236-246	0.020%	0.470%	0.220%	0.710%
S405227	BA-47-246-256	0.010%	0.080%	0.070%	0.160%
S405228	BC-55-0-11	0.030%	1.89%	0.480%	2.40%
S405229	BC-55-31-41	0.030%	2.14%	0.370%	2.54%
S405230	BC-55-41-51	0.070%	1.63%	0.290%	1.99%
S405231	BC-55-51-61	0.060%	1.85%	0.320%	2.23%
S405232	BC-55-61-71	0.050%	1.90%	0.300%	2.25%
S405233	BC-55-91-101	0.070%	2.16%	0.260%	2.49%
S405234	BC-55-101-111	0.070%	1.00%	0.240%	1.31%
S405235	BC-55-111-121	0.070%	1.59%	0.260%	1.92%
S405236	BC-55-121-131	0.130%	1.52%	0.300%	1.95%
S405237	BC-55-131-141	0.140%	1.52%	0.230%	1.89%
S405238	BC-55-151-161	0.110%	1.48%	0.240%	1.83%
S405239	BC-55-201-211	0.030%	0.760%	0.350%	1.14%

Soil Samples: As Received Basis

Certificate: ID ID00019

Reviewed By:__________ Date: 8/31/04

SVL ANALYTICAL, INC.

Quality Control Report
Part I Prep Blank and Laboratory Control Sample

Client :PHELPS DODGE - TYRONE

SVL JOB No: 112678

Analyte	Method	Matrix	Units	Prep Blank	True——LCS——Found		LCS %R	Analysis Date
Spec. Cond.	120.1	SOIL	umhos/cm	3.80	206	192	93.2	8/30/04
Acid Generating	EPA600	SOIL	TCaCO3/k	N/A	9.36	9.06	96.8	8/26/04
Acid Neut. Pot.	EPA600	SOIL	TCaCO3/k	N/A	52.0	52.1	100.2	8/26/04
pH Paste	ASA M9	SOIL		5.62	8.45	8.31	98.3	8/26/04
Non-Ext Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	8/26/04
Pyritic Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	8/26/04
Sulfate Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	8/26/04
Total Sulfur, S	LECO	SOIL	%	<0.010	0.298	0.290	97.3	8/26/04

LEGEND:

LCS = Laboratory Control Sample

LCS %R = LCS Percent Recovery

N/A = Not Applicable

8/31/04 9:47

SVL ANALYTICAL, INC.

Quality Control Report
Part II Duplicate and Spike Analysis

Client :PHELPS DODGE - TYRONE

SVL JOB No: 112678

			QC SAMPLE ID			Duplicate or MSD		Matrix Spike			Analysis
Test	Method	Mtx		Units	Result	Found	RPD%	Result	SPK ADD	%R	Date
COND	120.1	S	1			I/S	N/A	N/A	N/A	N/A	
ABP	EPA600	S	1	TCaCO3/	-19.4	-19.7	1.5	N/A	N/A	N/A	8/26/04
AGP	EPA600	S	1	TCaCO3/	19.4	19.7	1.5	N/A	N/A	N/A	8/26/04
ANP	EPA600	S	1	TCaCO3/	<0.30	<0.30	UDL	N/A	N/A	N/A	8/26/04
S N-EX	LECO	S	1	%	0.080	0.080	0.0	N/A	N/A	N/A	8/26/04
S-PYR	LECO	S	1	%	0.620	0.630	1.6	N/A	N/A	N/A	8/26/04
S-SO4	LECO	S	1	%	0.260	0.270	3.8	N/A	N/A	N/A	8/26/04
S-TOT	LECO	S	1	%	0.960	0.980	2.1	N/A	N/A	N/A	8/26/04

LEGEND:

RPD% = (|SAM - DUP|/((SAM + DUP)/2) * 100) UDL = Both SAM & DUP not detected. *Result or *Found: Interference required dilution.

RPD% = (|SPK - MSD|/((SPK + MSD)/2) * 100) M in Duplicate/MSD column indicates MSD.

SPIKE ADD column, A = Post Digest Spike; %R = Percent Recovery N/A = Not Analyzed; R > 4S = Result more than 4X the Spike Added

QC limits for MS recoveries apply only if the spike is at least 1/4 the concentration of the analyte in the sample.

Control limits for the RPD apply only if the concentration of the analyte in the sample is at least five times the reporting limit.

I/S: Insufficient sample for QC test.

QC Sample 1: SVL SAM No.: 405221 Client Sample ID: BA-47-176-186

112678

SVL ANALYTICAL

CHAIN OF CUSTODY RECORD

Page 5 of 18

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4) Indicate state of sample origination
PO#:
Project Name: 1490

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1 = Surface Water, 2 = Ground Water
3 = Soil/Sediment, 4 = Rinsate, 5 = Oil
6=Waste, 7=Other (Specify)

State: NM

Samplers Signature:

FOR SVL USE ONLY
SVL JOB #

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Address: One Government Gulch, Kellogg, ID 83837-0929

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2.	BA-47-186-196																							with sulfur forms
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4.	BA-47-216-226																							available. Otherwise
5.	BA-47-226-236																							run basic AGP and
6.	BA-47-236-246																							ANP to determine
7.	BA-47-246-256																							ABA on total
8.	[redacted]																							sulfur.
9.	BC-55-0-11																							
10.	BC-55-31-41																							

Relinquished by: Ramon Seas	Date: 8/9/04	Time: 11:30	Received by:	Date: 8/16/04	Time: 12:00
Relinquished by:	Date:	Time:	Received by:	Date:	Time:

* Sample Reject: ☒ Return ☐ Dispose ☐ Other ____

White: LAB COPY Yellow: CUSTOMER COPY SVL-COC 4/03

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SVL ANALYTICAL

CHAIN OF CUSTODY RECORD

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State: NM

FOR SVL USE ONLY
SVL JOB #

Samplers Signature:

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1.	BC-55-41-51					3								X										* Full ABA
2.	BC-55-51-61																							with sulfur forms
3.	BC-55-61-71																							if enough sample is
4.	BC-55-91-101																							available. Otherwise
5.	BC-55-101-111																							run basic AGP and
6.	BC-55-111-121																							ANP to determine
7.	BC-55-121-131																							ABA on total
8.	BC-55-131-141																							sulfur.
9.	BC-55-151-161																							
10.	BC-55-201-211																							

Relinquished by: Ramon Seas	Date: 8/9/04	Time: 11:30	Received by:	Date: 8/16/04	Time: 12:00
Relinquished by:	Date:	Time:	Received by:	Date:	Time:

* Sample Reject: ☒ Return ☐ Dispose ☐ Other ______

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AF-24	57-67	
AF-24	67-77	
AF-24	77-87	
AF-24	97-107	
AI-20	0-7	
AI-20	7-17	
AI-20	17-27	
AI-20	27-37	
AI-20	37-47	
AI-20	47-57	
AI-20	57-67	
AI-20	67-77	
AI-20	77-87	
AI-20	87-97	
AI-20	97-107	
AI-20	107-117	
AI-20	117-127	
AI-20	127-137	
AI-20	137-147	
AI-20	147-157	
BA-47	0-6	
BA-47	6-16	
BA-47	16-26	
BA-47	26-36	
BA-47	36-46	
BA-47	46-56	
BA-47	56-66	
BA-47	66-76	
BA-47	76-86	
BA-47	86-96	
BA-47	96-106	XXXXX
BA-47	106-116	
BA-47	116-126	
BA-47	126-136	
BA-47	136-146	
BA-47	146-156	
BA-47	156-166	
BA-47	166-176	
BA-47	176-186	
BA-47	186-196	
BA-47	196-206	
BA-47	216-226	
BA-47	226-236	
BA-47	236-246	

BA-47	246-256	
BA-47	256-266	XXXXX
BC-55	0-11	
BC-55	31-41	
BC-55	41-51	
BC-55	51-61	
BC-55	61-71	
BC-55	91-101	
BC-55	101-111	
BC-55	111-121	
BC-55	121-131	
BC-55	131-141	
BC-55	151-161	
BC-55	201-211	
BC-55	211-221	
BC-55	221-231	
BC-55	231-241	
BC-55	241-251	
BC-55	251-261	
BC-55	261-271	
BC-55	271-281	
BC-55	281-291	
BC-55	291-301	
BC-55	301-311	
BC-55	311-321	
BC-55	321-331	
BG-07	0-7	
BG-07	7-17	
BG-07	17-27	
BG-07	27-37	
BG-07	37-47	
BG-07	47-57	
BG-07	57-67	
BG-07	67-77	
BG-07	77-87	
BJ-07	0-7.3	
BJ-07	7.3-17.3	
BJ-07	17.3-27.3	
BJ-07	27.3-37.3	
BJ-07	37.3-47.3	
BJ-07	47.3-57.3	
BJ-07	57.3-67.3	
BJ-07	67.3-77.3	XXXXX
BN-011	0-9	
BN-011	9-19	
BN-011	19-29	
BN-011	29-39	
BN-011	39-49	
BN-011	49-59	

Page 1 of 1

SVL ANALYTICAL, INC.
ernment Gulch - Kellogg, ID 83837-0929

SAMPLE RECEIPT CONFIRMATION

SVL JOB No: 112678
Received: 8/16/04
Expected Due date: 8/30/04

By	Received	Sample Comments
	8/16/04	
	8/16/04	
	8/16/04	
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	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	

ontainer temp not measured upon receipt.

after job completion.
then you will receive a letter requesting disposal options.

you have questions regarding the receipt of these samples. 8/16/04 15:32

TRANSMISSION VERIFICATION REPORT

TIME : 08/17/2004 09:02
NAME : SVL ANALYTICAL
FAX : 2087830891
TEL : 2087841258
SER.# : BROF3J496071

DATE,TIME	08/17 09:02
FAX NO./NAME	915053885773
DURATION	00:00:21
PAGE(S)	01
RESULT	OK
MODE	FINE ECM

SVL ANALYTICAL, INC. **REPORT OF ANALYTICAL RESULTS**

One Government Gulch ▪ P.O. Box 929 ▪ Kellogg, Idaho 83827-0929 ▪ Phone: (208)784-1258 ▪ Fax: (208)783-0891

CLIENT : PHELPS DODGE - TYRONE
PROJECT: 1490
Sample Receipt: 8/16/04
Report Date: 8/31/04
Page 1 of 2
SVL JOB: 112680

SVL ID	CLIENT SAMPLE ID	COND 120.1	ABP EPA600	AGP EPA600	ANP EPA600	pH Pst ASA M9
S405245	BC-55-211-221	I/S	-37.2TCaC03/k	38.8TCaC03/k	1.52TCaC03/k	5.24
S405246	BC-55-221-231	I/S	-19.4TCaC03/k	19.4TCaC03/k	<0.30TCaC03/k	6.51
S405247	BC-55-231-241	900umhos/cm	-7.19TCaC03/k	7.19TCaC03/k	<0.30TCaC03/k	6.53
S405248	BC-55-241-251	I/S	-2.67TCaC03/k	4.69TCaC03/k	2.02TCaC03/k	5.28
S405249	BC-55-251-261	I/S	1.15TCaC03/k	1.88TCaC03/k	3.03TCaC03/k	5.66
S405250	BC-55-261-271	I/S	2.85TCaC03/k	0.94TCaC03/k	3.79TCaC03/k	5.36
S405251	BC-55-271-281	I/S	2.40TCaC03/k	0.63TCaC03/k	3.03TCaC03/k	6.95
S405252	BC-55-281-291	350umhos/cm	3.16TCaC03/k	0.63TCaC03/k	3.79TCaC03/k	4.96
S405253	BC-55-291-301	397umhos/cm	-12.5TCaC03/k	12.5TCaC03/k	<0.30TCaC03/k	4.16
S405254	BC-55-301-311	278umhos/cm	-5.74TCaC03/k	6.25TCaC03/k	0.51TCaC03/k	4.96
S405255	BC-55-311-321	275umhos/cm	-0.80TCaC03/k	1.56TCaC03/k	0.76TCaC03/k	4.95
S405256	BC-55-321-331	204umhos/cm	0.32TCaC03/k	0.94TCaC03/k	1.26TCaC03/k	5.33
S405257	BG-07-0-7	502umhos/cm	-3.44TCaC03/k	3.44TCaC03/k	<0.30TCaC03/k	4.86
S405258	BG-07-7-17	642umhos/cm	-5.00TCaC03/k	5.00TCaC03/k	<0.30TCaC03/k	5.45
S405259	BG-07-17-27	633umhos/cm	-7.81TCaC03/k	7.81TCaC03/k	<0.30TCaC03/k	4.80
S405260	BG-07-27-37	836umhos/cm	-10.3TCaC03/k	10.3TCaC03/k	<0.30TCaC03/k	5.17
S405261	BG-07-37-47	811umhos/cm	-3.44TCaC03/k	3.44TCaC03/k	<0.30TCaC03/k	5.05
S405262	BG-07-47-57	1100umhos/cm	-4.69TCaC03/k	4.69TCaC03/k	<0.30TCaC03/k	4.99
S405263	BG-07-57-67	1210umhos/cm	-1.88TCaC03/k	1.88TCaC03/k	<0.30TCaC03/k	5.14
S405264	BG-07-67-77	692umhos/cm	-3.13TCaC03/k	3.13TCaC03/k	<0.30TCaC03/k	5.14

I.S. Insufficient sample   Soil Samples: As Received Basis

ID ID00019

Reviewed By:____________________ Date: 8/31/04

CLIENT : PHELPS DODGE - TYRONE	Sample Receipt: 8/16/04	Page 2 of 2
PROJECT: 1490	Report Date: 8/31/04	SVL JOB: 112680

SVL ID	CLIENT SAMPLE ID	S N-EX LECO	S-PYR LECO	S-SO4 LECO	S-TOT LECO
S405245	BC-55-211-221	0.070%	1.24%	0.380%	1.69%
S405246	BC-55-221-231	0.030%	0.620%	0.300%	0.950%
S405247	BC-55-231-241	0.020%	0.230%	0.190%	0.440%
S405248	BC-55-241-251	0.020%	0.150%	0.110%	0.280%
S405249	BC-55-251-261	<0.010%	0.060%	0.050%	0.110%
S405250	BC-55-261-271	<0.010%	0.030%	0.030%	0.060%
S405251	BC-55-271-281	<0.010%	0.020%	0.010%	0.030%
S405252	BC-55-281-291	0.010%	0.020%	0.010%	0.040%
S405253	BC-55-291-301	0.020%	0.400%	0.150%	0.570%
S405254	BC-55-301-311	0.020%	0.200%	0.070%	0.290%
S405255	BC-55-311-321	<0.010%	0.050%	0.040%	0.090%
S405256	BC-55-321-331	0.020%	0.030%	0.030%	0.080%
S405257	BG-07-0-7	0.090%	0.110%	0.190%	0.390%
S405258	BG-07-7-17	0.080%	0.160%	0.180%	0.420%
S405259	BG-07-17-27	0.060%	0.250%	0.180%	0.490%
S405260	BG-07-27-37	0.090%	0.330%	0.230%	0.650%
S405261	BG-07-37-47	0.040%	0.110%	0.160%	0.310%
S405262	BG-07-47-57	0.040%	0.150%	0.200%	0.390%
S405263	BG-07-57-67	0.040%	0.060%	0.220%	0.320%
S405264	BG-07-67-77	0.050%	0.100%	0.130%	0.280%

Soil Samples: As Received Basis

Certificate: ID ID00019

Reviewed By:______________________ Date: 8/31/04

SVL ANALYTICAL, INC.

Quality Control Report
Part I Prep Blank and Laboratory Control Sample

Client :PHELPS DODGE - TYRONE

SVL JOB No: 112680

Analyte	Method	Matrix	Units	Prep Blank	LCS		LCS %R	Analysis Date
					True	Found		
Spec. Cond.	120.1	SOIL	umhos/cm	3.80	206	192	93.2	8/30/04
Acid Generating	EPA600	SOIL	TCaCO3/k	N/A	9.36	9.25	98.8	8/27/04
Acid Neut. Pot.	EPA600	SOIL	TCaCO3/k	N/A	52.0	52.1	100.2	8/27/04
pH Paste	ASA M9	SOIL		5.62	8.45	8.31	98.3	8/27/04
Non-Ext Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	8/27/04
Pyritic Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	8/27/04
Sulfate Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	8/27/04
Total Sulfur, S	LECO	SOIL	%	<0.010	0.298	0.300	100.7	8/27/04

LEGEND:

LCS = Laboratory Control Sample

LCS %R = LCS Percent Recovery

N/A = Not Applicable

8/31/04 15:39

SVL ANALYTICAL, INC.

Quality Control Report
Part II Duplicate and Spike Analysis

Client :PHELPS DODGE - TYRONE

SVL JOB No: 112680

Test	Method	Mtx	QC SAMPLE ID Units	Result	Duplicate or Found	MSD RPD%	Matrix Spike Result	Matrix Spike SPK ADD	Matrix Spike %R	Analysis Date
COND	120.1	S	1		I/S	N/A	N/A	N/A	N/A	
ABP	EPA600	S	1 TCaCO3/	-37.2	-38.1	2.4	N/A	N/A	N/A	8/27/04
AGP	EPA600	S	1 TCaCO3/	38.8	39.4	1.5	N/A	N/A	N/A	8/27/04
ANP	EPA600	S	1 TCaCO3/	1.52	1.26	18.7	N/A	N/A	N/A	8/27/04
S N-EX	LECO	S	1 %	0.070	0.070	0.0	N/A	N/A	N/A	8/27/04
S-PYR	LECO	S	1 %	1.24	1.26	1.6	N/A	N/A	N/A	8/27/04
S-SO4	LECO	S	1 %	0.380	0.370	2.7	N/A	N/A	N/A	8/27/04
S-TOT	LECO	S	1 %	1.69	1.70	0.6	N/A	N/A	N/A	8/27/04

LEGEND:

RPD% = (|SAM - DUP|/((SAM + DUP)/2) * 100) UDL = Both SAM & DUP not detected. *Result or *Found: Interference required dilution.

RPD% = (|SPK - MSD|/((SPK + MSD)/2) * 100) M in Duplicate/MSD column indicates MSD.

SPIKE ADD column, A = Post Digest Spike; %R = Percent Recovery N/A = Not Analyzed; R > 4S = Result more than 4X the Spike Added

QC limits for MS recoveries apply only if the spike is at least 1/4 the concentration of the analyte in the sample.

Control limits for the RPD apply only if the concentration of the analyte in the sample is at least five times the reporting limit.

I/S: Insufficient sample for QC test.

QC Sample 1: SVL SAM No.: 405245 Client Sample ID: BC-55-211-221

112680

SVL ANALYTICAL

CHAIN OF CUSTODY RECORD

Page 7 of 18

Client: Phelps Dodge Tyrone Inc.
Contact: William Seibert III
Address: P.O. Drawer 571
Tyrone, NM 88065
Phone Number: 505-538-7151
FAX Number: 505-388-5773

NOTES:
1) Ensure proper container packaging.
2) Ship samples promptly following collection.
* 3) **Designate Sample Reject Disposition**
4) **Indicate state of sample origination**
PO#:
Project Name: 1490

Table 1. -- Matrix Type
1 = Surface Water, 2 = Ground Water
3 = Soil/Sediment, 4 = Rinsate, 5 = Oil
6=Waste, 7=Other (Specify)

State: NM

Samplers Signature:

FOR SVL USE ONLY
SVL JOB #

Lab Name: **SVL Analytical, Inc. (208) 784-1258 FAX (208) 783-0891**
Address: **One Government Gulch, Kellogg, ID 83837-0929**

	Sample ID	Collection				Miscellaneous			Preservative(s)						Analyses Required									Comments
		Date	Time	24 hour grab?	Collected by: (Init.)	Matrix Type From Table 1	No. of Containers	Sample Filtered ? Y/N	Unpreserved (Ice Only)	HNO3	HCl	H2SO4	NaOH	Other (Specify) N/A	ABA *	paste pH	paste E.C.							
1.	BC-55-211-221					3								X										* Full ABA
2.	BC-55-221-231																							with sulfur forms
3.	BC-55-231-241																							if enough sample is
4.	BC-55-241-251																							available. Otherwise
5.	BC-55-251-261																							run basic AGP and
6.	BC-55-261-271																							ANP to determine
7.	BC-55-271-281																							ABA on total
8.	BC-55-281-291																							sulfur.
9.	BC-55-291-301																							
10.	BC-55-301-311																							

Relinquished by: Ramon Sias	Date: 8/9/04	Time: 11:30	Received by: Seeley
	Date: 8/10/04	Time: 10:50	
Relinquished by:	Date:	Time:	Received by:
	Date:	Time:	

* Sample Reject: ☒ Return ☐ Dispose ☐ Other ______

White: LAB COPY Yellow: CUSTOMER COPY SVL-COC 4/03

112680

SVL ANALYTICAL

CHAIN OF CUSTODY RECORD

Page 8 of 18

Client: Phelps Dodge Tyrone Inc.
Contact: William Seibert III
Address: P.O. Drawer 571
Tyrone, NM 88065
Phone Number: 505-538-7151
FAX Number: 505-388-5773

NOTES:
1) Ensure proper container packaging.
2) Ship samples promptly following collection.
* 3) **Designate Sample Reject Disposition**
4) **Indicate state of sample origination**

PO#:
Project Name: 1490

Table 1. – Matrix Type
1 = Surface Water, 2 = Ground Water
3 = Soil/Sediment, 4 = Rinsate, 5 = Oil
6=Waste, 7=Other (Specify)

State: NM

FOR SVL USE ONLY
SVL JOB #:

Samplers Signature:

Lab Name: **SVL Analytical, Inc.** **(208) 784-1258** **FAX (208) 783-0891**
Address: **One Government Gulch, Kellogg, ID 83837-0929**

		Collection				Miscellaneous			Preservative(s)						Analyses Required									
	Sample ID	Date	Time	24 hour grab?	Collected by: (Init.)	Matrix Type From Table 1	No. of Containers	Sample Filtered ? Y/N	Unpreserved (Ice Only)	HNO3	HCl	H2SO4	NaOH	Other (Specify) N/A	ABA*	paste pH	paste E.C.							Comments
1.	BC-55-311-321					3								X										* Full ABA
2.	BC-55-321-331																							with sulfur forms
3.	BG-07-0-7																							if enough sample is
4.	BG-07-7-17																							available. Otherwise
5.	BG-07-17-27																							run basic AGP and
6.	BG-07-27-37																							ANP to determine
7.	BG-07-37-47																							ABA on total
8.	BG-07-47-57																							sulfur.
9.	BG-07-57-67																							
10.	BG-07-67-77																							

Relinquished by: Ramon Seas	Date: 8/9/04	Time: 11:30	Received by:	Date: 8/16/04	Time: 12:02
Relinquished by:	Date:	Time:	Received by:	Date:	Time:

* Sample Reject: ☒ Return ☐ Dispose ☐ Other ________ White: LAB COPY Yellow: CUSTOMER COPY SVL-COC 4/03

BA-47	246-256	
BA-47	256-266	XXXXX
BC-55	0-11	
BC-55	31-41	
BC-55	41-51	
BC-55	51-61	
BC-55	61-71	
BC-55	91-101	
BC-55	101-111	
BC-55	111-121	
BC-55	121-131	
BC-55	131-141	
BC-55	151-161	
BC-55	201-211	
BC-55	211-221	
BC-55	221-231	
BC-55	231-241	
BC-55	241-251	
BC-55	251-261	
BC-55	261-271	
BC-55	271-281	
BC-55	281-291	
BC-55	291-301	
BC-55	301-311	
BC-55	311-321	
BC-55	321-331	
BG-07	0-7	
BG-07	7-17	
BG-07	17-27	
BG-07	27-37	
BG-07	37-47	
BG-07	47-57	
BG-07	57-67	
BG-07	67-77	
BG-07	77-87	
BJ-07	0-7.3	
BJ-07	7.3-17.3	
BJ-07	17.3-27.3	
BJ-07	27.3-37.3	
BJ-07	37.3-47.3	
BJ-07	47.3-57.3	
BJ-07	57.3-67.3	
BJ-07	67.3-77.3	XXXXX
BN-011	0-9	
BN-011	9-19	
BN-011	19-29	
BN-011	29-39	
BN-011	39-49	
BN-011	49-59	

Page 1 of 1

SVL ANALYTICAL, INC.
vernment Gulch - Kellogg, ID 83837-0929

SAMPLE RECEIPT CONFIRMATION

SVL JOB No: 112680
Received: 8/16/04
Expected Due date: 8/30/04

By	Received	Sample Comments
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
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	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	

Container temp not measured upon receipt.

after job completion.
, then you will receive a letter requesting disposal options.

you have questions regarding the receipt of these samples. 8/16/04 15:38

TRANSMISSION VERIFICATION REPORT

TIME : 08/17/2004 09:09
NAME : SVL ANALYTICAL
FAX : 2087830891
TEL : 2087841258
SER.# : BROF3J496071

DATE,TIME	08/17 09:09
FAX NO./NAME	915053885773
DURATION	00:00:19
PAGE(S)	01
RESULT	OK
MODE	FINE ECM

SVL ANALYTICAL, INC.
One Government Gulch ▪ P.O. Box 929 ▪ Kellogg, Idaho 83827-0929 ▪ Phone: (208)784-1258 ▪ Fax: (208)783-0891

REPORT OF ANALYTICAL RESULTS

CLIENT : PHELPS DODGE - TYRONE
PROJECT: 1490
Sample Receipt: 8/16/04
Report Date: 9/01/04
Page 1 of 2
SVL JOB: 112681

SVL ID	CLIENT SAMPLE ID	COND 120.1	ABP EPA600	AGP EPA600	ANP EPA600	pH Pst ASA M9
S405268	BG-07-77-87	163umhos/cm	-0.35TCaC03/k	3.13TCaC03/k	2.78TCaC03/k	6.16
S405269	BJ-07-0-7.3	I/Sumhos/cm	-20.0TCaC03/k	20.0TCaC03/k	<0.30TCaC03/k	5.20
S405270	BJ-07-7.3-17.3	I/Sumhos/cm	-10.3TCaC03/k	10.3TCaC03/k	<0.30TCaC03/k	5.19
S405271	BJ-07-17.3-27.3	I/Sumhos/cm	-2.19TCaC03/k	2.19TCaC03/k	<0.30TCaC03/k	4.54
S405272	BJ-07-27.3-37.3	I/Sumhos/cm	-1.88TCaC03/k	1.88TCaC03/k	<0.30TCaC03/k	4.01
S405273	BJ-07-37.3-47.3	I/Sumhos/cm	-7.81TCaC03/k	7.81TCaC03/k	<0.30TCaC03/k	5.04
S405274	BJ-07-47.3-57.3	I/Sumhos/cm	-6.56TCaC03/k	6.56TCaC03/k	<0.30TCaC03/k	4.89
S405275	BJ-07-57.3-67.3	I/Sumhos/cm	-2.50TCaC03/k	2.50TCaC03/k	<0.30TCaC03/k	4.84
S405276	BN-011-0-9	I/Sumhos/cm	-4.06TCaC03/k	4.06TCaC03/k	<0.30TCaC03/k	6.25
S405277	BN-011-9-19	I/Sumhos/cm	-3.13TCaC03/k	3.13TCaC03/k	<0.30TCaC03/k	7.16
S405278	BN-011-19-29	I/Sumhos/cm	-5.00TCaC03/k	5.00TCaC03/k	<0.30TCaC03/k	6.27
S405279	BN-011-29-39	229umhos/cm	-6.88TCaC03/k	6.88TCaC03/k	<0.30TCaC03/k	6.09
S405280	BN-011-39-49	252umhos/cm	-3.44TCaC03/k	3.44TCaC03/k	<0.30TCaC03/k	5.60
S405281	BN-011-49-59	I/Sumhos/cm	-4.06TCaC03/k	4.06TCaC03/k	<0.30TCaC03/k	6.18
S405282	BN-011-59-69	I/Sumhos/cm	-5.31TCaC03/k	5.31TCaC03/k	<0.30TCaC03/k	6.02
S405283	BN-011-69-79	294umhos/cm	-6.56TCaC03/k	6.56TCaC03/k	<0.30TCaC03/k	6.10
S405284	BN-011-79-89	I/Sumhos/cm	-4.38TCaC03/k	4.38TCaC03/k	<0.30TCaC03/k	6.28
S405285	BN-011-89-99	254umhos/cm	-7.50TCaC03/k	7.50TCaC03/k	<0.30TCaC03/k	6.29
S405286	BN-011-99-109	272umhos/cm	-7.19TCaC03/k	7.19TCaC03/k	<0.30TCaC03/k	6.33
S405287	BN-011-109-119	321umhos/cm	-10.0TCaC03/k	10.0TCaC03/k	<0.30TCaC03/k	6.04

Soil Samples: As Received Basis

ID ID00019

Reviewed By:__________ Date: 9/1/04

CLIENT : PHELPS DODGE - TYRONE
PROJECT: 1490

Sample Receipt: 8/16/04
Report Date: 9/01/04

Page 2 of 2
SVL JOB: 112681

SVL ID	CLIENT SAMPLE ID	S N-EX LECO	S-PYR LECO	S-SO4 LECO	S-TOT LECO
S405268	BG-07-77-87	0.070%	0.100%	0.180%	0.350%
S405269	BJ-07-0-7.3	0.080%	0.640%	0.200%	0.920%
S405270	BJ-07-7.3-17.3	0.050%	0.330%	0.250%	0.630%
S405271	BJ-07-17.3-27.3	0.020%	0.070%	0.180%	0.270%
S405272	BJ-07-27.3-37.3	0.030%	0.060%	0.190%	0.280%
S405273	BJ-07-37.3-47.3	0.090%	0.250%	0.260%	0.600%
S405274	BJ-07-47.3-57.3	0.050%	0.210%	0.200%	0.460%
S405275	BJ-07-57.3-67.3	<0.010%	0.080%	0.220%	0.300%
S405276	BN-011-0-9	0.050%	0.130%	0.100%	0.280%
S405277	BN-011-9-19	0.020%	0.100%	0.120%	0.240%
S405278	BN-011-19-29	0.030%	0.160%	0.090%	0.280%
S405279	BN-011-29-39	<0.010%	0.220%	0.090%	0.310%
S405280	BN-011-39-49	0.020%	0.110%	0.160%	0.290%
S405281	BN-011-49-59	0.030%	0.130%	0.130%	0.290%
S405282	BN-011-59-69	0.020%	0.170%	0.130%	0.320%
S405283	BN-011-69-79	0.050%	0.210%	0.180%	0.440%
S405284	BN-011-79-89	0.040%	0.140%	0.170%	0.350%
S405285	BN-011-89-99	0.080%	0.240%	0.130%	0.450%
S405286	BN-011-99-109	0.120%	0.230%	0.150%	0.500%
S405287	BN-011-109-119	0.100%	0.320%	0.150%	0.570%

I/S: Insufficient sample.
Soil Samples: As Received Basis

Certificate: ID ID00019

Reviewed By:________________ Date: 9/1/04

SVL ANALYTICAL, INC.

Quality Control Report
Part I Prep Blank and Laboratory Control Sample

Client :PHELPS DODGE - TYRONE

SVL JOB No: 112681

Analyte	Method	Matrix	Units	Prep Blank	LCS True	LCS Found	LCS %R	Analysis Date
Spec. Cond.	120.1	SOIL	umhos/cm	3.60	206	194	94.2	9/01/04
Acid Generating	EPA600	SOIL	TCaCO3/k	N/A	9.36	9.25	98.8	8/30/04
Acid Neut. Pot.	EPA600	SOIL	TCaCO3/k	N/A	52.0	52.1	100.2	8/30/04
pH Paste	ASA M9	SOIL		5.78	8.45	8.35	98.8	8/30/04
Non-Ext Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	8/30/04
Pyritic Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	8/30/04
Sulfate Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	8/30/04
Total Sulfur, S	LECO	SOIL	%	<0.010	0.298	0.300	100.7	8/30/04

LEGEND:

LCS = Laboratory Control Sample LCS %R = LCS Percent Recovery N/A = Not Applicable

9/01/04 16:40

SVL ANALYTICAL, INC.

Quality Control Report
Part II Duplicate and Spike Analysis

Client :PHELPS DODGE - TYRONE

SVL JOB No: 112681

Test	Method	Mtx	QC SAMPLE ID	Units	Result	Duplicate or MSD Found	MSD RPD%	Matrix Spike Result	Matrix Spike SPK ADD	Matrix Spike %R	Analysis Date
COND	120.1	S	1			I/S	N/A	N/A	N/A	N/A	
ABP	EPA600	S	1	TCaCO3/	-0.35	-0.28	22.2	N/A	N/A	N/A	8/30/04
AGP	EPA600	S	1	TCaCO3/	3.13	2.81	10.8	N/A	N/A	N/A	8/30/04
ANP	EPA600	S	1	TCaCO3/	2.78	2.53	9.4	N/A	N/A	N/A	8/30/04
S N-EX	LECO	S	1	%	0.070	0.070	0.0	N/A	N/A	N/A	8/30/04
S-PYR	LECO	S	1	%	0.100	0.090	10.5	N/A	N/A	N/A	8/30/04
S-SO4	LECO	S	1	%	0.180	0.190	5.4	N/A	N/A	N/A	8/30/04
S-TOT	LECO	S	1	%	0.350	0.350	0.0	N/A	N/A	N/A	8/30/04

LEGEND:
RPD% = (|SAM - DUP|/((SAM + DUP)/2) * 100) UDL = Both SAM & DUP not detected. *Result or *Found: Interference required dilution.
RPD% = (|SPK - MSD|/((SPK + MSD)/2) * 100) M in Duplicate/MSD column indicates MSD.
SPIKE ADD column, A = Post Digest Spike; %R = Percent Recovery N/A = Not Analyzed; R > 4S = Result more than 4X the Spike Added
QC limits for MS recoveries apply only if the spike is at least 1/4 the concentration of the analyte in the sample.
Control limits for the RPD apply only if the concentration of the analyte in the sample is at least five times the reporting limit.
I/S: Insufficient sample for QC test.
QC Sample 1: SVL SAM No.: 405268 Client Sample ID: BG-07-77-87

BA-47	246-256	
BA-47	256-266	XXXXX
BC-55	0-11	
BC-55	31-41	
BC-55	41-51	
BC-55	51-61	
BC-55	61-71	
BC-55	91-101	
BC-55	101-111	
BC-55	111-121	
BC-55	121-131	
BC-55	131-141	
BC-55	151-161	
BC-55	201-211	
BC-55	211-221	
BC-55	221-231	
BC-55	231-241	
BC-55	241-251	
BC-55	251-261	
BC-55	261-271	
BC-55	271-281	
BC-55	281-291	
BC-55	291-301	
BC-55	301-311	
BC-55	311-321	
BC-55	321-331	
BG-07	0-7	
BG-07	7-17	
BG-07	17-27	
BG-07	27-37	
BG-07	37-47	
BG-07	47-57	
BG-07	57-67	
BG-07	67-77	
BG-07	77-87	
BJ-07	0-7.3	
BJ-07	7.3-17.3	
BJ-07	17.3-27.3	
BJ-07	27.3-37.3	
BJ-07	37.3-47.3	
BJ-07	47.3-57.3	
BJ-07	57.3-67.3	
BJ-07	67.3-77.3	XXXXX
BN-011	0-9	
BN-011	9-19	
BN-011	19-29	
BN-011	29-39	
BN-011	39-49	
BN-011	49-59	

BN-011	59-69	
BN-011	69-79	
BN-011	79-89	
BN-011	89-99	
BN-011	99-109	
BN-011	109-119	
BN-011	119-129	
BN-011	129-139	
BN-011	139-149	
BN-011	149-159	
BN-29	0-17	
BN-32	0-5	
BN-32	5-15	
BO+120-9	0-10	
BO+120-9	10-20	
BO+120-9	20-30	
BO+120-9	30-40	
BO+120-9	40-50	
BO+120-9	50-60	
BO+120-9	60-70	
BO+120-9	70-80	
BO+120-9	80-90	
BO+120-9	90-100	
BO+120-9	100-110	
BO+120-9	110-120	
BO-15+140	0-12	
BO-15+140	12-22	
BO-15+140	22-32	
BO-15+140	32-42	
BO-15+140	42-52	
BO-15+140	52-62	
BO-15+140	62-72	
BO-15+140	72-82	
BO-15+140	82-92	
BO-15+140	92-102	
BO-15+140	102-112	
BO-15+140	112-122	
BO-15+140	122-132	
BO-15+140	132-142	
BO-15+140	142-152	
BO-15+140	152-162	
BO-15+140	162-172	
BO-15+140	172-182	
BO-15+140	182-192	
BO-15+140	192-202	
BO-15+140	202-212	
BO-15+140	212-222	
BO-15+140	222-232	
BO-15+140	232-242	

112681

SVL ANALYTICAL

CHAIN OF COUSTODY RECORD

Page 9 of 18

Client: Phelps Dodge Tyrone Inc.
Contact: William Seibert III
Address: P.O. Drawer 571
Tyrone, NM 88065
Phone Number: 505-538-7151
FAX Number: 505-388-5773

NOTES:
1) Ensure proper container packaging.
2) Ship samples promptly following collection.
* 3) Designate Sample Reject Disposition
4) Indicate state of sample origination

PO#:
Project Name: 1490

Table 1. -- Matrix Type
1 = Surface Water, 2 = Ground Water
3 = Soil/Sediment, 4 = Rinsate, 5 = Oil
6=Waste, 7=Other (Specify)

State: NM

Samplers Signature:

FOR SVL USE ONLY
SVL JOB #:

Lab Name: **SVL Analytical, Inc.** (208) 784-1258 FAX (208) 783-0891
Address: One Government Gulch, Kellogg, ID 83837-0929

	Sample ID	Collection				Miscellaneous			Preservative(s)						Analyses Required									Comments
		Date	Time	24 hour grab?	Collected by: (Init.)	Matrix Type From Table 1	No. of Containers	Sample Filtered ? Y/N	Unpreserved (Ice Only)	HNO3	HCl	H2SO4	NaOH	Other (Specify) N/A	ABA *	paste pH	paste E.C.							
1.	BG-07-77-87					3								X										* Full ABA
2.	BJ-07-0-7.3																							with sulfur forms
3.	BJ-07-7.3-17.3																							if enough sample is
4.	BJ-07-17.3-27.3																							available. Otherwise
5.	BJ-07-27.3-37.3																							run basic AGP and
6.	BJ-07-37.3-47.3																							ANP to determine
7.	BJ-07-47.3-57.3																							ABA on total
8.	BJ-07-57.3-67.3																							sulfur.
9.	BN-011-0-9																							
10.	BN-011-9-19																							

Relinquished by:	Ramon Arias	Date: 8/9/04	Time: 11:30	Received by:		Date: 8/16/04	Time: 12:00
Relinquished by:		Date:	Time:	Received by:		Date:	Time:

* Sample Reject: ☒ Return ☐ Dispose ☐ Other ______ White: LAB COPY Yellow: CUSTOMER COPY SVL-COC 4/03

112681

SVL ANALYTICAL

CHAIN OF COUSTODY RECORD

Page 10 of 18

Client: Phelps Dodge Tyrone Inc.
Contact: William Seibert III
Address: P.O. Drawer 571
Tyrone, NM 88065
Phone Number: 505-538-7151
FAX Number: 505-388-5773

NOTES:
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2) Ship samples promptly following collection.
* 3) **Designate Sample Reject Disposition**
4) **Indicate state of sample origination**

PO#:
Project Name: 1490

Table 1. -- Matrix Type
1 = Surface Water, 2 = Ground Water
3 = Soil/Sediment, 4 = Rinsate, 5 = Oil
6=Waste, 7=Other (Specify)

State: NM

FOR SVL USE ONLY
SVL JOB #:

Samplers Signature:

Lab Name: **SVL Analytical, Inc. (208) 784-1258 FAX (208) 783-0891**
Address: **One Government Gulch, Kellogg, ID 83837-0929**

	Sample ID	Collection				Miscellaneous			Preservative(s)						Analyses Required									Comments
		Date	Time	24 hour grab?	Collected by: (Init.)	Matrix Type From Table 1	No. of Containers	Sample Filtered ? Y/N	Unpreserved (Ice Only)	HNO3	HCl	H2SO4	NaOH	Other (Specify) N/A	ABA *	paste pH	paste E.C.							
1.	BN-011-19-29					3								X										* Full ABA
2.	BN-011-29-39																							with sulfur forms
3.	BN-011-39-49																							if enough sample is
4.	BN-011-49-59																							available. Otherwise
5.	BN-011-59-69																							run basic AGP and
6.	BN-011-69-79																							ANP to determine
7.	BN-011-79-89																							ABA on total
8.	BN-011-89-99																							sulfur.
9.	BN-011-99-109																							
10.	BN-~~011-109~~-119					↓								↓										

Relinquished by: Ramon Sias	Date: 8/9/04	Time: 11:30	Received by:	Date: 8/10/04	Time: 12:00
Relinquished by:	Date:	Time:	Received by:	Date:	Time:

* Sample Reject: ☒ Return ☐ Dispose ☐ Other ______ White: LAB COPY Yellow: CUSTOMER COPY SVL-COC 4/03

Page 1 of 1

SVL ANALYTICAL, INC.
vernment Gulch - Kellogg, ID 83837-0929

SAMPLE RECEIPT CONFIRMATION

SVL JOB No: 112681
Received: 8/16/04
Expected Due date: 8/30/04

By	Received	Sample Comments
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
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	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	

:ontainer temp not measured upon receipt.

after job completion.
, then you will receive a letter requesting disposal options.

/ou have questions regarding the receipt of these samples. 8/16/04 15:42

TRANSMISSION VERIFICATION REPORT

TIME : 08/17/2004 09:08
NAME : SVL ANALYTICAL
FAX : 2087830891
TEL : 2087841258
SER.# : BROF3J496071

DATE,TIME	08/17 09:08
FAX NO./NAME	915053885773
DURATION	00:00:19
PAGE(S)	01
RESULT	OK
MODE	FINE ECM

SVL ANALYTICAL, INC.
One Government Gulch ▪ P.O. Box 929 ▪ Kellogg, Idaho 83827-0929 ▪ Phone: (208)784-1258 ▪ Fax: (208)783-0891

REPORT OF ANALYTICAL RESULTS

CLIENT : PHELPS DODGE - TYRONE
PROJECT: 1490

Sample Receipt: 8/16/04
Report Date: 9/01/04

Page 1 of 2
SVL JOB: 112682

SVL ID	CLIENT SAMPLE ID	COND 120.1	ABP EPA600	AGP EPA600	ANP EPA600	pH Pst ASA M9
S405290	BN-011-119-129	I/S	-11.6TCaCO3/k	11.6TCaCO3/k	<0.30TCaCO3/k	4.95
S405291	BN-011-129-139	I/S	-34.1TCaCO3/k	34.1TCaCO3/k	<0.30TCaCO3/k	4.97
S405292	BN-011-139-149	I/S	-14.1TCaCO3/k	14.1TCaCO3/k	<0.30TCaCO3/k	5.06
S405293	BN-011-149-159	I/S	-19.4TCaCO3/k	19.4TCaCO3/k	<0.30TCaCO3/k	4.27
S405294	BN-29-0-17	I/S	-3.13TCaCO3/k	3.13TCaCO3/k	<0.30TCaCO3/k	5.18
S405295	BN-32-0-5	I/S	-4.06TCaCO3/k	4.06TCaCO3/k	<0.30TCaCO3/k	6.13
S405296	BN-32-5-15	I/S	-5.94TCaCO3/k	5.94TCaCO3/k	<0.30TCaCO3/k	5.77
S405297	B0+120-9-0-10	I/S	-4.69TCaCO3/k	4.69TCaCO3/k	<0.30TCaCO3/k	5.28
S405298	B0+120-9-10-20	I/S	-33.1TCaCO3/k	33.1TCaCO3/k	<0.30TCaCO3/k	4.89
S405299	B0+120-9-20-30	722umhos/cm	-40.6TCaCO3/k	40.6TCaCO3/k	<0.30TCaCO3/k	4.85
S405300	B0+120-9-30-40	736umhos/cm	-13.4TCaCO3/k	13.4TCaCO3/k	<0.30TCaCO3/k	5.36
S405301	B0+120-9-40-50	I/S	-5.94TCaCO3/k	5.94TCaCO3/k	<0.30TCaCO3/k	4.97
S405302	B0+120-9-50-60	I/S	-5.00TCaCO3/k	5.00TCaCO3/k	<0.30TCaCO3/k	4.85
S405303	B0+120-9-60-70	I/S	-35.0TCaCO3/k	35.0TCaCO3/k	<0.30TCaCO3/k	4.83
S405304	B0+120-9-70-80	I/S	-8.13TCaCO3/k	8.13TCaCO3/k	<0.30TCaCO3/k	5.10
S405305	B0+120-9-80-90	I/S	-36.9TCaCO3/k	36.9TCaCO3/k	<0.30TCaCO3/k	4.21
S405306	B0+120-9-90-100	I/S	-42.2TCaCO3/k	42.2TCaCO3/k	<0.30TCaCO3/k	4.43
S405307	B0+120-9-100-110	I/S	-16.9TCaCO3/k	16.9TCaCO3/k	<0.30TCaCO3/k	4.61
S405308	B0+120-9-110-120	I/S	-49.1TCaCO3/k	49.1TCaCO3/k	<0.30TCaCO3/k	4.84
S405309	B0-15+140-0-12	629umhos/cm	-2.50TCaCO3/k	2.50TCaCO3/k	<0.30TCaCO3/k	4.44

Soil Samples: As Received Basis

CERFITCATE:ID I000019

Reviewed By: ______________ Date: 10/15/05

SVL ANALYTICAL, INC.
One Government Gulch ▪ P.O. Box 929 ▪ Kellogg, Idaho 83827-0929 ▪ Phone: (208)784-1258 ▪ Fax: (208)783-0891

REPORT OF ANALYTICAL RESULTS

CLIENT : PHELPS DODGE - TYRONE	Sample Receipt: 8/16/04		Page 2 of 2
PROJECT: 1490	Report Date: 9/01/04		SVL JOB: 112682

SVL ID	CLIENT SAMPLE ID	S N-EX LECO	S-PYR LECO	S-SO4 LECO	S-TOT LECO
S405290	BN-011-119-129	0.040%	0.370%	0.200%	0.610%
S405291	BN-011-129-139	0.040%	1.09%	0.330%	1.46%
S405292	BN-011-139-149	0.010%	0.450%	0.210%	0.670%
S405293	BN-011-149-159	0.010%	0.620%	0.320%	0.950%
S405294	BN-29-0-17	<0.010%	0.100%	0.170%	0.270%
S405295	BN-32-0-5	0.030%	0.130%	0.180%	0.340%
S405296	BN-32-5-15	0.020%	0.190%	0.250%	0.460%
S405297	BO+120-9-0-10	<0.010%	0.150%	0.190%	0.340%
S405298	BO+120-9-10-20	0.020%	1.06%	0.300%	1.38%
S405299	BO+120-9-20-30	0.030%	1.30%	0.270%	1.60%
S405300	BO+120-9-30-40	<0.010%	0.430%	0.280%	0.710%
S405301	BO+120-9-40-50	0.020%	0.190%	0.230%	0.440%
S405302	BO+120-9-50-60	0.020%	0.160%	0.190%	0.370%
S405303	BO+120-9-60-70	0.020%	1.12%	0.300%	1.44%
S405304	BO+120-9-70-80	<0.010%	0.260%	0.240%	0.500%
S405305	BO+120-9-80-90	0.020%	1.18%	0.430%	1.63%
S405306	BO+120-9-90-100	0.020%	1.35%	0.420%	1.79%
S405307	BO+120-9-100-110	0.010%	0.540%	0.300%	0.850%
S405308	BO+120-9-110-120	0.020%	1.57%	0.410%	2.00%
S405309	BO-15+140-0-12	0.030%	0.080%	0.280%	0.390%

I/S: Insufficient sample.

Soil Samples: As Received Basis

Certificate: ID ID00019

Reviewed By:________________ Date: 9/1/04

SVL ANALYTICAL, INC.

Quality Control Report
Part I Prep Blank and Laboratory Control Sample

Client :PHELPS DODGE - TYRONE

SVL JOB No: 112682

Analyte	Method	Matrix	Units	Prep Blank	True——LCS——Found		LCS %R	Analysis Date
Spec. Cond.	120.1	SOIL	umhos/cm	3.60	206	194	94.2	9/01/04
Acid Neut. Pot.	EPA600	SOIL	TCaCO3/k	N/A	52.0	52.1	100.2	8/31/04
pH Paste	ASA M9	SOIL		5.78	8.45	8.35	98.8	8/31/04
Non-Ext Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	8/31/04
Pyritic Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	8/31/04
Sulfate Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	8/31/04
Total Sulfur, S	LECO	SOIL	%	<0.010	0.298	0.300	100.7	8/31/04

LEGEND:

LCS = Laboratory Control Sample

LCS %R = LCS Percent Recovery

N/A = Not Applicable

9/01/04 15:42

SVL ANALYTICAL, INC.

Quality Control Report
Part II Duplicate and Spike Analysis

Client :PHELPS DODGE - TYRONE

SVL JOB No: 112682

Test	Method	Mtx	QC SAMPLE ID	Units	Result	Duplicate or MSD Found	MSD RPD%	Matrix Spike Result	SPK ADD	%R	Analysis Date
COND	120.1	S	1			I/S	N/A	N/A	N/A	N/A	
ABP	EPA600	S	1	TCaCO3/	-11.3	-11.6	2.6	N/A	N/A	N/A	9/01/04
ANP	EPA600	S	1	TCaCO3/	<0.30	<0.30	UDL	N/A	N/A	N/A	8/31/04
S N-EX	LECO	S	1	%	0.040	0.040	0.0	N/A	N/A	N/A	8/31/04
S-PYR	LECO	S	1	%	0.370	0.380	2.7	N/A	N/A	N/A	8/31/04
S-SO4	LECO	S	1	%	0.200	0.200	0.0	N/A	N/A	N/A	8/31/04
S-TOT	LECO	S	1	%	0.610	0.620	1.6	N/A	N/A	N/A	8/31/04

LEGEND:
RPD% = (|SAM - DUP|/((SAM + DUP)/2) * 100)   UDL = Both SAM & DUP not detected.   *Result or *Found: Interference required dilution.
RPD% = (|SPK - MSD|/((SPK + MSD)/2) * 100)   M in Duplicate/MSD column indicates MSD.
SPIKE ADD column, A = Post Digest Spike; %R = Percent Recovery N/A = Not Analyzed; R > 4S = Result more than 4X the Spike Added
QC limits for MS recoveries apply only if the spike is at least 1/4 the concentration of the analyte in the sample.
Control limits for the RPD apply only if the concentration of the analyte in the sample is at least five times the reporting limit.
I/S: Insufficient sample for QC test.
QC Sample 1:   SVL SAM No.: 405290   Client Sample ID: BN-011-119-129

BN-011	59-69	
BN-011	69-79	
BN-011	79-89	
BN-011	89-99	
BN-011	99-109	
BN-011	109-119	
BN-011	119-129	
BN-011	129-139	
BN-011	139-149	
BN-011	149-159	
BN-29	0-17	
BN-32	0-5	
BN-32	5-15	
BO+120-9	0-10	
BO+120-9	10-20	
BO+120-9	20-30	
BO+120-9	30-40	
BO+120-9	40-50	
BO+120-9	50-60	
BO+120-9	60-70	
BO+120-9	70-80	
BO+120-9	80-90	
BO+120-9	90-100	
BO+120-9	100-110	
BO+120-9	110-120	
BO-15+140	0-12	
BO-15+140	12-22	
BO-15+140	22-32	
BO-15+140	32-42	
BO-15+140	42-52	
BO-15+140	52-62	
BO-15+140	62-72	
BO-15+140	72-82	
BO-15+140	82-92	
BO-15+140	92-102	
BO-15+140	102-112	
BO-15+140	112-122	
BO-15+140	122-132	
BO-15+140	132-142	
BO-15+140	142-152	
BO-15+140	152-162	
BO-15+140	162-172	
BO-15+140	172-182	
BO-15+140	182-192	
BO-15+140	192-202	
BO-15+140	202-212	
BO-15+140	212-222	
BO-15+140	222-232	
BO-15+140	232-242	

112682

SVL ANALYTICAL

CHAIN OF CUSTODY RECORD

Page 11 of 18

Client: Phelps Dodge Tyrone Inc.
Contact: William Seibert III
Address: P.O. Drawer 571
Tyrone, NM 88065
Phone Number: 505-538-7151
FAX Number: 505-388-5773

NOTES:
1) Ensure proper container packaging.
2) Ship samples promptly following collection.
* 3) **Designate Sample Reject Disposition**
4) **Indicate state of sample origination**

Table 1. – Matrix Type
1 = Surface Water, 2 = Ground Water
3 = Soil/Sediment, 4 = Rinsate, 5 = Oil
6=Waste, 7=Other (Specify)

FOR SVL USE ONLY
SVL JOB #

State: NM
PO#:
Project Name: 1490
Samplers Signature:

Lab Name: **SVL Analytical, Inc.** (208) 784-1258 FAX (208) 783-0891
Address: **One Government Gulch, Kellogg, ID 83837-0929**

		Collection				Miscellaneous			Preservative(s)						Analyses Required									
	Sample ID	Date	Time	24 hour grab?	Collected by: (Init.)	Matrix Type From Table 1	No. of Containers	Sample Filtered ? Y/N	Unpreserved (Ice Only)	HNO3	HCl	H2SO4	NaOH	Other (Specify) N/A	ABA *	paste pH	paste E.C.							Comments
1.	BN-011-119-129					3								X										* Full ABA
2.	BN-011-129-139																							with sulfur forms
3.	BN-011-139-149																							if enough sample is
4.	BN-011-149-159																							available. Otherwise
5.	BN-29-0-17																							run basic AGP and
6.	BN-32-0-5																							ANP to determine
7.	BN-32-5-15																							ABA on total
8.	B0+120-9-0-10																							sulfur.
9.	B0+120-9-10-20																							
10.	B0+120-9-20-30																							

Relinquished by: Ramon Seas	Date: 8/9/04	Time: 11:30	Received by:	Date: 8/16/04	Time: 12:50
Relinquished by:	Date:	Time:	Received by:	Date:	Time:

* Sample Reject: ☒ Return ☐ Dispose ☐ Other ____________ White: LAB COPY Yellow: CUSTOMER COPY SVL-COC 4/03

112682

SVL ANALYTICAL

CHAIN OF CUSTODY RECORD

Page 12 of 18

Client: Phelps Dodge Tyrone Inc.
Contact: William Seibert III
Address: P.O. Drawer 571
Tyrone, NM 88065
Phone Number: 505-538-7151
FAX Number: 505-388-5773

NOTES:
1) Ensure proper container packaging.
2) Ship samples promptly following collection.
* 3) Designate Sample Reject Disposition
4) Indicate state of sample origination
PO#:
Project Name: 1490

Table 1. -- Matrix Type
1 = Surface Water, 2 = Ground Water
3 = Soil/Sediment, 4 = Rinsate, 5 = Oil
6=Waste, 7=Other (Specify)

FOR SVL USE ONLY
SVL JOB #

State: NM

Samplers Signature:

Lab Name: SVL Analytical, Inc. (208) 784-1258 FAX (208) 783-0891
Address: One Government Gulch, Kellogg, ID 83837-0929

	Sample ID	Collection				Miscellaneous			Preservative(s)						Analyses Required									Comments
		Date	Time	24 hour grab?	Collected by: (Init.)	Matrix Type From Table 1	No. of Containers	Sample Filtered ? Y/N	Unpreserved (Ice Only)	HNO3	HCl	H2SO4	NaOH	Other (Specify) N/A	ABA *	paste pH	paste E.C.							
1.	B0+120-9-30-40					3								X										* Full ABA
2.	B0+120-9-40-50																							with sulfur forms
3.	B0+120-9-50-60																							if enough sample is
4.	B0+120-9-60-70																							available. Otherwise
5.	B0+120-9-70-80																							run basic AGP and
6.	B0+120-9-80-90																							ANP to determine
7.	B0+120-9-90-100																							ABA on total
8.	B0+120-9-100-110																							sulfur.
9.	B0+120-9-110-120																							
10.	B0-15+140-9-12																							

Relinquished by:	Ramon Sias	Date: 8/9/04	Time: 11:30	Received by:		Date: 8/16/04	Time: 12'00
Relinquished by:		Date:	Time:	Received by:		Date:	Time:

* Sample Reject: ☒ Return ☐ Dispose ☐ Other ________ White: LAB COPY Yellow: CUSTOMER COPY SVL-COC 4/03

SVL ANALYTICAL, INC.
vernment Gulch - Kellogg, ID 83837-0929

Page 1 of 1

SAMPLE RECEIPT CONFIRMATION

SVL JOB No: 112682
Received: 8/16/04
Expected Due date: 8/30/04

By	Received	Sample Comments
	8/16/04	
	8/16/04	
	8/16/04	
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	8/16/04	
	8/16/04	

ontainer temp not measured upon receipt.

after job completion.
then you will receive a letter requesting disposal options.

ou have questions regarding the receipt of these samples. 8/16/04 15:48

TRANSMISSION VERIFICATION REPORT

TIME : 08/17/2004 09:07
NAME : SVL ANALYTICAL
FAX : 2087830891
TEL : 2087841258
SER.# : BROF3J496071

DATE,TIME	08/17 09:07
FAX NO./NAME	915053885773
DURATION	00:00:19
PAGE(S)	01
RESULT	OK
MODE	FINE ECM

SVL ANALYTICAL, INC.

One Government Gulch ▪ P.O. Box 929 ▪ Kellogg, Idaho 83827-0929 ▪ Phone: (208)784-1258 ▪ Fax: (208)783-0891

REPORT OF ANALYTICAL RESULTS

CLIENT : PHELPS DODGE - TYRONE
PROJECT: 1490

Sample Receipt: 8/16/04
Report Date: 9/03/04

Page 1 of 2
SVL JOB: 112683

SVL ID	CLIENT SAMPLE ID	COND 120.1	ABP EPA600	AGP EPA600	ANP EPA600	pH Pst ASA M9
S405312	BO-15+140-12-22	1040umhos/cm	-1.88TCaCO3	1.88TCaCO3	<0.30TCaCO3	4.59
S405313	BO-15+140-22-32	I/S	-0.94TCaCO3	0.94TCaCO3	<0.30TCaCO3	4.91
S405314	BO-15+140-32-42	I/S	-19.4TCaCO3	19.4TCaCO3	<0.30TCaCO3	4.30
S405315	BO-15+140-42-52	I/S	-36.3TCaCO3	36.3TCaCO3	<0.30TCaCO3	4.06
S405316	BO-15+140-52-62	1550umhos/cm	-41.9TCaCO3	41.9TCaCO3	<0.30TCaCO3	3.96
S405317	BO-15+140-62-72	I/S	-56.3TCaCO3	56.3TCaCO3	<0.30TCaCO3	4.16
S405318	BO-15+140-72-82	I/S	-30.6TCaCO3	30.6TCaCO3	<0.30TCaCO3	4.22
S405319	BO-15+140-82-92	I/S	-28.4TCaCO3	28.4TCaCO3	<0.30TCaCO3	4.23
S405320	BO-15+140-92-102	I/S	-50.3TCaCO3	50.3TCaCO3	<0.30TCaCO3	4.11
S405321	BO-15+140-102-112	1030umhos/cm	-14.7TCaCO3	14.7TCaCO3	<0.30TCaCO3	4.43
S405322	BO-15+140-112-122	I/S	-12.2TCaCO3	12.2TCaCO3	<0.30TCaCO3	4.18
S405323	BO-15+140-122-132	I/S	-9.69TCaCO3	9.69TCaCO3	<0.30TCaCO3	4.48
S405324	BO-15+140-132-142	946umhos/cm	-1.25TCaCO3	1.25TCaCO3	<0.30TCaCO3	4.76
S405325	BO-15+140-142-152	I/S	-1.56TCaCO3	1.56TCaCO3	<0.30TCaCO3	4.97
S405326	BO-15+140-152-162	I/S	-3.75TCaCO3	3.75TCaCO3	<0.30TCaCO3	4.98
S405327	BO-15+140-162-172	1130umhos/cm	-1.56TCaCO3	1.56TCaCO3	<0.30TCaCO3	4.96
S405328	BO-15+140-172-182	I/S	-1.56TCaCO3	1.56TCaCO3	<0.30TCaCO3	4.69
S405329	BO-15+140-182-192	I/S	-3.13TCaCO3	3.13TCaCO3	<0.30TCaCO3	4.69
S405330	BO-15+140-192-202	1200umhos/cm	-2.19TCaCO3	2.19TCaCO3	<0.30TCaCO3	4.60
S405331	BO-15+140-202-212	I/S	-2.50TCaCO3	2.50TCaCO3	<0.30TCaCO3	4.97

I/S: Insufficient sample   Soil Samples: As Received Basis

ID ID00019

Reviewed By:_______________ Date: 9/3/04

SVL ANALYTICAL, INC.

REPORT OF ANALYTICAL RESULTS

One Government Gulch ▪ P.O. Box 929 ▪ Kellogg, Idaho 83827-0929 ▪ Phone: (208)784-1258 ▪ Fax: (208)783-0891

CLIENT : PHELPS DODGE - TYRONE
PROJECT: 1490

Sample Receipt: 8/16/04
Report Date: 9/03/04

Page 2 of 2
SVL JOB: 112683

SVL ID	CLIENT SAMPLE ID	S N-EX LECO	S-PYR LECO	S-SO4 LECO	S-TOT LECO
S405312	BO-15+140-12-22	0.020%	0.060%	0.230%	0.310%
S405313	BO-15+140-22-32	<0.010%	0.030%	0.110%	0.140%
S405314	BO-15+140-32-42	0.020%	0.620%	0.350%	0.990%
S405315	BO-15+140-42-52	0.020%	1.16%	0.400%	1.58%
S405316	BO-15+140-52-62	0.020%	1.34%	0.730%	2.09%
S405317	BO-15+140-62-72	0.030%	1.80%	0.380%	2.21%
S405318	BO-15+140-72-82	0.020%	0.980%	0.360%	1.36%
S405319	BO-15+140-82-92	0.020%	0.910%	0.330%	1.26%
S405320	BO-15+140-92-102	0.030%	1.61%	0.360%	2.00%
S405321	BO-15+140-102-112	0.040%	0.470%	0.230%	0.740%
S405322	BO-15+140-112-122	0.030%	0.390%	0.360%	0.780%
S405323	BO-15+140-122-132	0.030%	0.310%	0.230%	0.570%
S405324	BO-15+140-132-142	<0.010%	0.040%	0.080%	0.120%
S405325	BO-15+140-142-152	0.010%	0.050%	0.100%	0.160%
S405326	BO-15+140-152-162	<0.010%	0.120%	0.140%	0.260%
S405327	BO-15+140-162-172	<0.010%	0.050%	0.110%	0.160%
S405328	BO-15+140-172-182	<0.010%	0.050%	0.190%	0.240%
S405329	BO-15+140-182-192	0.020%	0.100%	0.220%	0.340%
S405330	BO-15+140-192-202	0.010%	0.070%	0.230%	0.310%
S405331	BO-15+140-202-212	<0.010%	0.080%	0.140%	0.220%

Soil Samples: As Received Basis

Certificate: ID ID00019

Reviewed By:

Date: 9/3/04

SVL ANALYTICAL, INC.

Quality Control Report
Part I Prep Blank and Laboratory Control Sample

Client :PHELPS DODGE - TYRONE

SVL JOB No: 112683

Analyte	Method	Matrix	Units	Prep Blank	True—LCS—Found		LCS %R	Analysis Date
Spec. Cond.	120.1	SOIL	umhos/cm	3.80	206	192	93.2	9/03/04
Acid Generating	EPA600	SOIL	TCaCO3/k	N/A	9.36	9.25	98.8	9/03/04
Acid Neut. Pot.	EPA600	SOIL	TCaCO3/k	N/A	52.0	51.1	98.3	9/03/04
pH Paste	ASA M9	SOIL		5.91	8.45	8.32	98.5	9/03/04
Non-Ext Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	9/03/04
Pyritic Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	9/03/04
Sulfate Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	9/03/04
Total Sulfur, S	LECO	SOIL	%	<0.010	0.298	0.300	100.7	9/03/04

LEGEND:

LCS = Laboratory Control Sample
LCS %R = LCS Percent Recovery
N/A = Not Applicable

9/03/04 15:54

Quality Control Report
Part II Duplicate and Spike Analysis

Client :PHELPS DODGE - TYRONE

SVL JOB No: 112683

Test	Method	Mtx	QC SAMPLE ID Units	QC SAMPLE ID Result	Duplicate or Found	MSD RPD%	Matrix Spike Result	Matrix Spike SPK ADD	Matrix Spike %R	Analysis Date
COND	120.1	S	1	1940	I/S	N/A	N/A	N/A	N/A	9/03/04
ABP	EPA600	S	1 TCaCO3/	-1.88	-1.88	0.0	N/A	N/A	N/A	9/03/04
AGP	EPA600	S	1 TCaCO3/	1.88	1.88	0.0	N/A	N/A	N/A	9/03/04
ANP	EPA600	S	1 TCaCO3/	<0.30	<0.30	UDL	N/A	N/A	N/A	9/03/04
S N-EX	LECO	S	1 %	0.020	0.020	0.0	N/A	N/A	N/A	9/03/04
S-PYR	LECO	S	1 %	0.060	0.060	0.0	N/A	N/A	N/A	9/03/04
S-SO4	LECO	S	1 %	0.230	0.220	4.4	N/A	N/A	N/A	9/03/04
S-TOT	LECO	S	1 %	0.310	0.300	3.3	N/A	N/A	N/A	9/03/04

LEGEND:
RPD% = (|SAM - DUP|/((SAM + DUP)/2) * 100) UDL = Both SAM & DUP not detected. *Result or *Found: Interference required dilution.
RPD% = (|SPK - MSD|/((SPK + MSD)/2) * 100) M in Duplicate/MSD column indicates MSD.
SPIKE ADD column, A = Post Digest Spike; %R = Percent Recovery N/A = Not Analyzed; R > 4S = Result more than 4X the Spike Added
QC limits for MS recoveries apply only if the spike is at least 1/4 the concentration of the analyte in the sample.
Control limits for the RPD apply only if the concentration of the analyte in the sample is at least five times the reporting limit.
I/S: Insufficient sample for QC test.
QC Sample 1: SVL SAM No.: 405312 Client Sample ID: BO-15+140-12-22

112683

SVL ANALYTICAL

CHAIN OF CUSTODY RECORD

Page 13 of 18

Client: Phelps Dodge Tyrone Inc.
Contact: William Seibert III
Address: P.O. Drawer 571
Tyrone, NM 88065
Phone Number: 505-538-7151
FAX Number: 505-388-5773

NOTES:
1) Ensure proper container packaging.
2) Ship samples promptly following collection.
* 3) Designate Sample Reject Disposition
4) Indicate state of sample origination

PO#:
Project Name: 1490

Table 1. -- Matrix Type
1 = Surface Water, 2 = Ground Water
3 = Soil/Sediment, 4 = Rinsate, 5 = Oil
6=Waste, 7=Other (Specify)

State: NM

FOR SVL USE ONLY
SVL JOB #

Samplers Signature:

Lab Name: SVL Analytical, Inc. (208) 784-1258 FAX (208) 783-0891
Address: One Government Gulch, Kellogg, ID 83837-0929

		Collection				Miscellaneous			Preservative(s)						Analyses Required									
	Sample ID	Date	Time	24 hour grab?	Collected by: (Init.)	Matrix Type From Table 1	No. of Containers	Sample Filtered ? Y/N	Unpreserved (Ice Only)	HNO3	HCl	H2SO4	NaOH	Other (Specify) N/A	ABA *	paste pH	paste E.C.							Comments
1.	B0-15+140-12-22					3								X										* Full ABA
2.	B0-15+140-22-32																							with sulfur forms
3.	B0-15+140-32-42																							if enough sample is
4.	B0-15+140-42-52																							available. Otherwise
5.	B0-15+140-52-62																							run basic AGP and
6.	B0-15+140-62-72																							ANP to determine
7.	B0-15+140-72-82																							ABA on total
8.	B0-15+140-82-92																							sulfur.
9.	B0-15+140-92-102																							
10.	B0-15+140-102-112																							

Relinquished by: Ramon Seas	Date: 8/9/04	Time: 11:30	Received by: CR Sewy	Date: 8/16/04	Time: 12:02
Relinquished by:	Date:	Time:	Received by:	Date:	Time:

* Sample Reject: ☒ Return ☐ Dispose ☐ Other ______ White: LAB COPY Yellow: CUSTOMER COPY SVL-COC 4/03

112683

SVL ANALYTICAL

CHAIN OF CUSTODY RECORD

Page 14 of 18

Client: Phelps Dodge Tyrone Inc.
Contact: William Seibert III
Address: P.O. Drawer 571
Tyrone, NM 88065
Phone Number: 505-538-7151
FAX Number: 505-388-5773

NOTES:
1) Ensure proper container packaging.
2) Ship samples promptly following collection.
* 3) Designate Sample Reject Disposition
4) Indicate state of sample origination

State: NM
PO#:
Project Name: 1490

Table 1. – Matrix Type
1 = Surface Water, 2 = Ground Water
3 = Soil/Sediment, 4 = Rinsate, 5 = Oil
6=Waste, 7=Other (Specify)

FOR SVL USE ONLY
SVL JOB #

Samplers Signature:

Lab Name: SVL Analytical, Inc. (208) 784-1258 FAX (208) 783-0891
Address: One Government Gulch, Kellogg, ID 83837-0929

		Collection				Miscellaneous			Preservative(s)						Analyses Required									
	Sample ID	Date	Time	24 hour grab?	Collected by: (Init.)	Matrix Type From Table 1	No. of Containers	Sample Filtered ? Y/N	Unpreserved (Ice Only)	HNO3	HCl	H2SO4	NaOH	Other (Specify) N/A	ABA *	paste pH	paste E.C.							Comments
1.	B0-15+140-112-122					3								X										* Full ABA
2.	B0-15+140-122-132																							with sulfur forms
3.	B0-15+140-132-142																							if enough sample is
4.	B0-15+140-142-152																							available. Otherwise
5.	B0-15+140-152-162																							run basic AGP and
6.	B0-15+140-162-172																							ANP to determine
7.	B0-15+140-172-182																							ABA on total
8.	B0-15+140-182-192																							sulfur.
9.	B0-15+140-192-202																							
10.	B0-15+140-202-212																							

Relinquished by: Ramon Seas	Date: 8/9/04	Time: 11:30	Received by:	Date: 8/16/04	Time: 12:00
Relinquished by:	Date:	Time:	Received by:	Date:	Time:

* Sample Reject: ☒ Return ☐ Dispose ☐ Other ______ White: LAB COPY Yellow: CUSTOMER COPY SVL-COC 4/03

BN-011	59-69	
BN-011	69-79	
BN-011	79-89	
BN-011	89-99	
BN-011	99-109	
BN-011	109-119	
BN-011	119-129	
BN-011	129-139	
BN-011	139-149	
BN-011	149-159	
BN-29	0-17	
BN-32	0-5	
BN-32	5-15	
BO+120-9	0-10	
BO+120-9	10-20	
BO+120-9	20-30	
BO+120-9	30-40	
BO+120-9	40-50	
BO+120-9	50-60	
BO+120-9	60-70	
BO+120-9	70-80	
BO+120-9	80-90	
BO+120-9	90-100	
BO+120-9	100-110	
BO+120-9	110-120	
BO-15+140	0-12	
BO-15+140	12-22	
BO-15+140	22-32	
BO-15+140	32-42	
BO-15+140	42-52	
BO-15+140	52-62	
BO-15+140	62-72	
BO-15+140	72-82	
BO-15+140	82-92	
BO-15+140	92-102	
BO-15+140	102-112	
BO-15+140	112-122	
BO-15+140	122-132	
BO-15+140	132-142	
BO-15+140	142-152	
BO-15+140	152-162	
BO-15+140	162-172	
BO-15+140	172-182	
BO-15+140	182-192	
BO-15+140	192-202	
BO-15+140	202-212	
BO-15+140	212-222	
BO-15+140	222-232	
BO-15+140	232-242	

SVL ANALYTICAL, INC.
vernment Gulch - Kellogg, ID 83837-0929

Page 1 of 1

SAMPLE RECEIPT CONFIRMATION

SVL JOB No: 112683
Received: 8/16/04
Expected Due date: 8/30/04

By	Received	Sample Comments
	8/16/04	
	8/16/04	
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	8/16/04	

ontainer temp not measured upon receipt.

after job completion.
then you will receive a letter requesting disposal options.

ou have questions regarding the receipt of these samples. 8/16/04 16:08

TRANSMISSION VERIFICATION REPORT

TIME : 08/17/2004 09:06
NAME : SVL ANALYTICAL
FAX : 2087830891
TEL : 2087841258
SER.# : BROF3J496071

DATE,TIME	08/17 09:06
FAX NO./NAME	915053885773
DURATION	00:00:20
PAGE(S)	01
RESULT	OK
MODE	FINE ECM

SVL ANALYTICAL, INC.

One Government Gulch ▪ P.O. Box 929 ▪ Kellogg, Idaho 83827-0929 ▪ Phone: (208)784-1258 ▪ Fax: (208)783-0891

REPORT OF ANALYTICAL RESULTS

CLIENT : PHELPS DODGE - TYRONE
PROJECT: 1490

Sample Receipt: 8/16/04
Report Date: 9/03/04

Page 1 of 2
SVL JOB: 112684

SVL ID	CLIENT SAMPLE ID	COND 120.1	ABP EPA600	AGP EPA600	ANP EPA600	pH Pst ASA M9
S405334	BO-15+140-212-222	965umhos/cm	-4.38TCaC03/k	4.38TCaC03/k	<0.30TCaC03/k	5.53
S405335	BO-15+140-222-232	I/S	-16.6TCaC03/k	16.6TCaC03/k	<0.30TCaC03/k	4.74
S405336	BO-15+140-232-242	1630umhos/cm	-28.8TCaC03/k	28.8TCaC03/k	<0.30TCaC03/k	4.65
S405337	BO-15+140-242-252	933umhos/cm	-6.56TCaC03/k	6.56TCaC03/k	<0.30TCaC03/k	5.16
S405338	BO-15+140-252-262	I/S	-4.38TCaC03/k	4.38TCaC03/k	<0.30TCaC03/k	5.51
S405339	BO-15+140-262-272	I/S	-4.06TCaC03/k	4.06TCaC03/k	<0.30TCaC03/k	5.22
S405340	BO-15+140-272-282	I/S	-2.50TCaC03/k	2.50TCaC03/k	<0.30TCaC03/k	5.34
S405341	BO-15+140-282-292	1160umhos/cm	-3.44TCaC03/k	3.44TCaC03/k	<0.30TCaC03/k	5.30
S405342	BO-15+140-292-302	I/S	-1.88TCaC03/k	1.88TCaC03/k	<0.30TCaC03/k	4.55
S405343	BO-15+140-302-312	796umhos/cm	-1.25TCaC03/k	1.25TCaC03/k	<0.30TCaC03/k	4.84
S405344	BQ-1+150-0-7	I/S	-39.7TCaC03/k	39.7TCaC03/k	<0.30TCaC03/k	4.21
S405345	BQ-1+150-7-17	I/S	-23.4TCaC03/k	23.4TCaC03/k	<0.30TCaC03/k	4.06
S405346	BQ-1+150-17-27	I/S	-10.0TCaC03/k	10.0TCaC03/k	<0.30TCaC03/k	4.32
S405347	BR-16A-0-9	I/S	-15.0TCaC03/k	15.0TCaC03/k	<0.30TCaC03/k	4.43
S405348	BR-16A-9-19	I/S	-49.1TCaC03/k	49.1TCaC03/k	<0.30TCaC03/k	4.36
S405349	BR-16A-19-29	I/S	-41.3TCaC03/k	41.3TCaC03/k	<0.30TCaC03/k	4.50
S405350	BR-16A-29-39	I/S	-44.1TCaC03/k	44.1TCaC03/k	<0.30TCaC03/k	4.28
S405351	BR-16A-39-49	I/S	-21.6TCaC03/k	21.6TCaC03/k	<0.30TCaC03/k	4.46
S405352	BR-16A-49-59	I/S	-11.9TCaC03/k	11.9TCaC03/k	<0.30TCaC03/k	4.49
S405353	BR-16A-59-69	I/S	-13.8TCaC03/k	13.8TCaC03/k	<0.30TCaC03/k	4.69

Soil Samples: As Received Basis

I.S. Insufficient sample
ID ID00019

Reviewed By:______________________ Date: 9/3/04

CLIENT : PHELPS DODGE - TYRONE
PROJECT: 1490

Sample Receipt: 8/16/04
Report Date: 9/03/04

Page 2 of 2
SVL JOB: 112684

SVL ID	CLIENT SAMPLE ID	S N-EX LECO	S-PYR LECO	S-S04 LECO	S-TOT LECO
S405334	BO-15+140-212-222	0.020%	0.140%	0.180%	0.340%
S405335	BO-15+140-222-232	<0.010%	0.530%	0.410%	0.940%
S405336	BO-15+140-232-242	0.010%	0.920%	0.430%	1.36%
S405337	BO-15+140-242-252	0.010%	0.210%	0.180%	0.400%
S405338	BO-15+140-252-262	0.010%	0.140%	0.110%	0.260%
S405339	BO-15+140-262-272	0.010%	0.130%	0.210%	0.350%
S405340	BO-15+140-272-282	0.020%	0.080%	0.160%	0.260%
S405341	BO-15+140-282-292	0.030%	0.110%	0.220%	0.360%
S405342	BO-15+140-292-302	0.020%	0.060%	0.140%	0.220%
S405343	BO-15+140-302-312	0.010%	0.040%	0.070%	0.120%
S405344	BQ-1+150-0-7	0.010%	1.27%	0.550%	1.83%
S405345	BQ-1+150-7-17	0.040%	0.750%	0.440%	1.23%
S405346	BQ-1+150-17-27	0.070%	0.320%	0.350%	0.740%
S405347	BR-16A-0-9	<0.010%	0.480%	0.290%	0.770%
S405348	BR-16A-9-19	<0.010%	1.57%	0.410%	1.98%
S405349	BR-16A-19-29	0.010%	1.32%	0.630%	1.96%
S405350	BR-16A-29-39	0.010%	1.41%	0.520%	1.94%
S405351	BR-16A-39-49	0.010%	0.690%	0.410%	1.11%
S405352	BR-16A-49-59	0.020%	0.380%	0.320%	0.720%
S405353	BR-16A-59-69	0.040%	0.440%	0.390%	0.870%

Soil Samples: As Received Basis

Certificate: ID ID00019

Reviewed By: ____________ Date: 9/3/04

SVL ANALYTICAL, INC.

Quality Control Report
Part I Prep Blank and Laboratory Control Sample

Client :PHELPS DODGE - TYRONE

SVL JOB No: 112684

Analyte	Method	Matrix	Units	Prep Blank	True——LCS	——Found	LCS %R	Analysis Date
Spec. Cond.	120.1	SOIL	umhos/cm	3.80	206	192	93.2	9/03/04
Acid Generating	EPA600	SOIL	TCaCO3/k	N/A	9.36	9.25	98.8	9/03/04
Acid Neut. Pot.	EPA600	SOIL	TCaCO3/k	N/A	52.0	51.1	98.3	9/03/04
pH Paste	ASA M9	SOIL		5.91	8.45	8.32	98.5	9/03/04
Non-Ext Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	9/03/04
Pyritic Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	9/03/04
Sulfate Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	9/03/04
Total Sulfur, S	LECO	SOIL	%	<0.010	0.298	0.300	100.7	9/03/04

LEGEND:

LCS = Laboratory Control Sample

LCS %R = LCS Percent Recovery

N/A = Not Applicable

9/03/04 17:40

SVL ANALYTICAL, INC.

Quality Control Report
Part II Duplicate and Spike Analysis

Client :PHELPS DODGE - TYRONE

SVL JOB No: 112684

Test	Method	Mtx	QC SAMPLE ID		Duplicate or MSD	MSD	Matrix Spike			Analysis
			Units	Result	Found	RPD%	Result	SPK ADD	%R	Date
COND	120.1	S	1	965	I/S	N/A	N/A	N/A	N/A	9/03/04
ABP	EPA600	S	1 TCaCO3/	-4.38	-4.38	0.0	N/A	N/A	N/A	9/03/04
AGP	EPA600	S	1 TCaCO3/	4.38	4.38	0.0	N/A	N/A	N/A	9/03/04
ANP	EPA600	S	1 TCaCO3/	<0.30	<0.30	UDL	N/A	N/A	N/A	9/03/04
S N-EX	LECO	S	1 %	0.020	0.020	0.0	N/A	N/A	N/A	9/03/04
S-PYR	LECO	S	1 %	0.140	0.140	0.0	N/A	N/A	N/A	9/03/04
S-SO4	LECO	S	1 %	0.180	0.180	0.0	N/A	N/A	N/A	9/03/04
S-TOT	LECO	S	1 %	0.340	0.340	0.0	N/A	N/A	N/A	9/03/04

LEGEND:

RPD% = (|SAM - DUP|/((SAM + DUP)/2) * 100) UDL = Both SAM & DUP not detected. *Result or *Found: Interference required dilution.

RPD% = (|SPK - MSD|/((SPK + MSD)/2) * 100) M in Duplicate/MSD column indicates MSD.

SPIKE ADD column, A = Post Digest Spike; %R = Percent Recovery N/A = Not Analyzed; R > 4S = Result more than 4X the Spike Added

QC limits for MS recoveries apply only if the spike is at least 1/4 the concentration of the analyte in the sample.

Control limits for the RPD apply only if the concentration of the analyte in the sample is at least five times the reporting limit.

I/S: Insufficient sample for QC test.

QC Sample 1: SVL SAM No.: 405334 Client Sample ID: BO-15+140-212-222

112684

SVL ANALYTICAL

CHAIN OF CUSTODY RECORD

Page 15 of 18

Client: Phelps Dodge Tyrone Inc.
Contact: William Seibert III
Address: P.O. Drawer 571
Tyrone, NM 88065
Phone Number: 505-538-7151
FAX Number: 505-388-5773

NOTES:
1) Ensure proper container packaging.
2) Ship samples promptly following collection.
* 3) **Designate Sample Reject Disposition**
4) **Indicate state of sample origination**

State: NM
PO#:
Project Name: 1490

Table 1. -- Matrix Type
1 = Surface Water, 2 = Ground Water
3 = Soil/Sediment, 4 = Rinsate, 5 = Oil
6=Waste, 7=Other (Specify)

FOR SVL USE ONLY
SVL JOB #:

Samplers Signature:

Lab Name: **SVL Analytical, Inc.** **(208) 784-1258** **FAX (208) 783-0891**
Address: **One Government Gulch, Kellogg, ID 83837-0929**

		Collection				Miscellaneous			Preservative(s)						Analyses Required									
	Sample ID	Date	Time	24 hour grab?	Collected by: (Init.)	Matrix Type From Table 1	No. of Containers	Sample Filtered ? Y/N	Unpreserved (Ice Only)	HNO3	HCl	H2SO4	NaOH	Other (Specify) N/A	ABA *	paste pH	paste E.C.							Comments
1.	Bo-15+140-212-222					3								X										* Full ABA
2.	Bo-15+140-222-232					↓								↓										with sulfur forms
3.	Bo-15+140-232-242					↓								↓										if enough sample is
4.	Bo-15+140-242-252					↓								↓										available. Otherwise
5.	Bo-15+140-252-262					↓								↓										run basic AGP and
6.	Bo-15+140-262-272					↓								↓										ANP to determine
7.	Bo-15+140-272-282					↓								↓										ABA on total
8.	Bo-15+140-282-292					↓								↓										sulfur.
9.	Bo-15+140-292-302					↓								↓										
10.	Bo-15+140-302-312					↓								↓										

Relinquished by: Ramon Seas	Date: 8/9/04	Time: 11:30	Received by:	Date: 8/16/04	Time: 12:00
Relinquished by:	Date:	Time:	Received by:	Date:	Time:

* Sample Reject: ☒ Return ☐ Dispose ☐ Other ________

White: LAB COPY Yellow: CUSTOMER COPY SVL-COC 4/03

112684

SVL ANALYTICAL

CHAIN OF CUSTODY RECORD

Page 16 of 18

Client: Phelps Dodge Tyrone Inc.
Contact: William Seibert III
Address: P.O. Drawer 571
Tyrone, NM 88065
Phone Number: 505-538-7151
FAX Number: 505-388-5773

NOTES:
1) Ensure proper container packaging.
2) Ship samples promptly following collection.
* 3) Designate Sample Reject Disposition
4) Indicate state of sample origination

PO#:
Project Name: 1490

Table 1. – Matrix Type
1 = Surface Water, 2 = Ground Water
3 = Soil/Sediment, 4 = Rinsate, 5 = Oil
6=Waste, 7=Other (Specify)

State: NM

FOR SVL USE ONLY
SVL JOB #:

Samplers Signature:

Lab Name: **SVL Analytical, Inc.** (208) 784-1258 FAX (208) 783-0891
Address: **One Government Gulch, Kellogg, ID 83837-0929**

		Collection				Miscellaneous			Preservative(s)						Analyses Required									
	Sample ID	Date	Time	24 hour grab?	Collected by: (Init.)	Matrix Type From Table 1	No. of Containers	Sample Filtered ? Y/N	Unpreserved (Ice Only)	HNO3	HCl	H2SO4	NaOH	Other (Specify) N/A	ABA *	paste pH	paste E.C.							Comments
1.	BQ-1+150-0-7					3								X										* Full ABA
2.	BQ-1+150-7-17																							with sulfur forms
3.	BQ-1+150-17-27																							if enough sample is
4.	BR-16A-0-9																							available. Otherwise
5.	BR-16A-9-19																							run basic AGP and
6.	BR-16A-19-29																							ANP to determine
7.	BR-16A-29-39																							ABA on total
8.	BR-16A-39-49																							sulfur.
9.	BR-16A-49-59																							
10.	BR-16A-59-69																							

Relinquished by: Ramon Sias	Date: 8/9/04	Time: 11:30	Received by:	Date: 8/16/04	Time: 1200
Relinquished by:	Date:	Time:	Received by:	Date:	Time:

* Sample Reject: ☒ Return ☐ Dispose ☐ Other ______ White: LAB COPY Yellow: CUSTOMER COPY SVL-COC 4/03

BN-011	59-69	
BN-011	69-79	
BN-011	79-89	
BN-011	89-99	
BN-011	99-109	
BN-011	109-119	
BN-011	119-129	
BN-011	129-139	
BN-011	139-149	
BN-011	149-159	
BN-29	0-17	
BN-32	0-5	
BN-32	5-15	
BO+120-9	0-10	
BO+120-9	10-20	
BO+120-9	20-30	
BO+120-9	30-40	
BO+120-9	40-50	
BO+120-9	50-60	
BO+120-9	60-70	
BO+120-9	70-80	
BO+120-9	80-90	
BO+120-9	90-100	
BO+120-9	100-110	
BO+120-9	110-120	
BO-15+140	0-12	
BO-15+140	12-22	
BO-15+140	22-32	
BO-15+140	32-42	
BO-15+140	42-52	
BO-15+140	52-62	
BO-15+140	62-72	
BO-15+140	72-82	
BO-15+140	82-92	
BO-15+140	92-102	
BO-15+140	102-112	
BO-15+140	112-122	
BO-15+140	122-132	
BO-15+140	132-142	
BO-15+140	142-152	
BO-15+140	152-162	
BO-15+140	162-172	
BO-15+140	172-182	
BO-15+140	182-192	
BO-15+140	192-202	
BO-15+140	202-212	
BO-15+140	212-222	
BO-15+140	222-232	
BO-15+140	232-242	

BO-15+140	242-252	
BO-15+140	252-262	
BO-15+140	262-272	
BO-15+140	272-282	
BO-15+140	282-292	
BO-15+140	292-302	
BO-15+140	302-312	
BQ-1+150	0-7	
BQ-1+150	7-17	
BQ-1+150	17-27	
BR-16A	0-9	
BR-16A	9-19	
BR-16A	19-29	
BR-16A	29-39	
BR-16A	39-49	
BR-16A	49-59	
BR-16A	59-69	
BR-16A	69-79	
BR-16A	79-89	
BR-16A	89-99	
BR-16A	99-109	
BR-16A	109-119	
BR-16A	119-129	
BR-16A	129-139	
BR-16A	139-149	
BR-16A	149-159	
BR-16A	159-169	
BR-16A	169-179	
BR-16A	179-189	
BT-24	0-12	
BT-24	12-22	
BT-24	22-32	
BT-24	32-42	
BT-24	42-52	
BT-24	52-62	
BT-24	62-72	
I-07	0-6	

SVL ANALYTICAL, INC.
vernment Gulch - Kellogg, ID 83837-0929

Page 1 of 1

SAMPLE RECEIPT CONFIRMATION

SVL JOB No: 112684
Received: 8/16/04
Expected Due date: 8/30/04

By	Received	Sample Comments
	8/16/04	
	8/16/04	
	8/16/04	
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	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	

ontainer temp not measured upon receipt.

after job completion.
, then you will receive a letter requesting disposal options.

you have questions regarding the receipt of these samples. 8/16/04 16:15

TRANSMISSION VERIFICATION REPORT

TIME : 08/17/2004 09:19
NAME : SVL ANALYTICAL
FAX : 2087830891
TEL : 2087841258
SER.# : BROF3J496071

DATE,TIME 08/17 09:18
FAX NO./NAME 915053885773
DURATION 00:00:19
PAGE(S) 01
RESULT OK
MODE FINE
ECM

SVL ANALYTICAL, INC.
One Government Gulch ▪ P.O. Box 929 ▪ Kellogg, Idaho 83827-0929 ▪ Phone: (208)784-1258 ▪ Fax: (208)783-0891

REPORT OF ANALYTICAL RESULTS

CLIENT : PHELPS DODGE - TYRONE
PROJECT: 1490
Sample Receipt: 8/16/04
Report Date: 9/03/04
Page 1 of 2
SVL JOB: 112685

SVL ID	CLIENT SAMPLE ID	COND 120.1	ABP EPA600	AGP EPA600	ANP EPA600	pH Pst ASA M9
S405356	BR-16A-69-79	I/S	-6.25TCaC03/k	6.25TCaC03/k	<0.30TCaC03/k	4.94
S405357	BR-16A-79-89	I/S	-1.56TCaC03/k	1.56TCaC03/k	<0.30TCaC03/k	5.38
S405358	BR-16A-89-99	I/S	-1.56TCaC03/k	1.56TCaC03/k	<0.30TCaC03/k	5.42
S405359	BR-16A-99-109	I/S	-4.06TCaC03/k	4.06TCaC03/k	<0.30TCaC03/k	5.48
S405360	BR-16A-109-119	I/S	-13.4TCaC03/k	13.4TCaC03/k	<0.30TCaC03/k	4.64
S405361	BR-16A-119-129	I/S	-10.6TCaC03/k	10.6TCaC03/k	<0.30TCaC03/k	4.86
S405362	BR-16A-129-139	I/S	-29.7TCaC03/k	29.7TCaC03/k	<0.30TCaC03/k	4.74
S405363	BR-16A-139-149	I/S	-27.5TCaC03/k	27.5TCaC03/k	<0.30TCaC03/k	4.68
S405364	BR-16A-149-159	I/S	-25.6TCaC03/k	25.6TCaC03/k	<0.30TCaC03/k	4.62
S405365	BR-16A-159-169	I/S	-5.00TCaC03/k	5.00TCaC03/k	<0.30TCaC03/k	5.58
S405366	BR-16A-169-179	I/S	-1.25TCaC03/k	1.25TCaC03/k	<0.30TCaC03/k	6.43
S405367	BR-16A-179-189	I/S	-2.50TCaC03/k	2.50TCaC03/k	<0.30TCaC03/k	6.17
S405368	BT-24-0-12	I/S	-9.06TCaC03/k	9.06TCaC03/k	<0.30TCaC03/k	5.02
S405369	BT-24-12-22	I/S	-4.69TCaC03/k	4.69TCaC03/k	<0.30TCaC03/k	5.49
S405370	BT-24-22-32	433umhos/cm	-2.81TCaC03/k	2.81TCaC03/k	<0.30TCaC03/k	6.33
S405371	BT-24-32-42	I/S	-1.56TCaC03/k	1.56TCaC03/k	<0.30TCaC03/k	6.54
S405372	BT-24-42-52	I/S	-1.88TCaC03/k	1.88TCaC03/k	<0.30TCaC03/k	6.50
S405373	BT-24-52-62	I/S	-1.88TCaC03/k	1.88TCaC03/k	<0.30TCaC03/k	6.55
S405374	BT-24-62-72	I/S	-1.56TCaC03/k	1.56TCaC03/k	<0.30TCaC03/k	6.16
S405375	1-07-0-6	328umhos/cm	-2.81TCaC03/k	2.81TCaC03/k	<0.30TCaC03/k	6.39

Soil Samples: As Received Basis

I.S. Insufficient sample
ID ID00019

Reviewed By: Date: 9/3/04

SVL ANALYTICAL, INC.
One Government Gulch ▪ P.O. Box 929 ▪ Kellogg, Idaho 83827-0929 ▪ Phone: (208)784-1258 ▪ Fax: (208)783-0891

REPORT OF ANALYTICAL RESULTS

CLIENT : PHELPS DODGE - TYRONE
PROJECT: 1490
Sample Receipt: 8/16/04
Report Date: 9/03/04
Page 2 of 2
SVL JOB: 112685

SVL ID	CLIENT SAMPLE ID	S N-EX LECO	S-PYR LECO	S-SO4 LECO	S-TOT LECO
S405356	BR-16A-69-79	0.030%	0.200%	0.260%	0.490%
S405357	BR-16A-79-89	<0.010%	0.050%	0.120%	0.170%
S405358	BR-16A-89-99	0.040%	0.050%	0.190%	0.280%
S405359	BR-16A-99-109	0.030%	0.130%	0.250%	0.410%
S405360	BR-16A-109-119	0.020%	0.430%	0.340%	0.790%
S405361	BR-16A-119-129	0.030%	0.340%	0.310%	0.680%
S405362	BR-16A-129-139	0.030%	0.950%	0.370%	1.35%
S405363	BR-16A-139-149	0.030%	0.880%	0.380%	1.29%
S405364	BR-16A-149-159	0.030%	0.820%	0.380%	1.23%
S405365	BR-16A-159-169	<0.010%	0.160%	0.160%	0.320%
S405366	BR-16A-169-179	<0.010%	0.0%	0.040%	0.080%
S405367	BR-16A-179-189	0.010%	0.080%	0.090%	0.180%
S405368	BT-24-0-12	0.050%	0.290%	0.220%	0.560%
S405369	BT-24-12-22	0.040%	0.150%	0.270%	0.460%
S405370	BT-24-22-32	0.010%	0.090%	0.210%	0.310%
S405371	BT-24-32-42	0.010%	0.050%	0.110%	0.170%
S405372	BT-24-42-52	0.010%	0.060%	0.120%	0.190%
S405373	BT-24-52-62	0.010%	0.060%	0.120%	0.190%
S405374	BT-24-62-72	0.020%	0.050%	0.120%	0.190%
S405375	1-07-0-6	0.030%	0.090%	0.140%	0.260%

Soil Samples: As Received Basis

Certificate: ID ID00019

Reviewed By: ______________ Date: 9/3/04

SVL ANALYTICAL, INC.

Quality Control Report
Part I Prep Blank and Laboratory Control Sample

Client :PHELPS DODGE - TYRONE

SVL JOB No: 112685

Analyte	Method	Matrix	Units	Prep Blank	LCS		LCS %R	Analysis Date
					True	Found		
Spec. Cond.	120.1	SOIL	umhos/cm	3.80	206	192	93.2	9/03/04
Acid Generating	EPA600	SOIL	TCaCO3/k	N/A	9.36	9.25	98.8	9/03/04
Acid Neut. Pot.	EPA600	SOIL	TCaCO3/k	N/A	52.0	51.1	98.3	9/03/04
pH Paste	ASA M9	SOIL		5.91	8.45	8.32	98.5	9/03/04
Non-Ext Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	9/03/04
Pyritic Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	9/03/04
Sulfate Sulfur,S	LECO	SOIL	%	<0.010	N/A		N/A	9/03/04
Total Sulfur, S	LECO	SOIL	%	<0.010	0.298	0.300	100.7	9/03/04

LEGEND:

LCS = Laboratory Control Sample

LCS %R = LCS Percent Recovery

N/A = Not Applicable

SVL ANALYTICAL, INC.

Quality Control Report
Part II Duplicate and Spike Analysis

Client :PHELPS DODGE - TYRONE

SVL JOB No: 112685

Test	Method	Mtx	QC SAMPLE ID	Units	Result	Duplicate or MSD Found	MSD RPD%	Matrix Spike Result	Matrix Spike SPK ADD	Matrix Spike %R	Analysis Date
COND	120.1	S	1			I/S	N/A	N/A	N/A	N/A	
ABP	EPA600	S	1	TCaCO3/	-6.25	-5.63	10.4	N/A	N/A	N/A	9/03/04
AGP	EPA600	S	1	TCaCO3/	6.25	5.63	10.4	N/A	N/A	N/A	9/03/04
ANP	EPA600	S	1	TCaCO3/	<0.30	<0.30	UDL	N/A	N/A	N/A	9/03/04
S N-EX	LECO	S	1	%	0.030	0.030	0.0	N/A	N/A	N/A	9/03/04
S-PYR	LECO	S	1	%	0.200	0.180	10.5	N/A	N/A	N/A	9/03/04
S-SO4	LECO	S	1	%	0.260	0.280	7.4	N/A	N/A	N/A	9/03/04
S-TOT	LECO	S	1	%	0.490	0.490	0.0	N/A	N/A	N/A	9/03/04

LEGEND:
RPD% = (|SAM - DUP|/((SAM + DUP)/2) * 100) UDL = Both SAM & DUP not detected. *Result or *Found: Interference required dilution.
RPD% = (|SPK - MSD|/((SPK + MSD)/2) * 100) M in Duplicate/MSD column indicates MSD.
SPIKE ADD column, A = Post Digest Spike; %R = Percent Recovery N/A = Not Analyzed; R > 4S = Result more than 4X the Spike Added
QC limits for MS recoveries apply only if the spike is at least 1/4 the concentration of the analyte in the sample.
Control limits for the RPD apply only if the concentration of the analyte in the sample is at least five times the reporting limit.
I/S: Insufficient sample for QC test.
QC Sample 1:   SVL SAM No.: 405356   Client Sample ID: BR-16A-69-79

112685

SVL ANALYTICAL

CHAIN OF CUSTODY RECORD

Page 17 of 18

Client: Phelps Dodge Tyrone Inc.
Contact: William Seibert III
Address: P.O. Drawer 571
Tyrone, NM 88065
Phone Number: 505-538-7151
FAX Number: 505-388-5773

NOTES:
1) Ensure proper container packaging.
2) Ship samples promptly following collection.
* 3) Designate Sample Reject Disposition
4) Indicate state of sample origination
PO#:
Project Name: 1490

Table 1. – Matrix Type
1 = Surface Water, 2 = Ground Water
3 = Soil/Sediment, 4 = Rinsate, 5 = Oil
6=Waste, 7=Other (Specify)

State: NM

FOR SVL USE ONLY
SVL JOB #:

Samplers Signature:

Lab Name: SVL Analytical, Inc. (208) 784-1258 FAX (208) 783-0891
Address: One Government Gulch, Kellogg, ID 83837-0929

		Collection				Miscellaneous			Preservative(s)						Analyses Required									
	Sample ID	Date	Time	24 hour grab?	Collected by: (Init.)	Matrix Type From Table 1	No. of Containers	Sample Filtered ? Y/N	Unpreserved (Ice Only)	HNO3	HCl	H2SO4	NaOH	Other (Specify) N/A	ABA *	paste pH	paste E.C.							Comments
1.	BR-16A-69-79					3								X										* Full ABA
2.	BR-16A-79-89																							with sulfur forms
3.	BR-16A-89-99																							if enough sample is
4.	BR-16A-99-109																							available. Otherwise
5.	BR-16A-109-119																							run basic AGP and
6.	BR-16A-119-129																							ANP to determine
7.	BR-16A-129-139																							ABA on total
8.	BR-16A-139-149																							sulfur.
9.	BR-16A-149-159																							
10.	BR-16A-159-169					↓								↓										

Relinquished by: Ramon Sieis	Date: 8/9/04	Time: 11:30	Received by:	Date: 8/10/0	Time: 12'02
Relinquished by:	Date:	Time:	Received by:	Date:	Time:

* Sample Reject: ☒ Return ☐ Dispose ☐ Other ______

White: LAB COPY Yellow: CUSTOMER COPY SVL-COC 4/03

112685

SVL ANALYTICAL

CHAIN OF CUSTODY RECORD

Page 18 of 18

Client: Phelps Dodge Tyrone Inc.
Contact: William Seibert III
Address: P.O. Drawer 571
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State: NM

FOR SVL USE ONLY
SVL JOB #:

Samplers Signature:

Lab Name: SVL Analytical, Inc. (208) 784-1258 FAX (208) 783-0891
Address: One Government Gulch, Kellogg, ID 83837-0929

		Collection				Miscellaneous			Preservative(s)						Analyses Required									
	Sample ID	Date	Time	24 hour grab?	Collected by: (Init.)	Matrix Type From Table 1	No. of Containers	Sample Filtered ? Y/N	Unpreserved (Ice Only)	HNO3	HCl	H2SO4	NaOH	Other (Specify) N/A	ABA *	paste pH	paste E.C.							Comments
1.	BR-16A-169-179					3								X										* Full ABA
2.	BR-16A-179-189																							with sulfur forms
3.	BT-24 -0-12																							if enough sample is
4.	BT-24 -12-22																							available. Otherwise
5.	BT-24 -22-32																							run basic AGP and
6.	BT-24 -32-42																							ANP to determine
7.	BT-24 - 42-52																							ABA on total
8.	BT-24 -52-62																							sulfur.
9.	BT-24 -62-72																							
10.	1-07 ~~-0-6~~																							

Relinquished by: Ramon Sias	Date: 8/9/04	Time: 11:30	Received by:	Date: 8/10/04	Time: 12:50
Relinquished by:	Date:	Time:	Received by:	Date:	Time:

* Sample Reject: ☒ Return ☐ Dispose ☐ Other ______ White: LAB COPY Yellow: CUSTOMER COPY SVL-COC 4/03

BO-15+140	242-252	
BO-15+140	252-262	
BO-15+140	262-272	
BO-15+140	272-282	
BO-15+140	282-292	
BO-15+140	292-302	
BO-15+140	302-312	
BQ-1+150	0-7	
BQ-1+150	7-17	
BQ-1+150	17-27	
BR-16A	0-9	
BR-16A	9-19	
BR-16A	19-29	
BR-16A	29-39	
BR-16A	39-49	
BR-16A	49-59	
BR-16A	59-69	
BR-16A	69-79	
BR-16A	79-89	
BR-16A	89-99	
BR-16A	99-109	
BR-16A	109-119	
BR-16A	119-129	
BR-16A	129-139	
BR-16A	139-149	
BR-16A	149-159	
BR-16A	159-169	
BR-16A	169-179	
BR-16A	179-189	
BT-24	0-12	
BT-24	12-22	
BT-24	22-32	
BT-24	32-42	
BT-24	42-52	
BT-24	52-62	
BT-24	62-72	
I-07	0-6	

Page 1 of 1

SVL ANALYTICAL, INC.
ıvernment Gulch - Kellogg, ID 83837-0929

SAMPLE RECEIPT CONFIRMATION

SVL JOB No: 112685
Received: 8/16/04
Expected Due date: 8/30/04

By	Received	Sample Comments
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	
	8/16/04	

Container temp not measured upon receipt.

after job completion.
, then you will receive a letter requesting disposal options.

you have questions regarding the receipt of these samples. 8/17/04 8:44

TRANSMISSION VERIFICATION REPORT

TIME : 08/17/2004 09:12
NAME : SVL ANALYTICAL
FAX : 2087830891
TEL : 2087841258
SER.# : BROF3J496071

DATE,TIME	08/17 09:12
FAX NO./NAME	915053885773
DURATION	00:00:21
PAGE(S)	01
RESULT	OK
MODE	FINE ECM

phelps dodge Corporation

Tyrone Mine

ABA Charts Menu

Stockpile Boreholes (Condition 80):

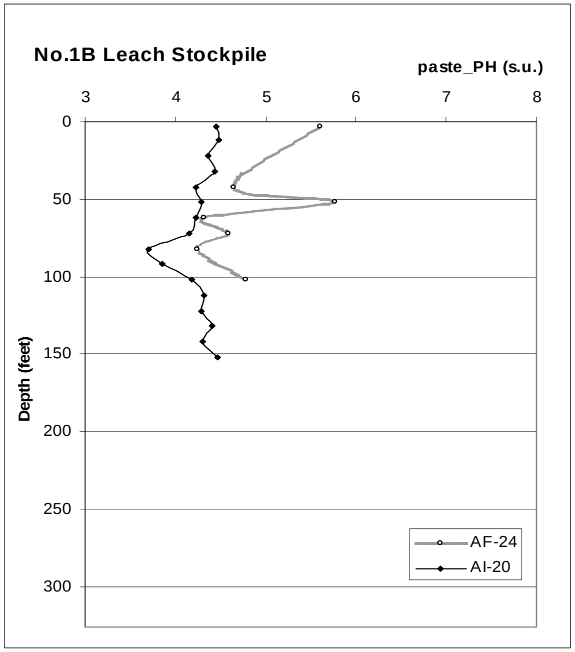
- ☐ Paste_pH vs. Depth
- ☐ S_Pyritic_NNP vs. Depth
- ☐ S_Total_NNP vs. Depth
- ☐ S_Sulfate vs. Depth

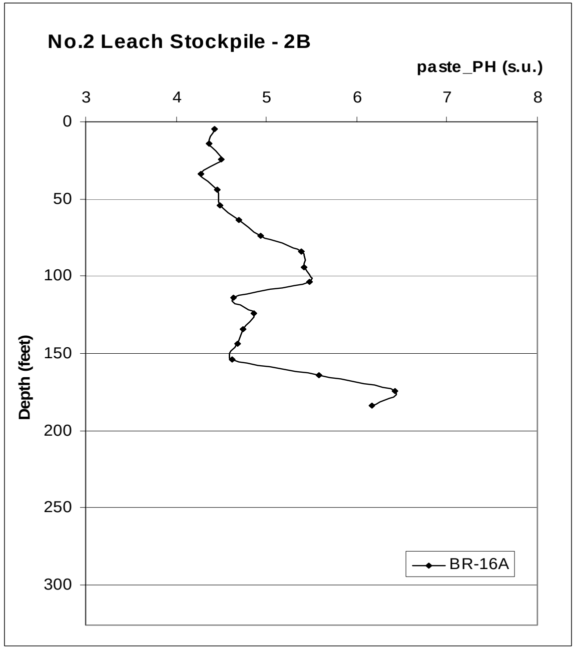
Stockpile Boreholes (SARB):

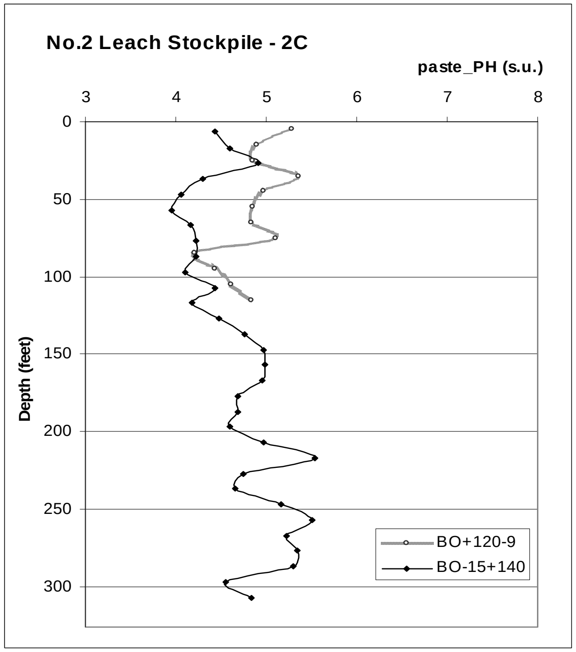
- ☐ S_Pyritic_NNP vs. Depth
- ☐ S_Total_NNP vs. Depth
- ☐ S_Sulfate vs. Depth

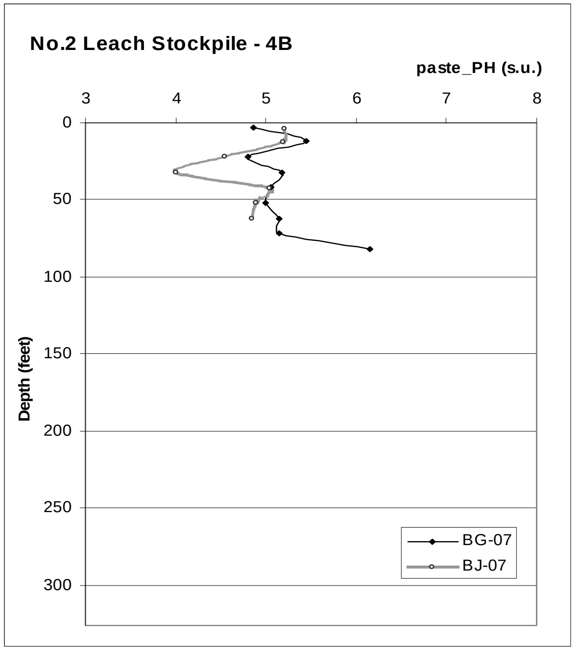
All Samples:

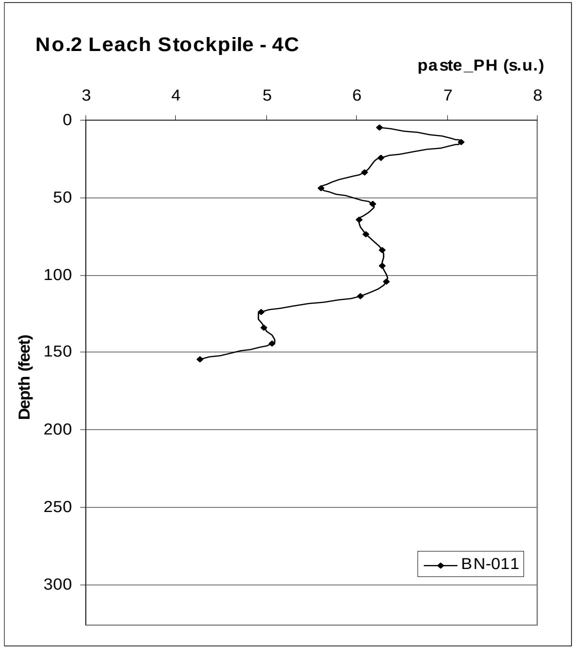
- ☐ S_Pyritic_AGP vs. ANP
- ☐ S_Total_AGP vs. ANP
- ☐ S_Sulfate vs. S_Pyritic_AGP
- ☐ S_Sulfate vs. S_Total_AGP

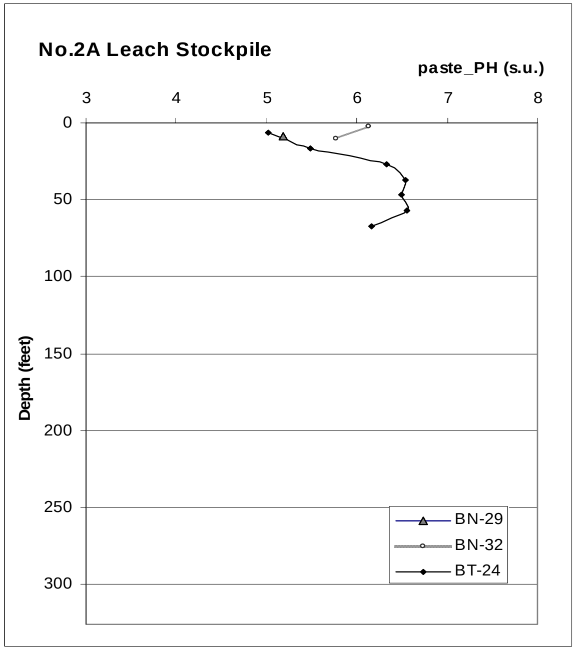

No.1B Leach Stockpile
paste_PH (s.u.)
3
4
5
6
7
8
Depth (feet)
0
50
100
150
200
250
300
AF-24
AI-20

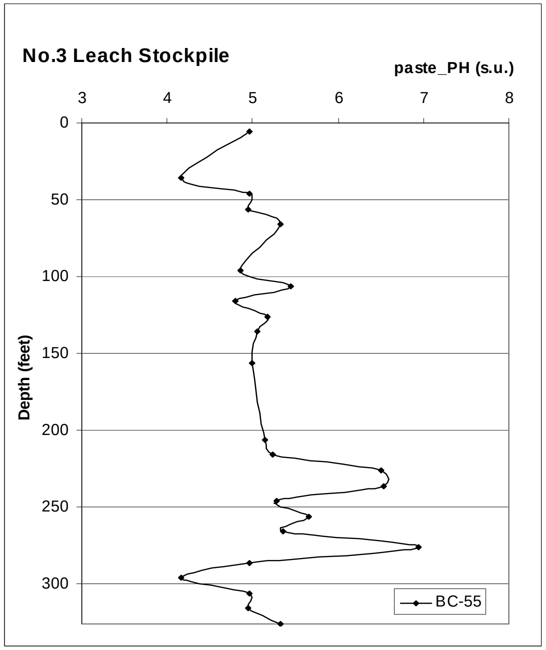

No.2 Leach Stockpile - 2B
paste_PH (s.u.)
3
4
5
6
7
8
Depth (feet)
0
50
100
150
200
250
300
BR-16A

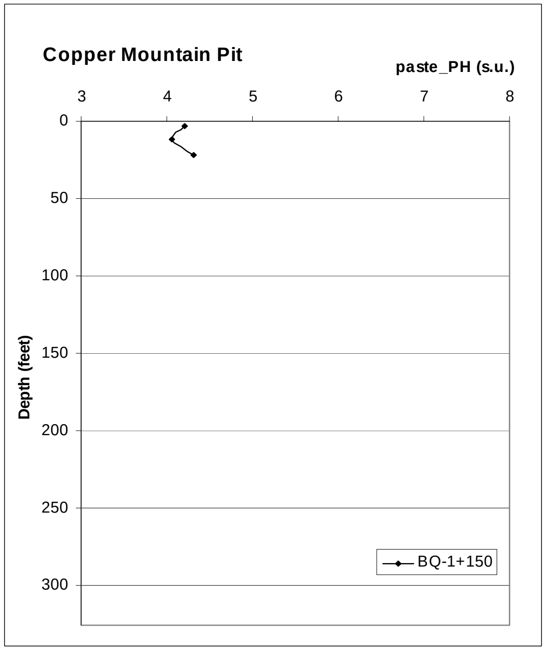

No.2 Leach Stockpile - 2C
paste_PH (s.u.)
3
4
5
6
7
8
Depth (feet)
0
50
100
150
200
250
300
BO+120-9
BO-15+140

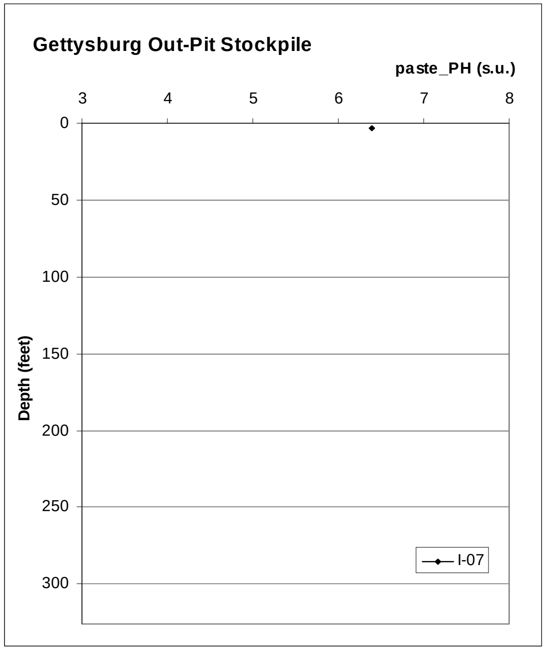

No.2 Leach Stockpile - 4B
paste_PH (s.u.)
3
4
5
6
7
8
Depth (feet)
0
50
100
150
200
250
300
BG-07
BJ-07

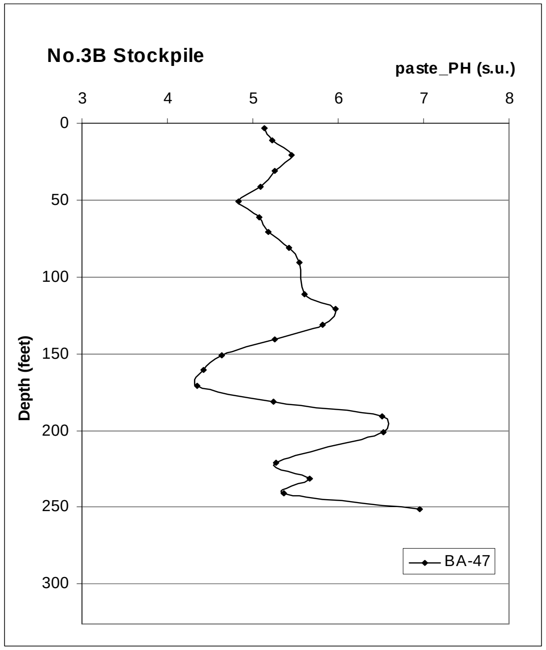

No.2 Leach Stockpile - 4C
paste_PH (s.u.)
3
4
5
6
7
8
Depth (feet)
0
50
100
150
200
250
300
BN-011

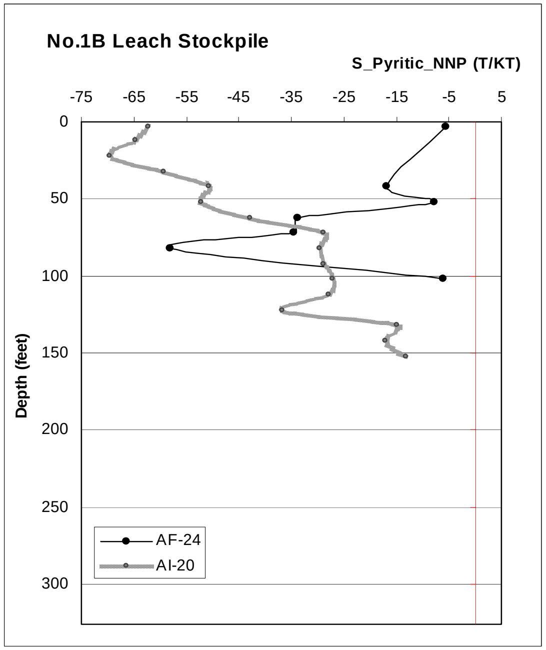

No.2A Leach Stockpile
paste_PH (s.u.)
3
4
5
6
7
8
Depth (feet)
0
50
100
150
200
250
300
BN-29
BN-32
BT-24

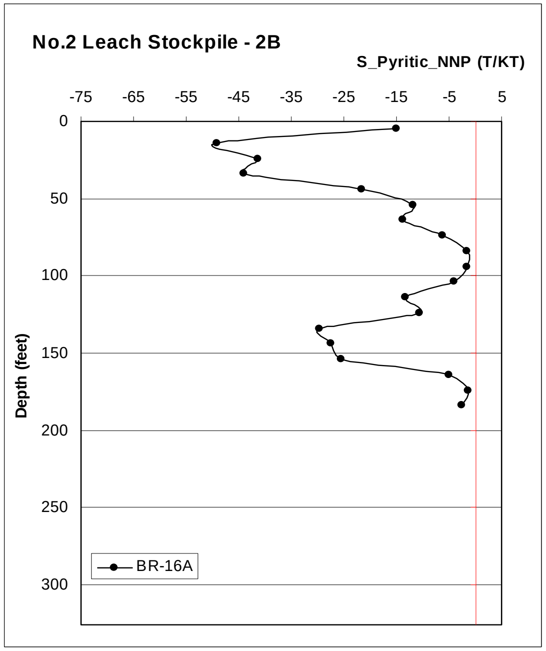

No.3 Leach Stockpile

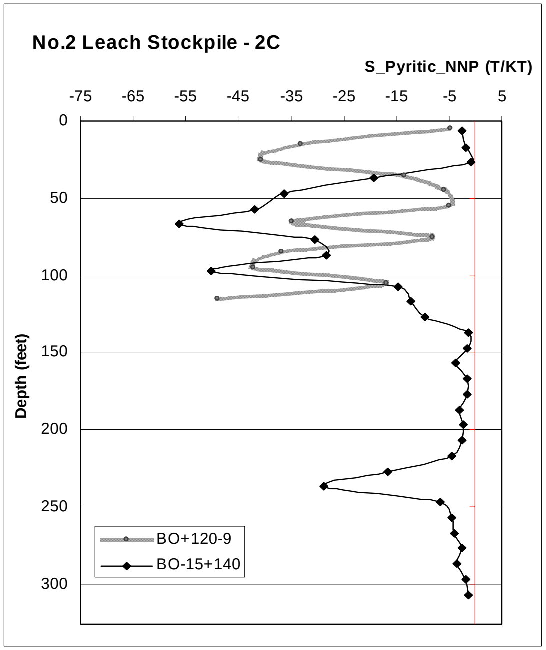

Copper Mountain Pit

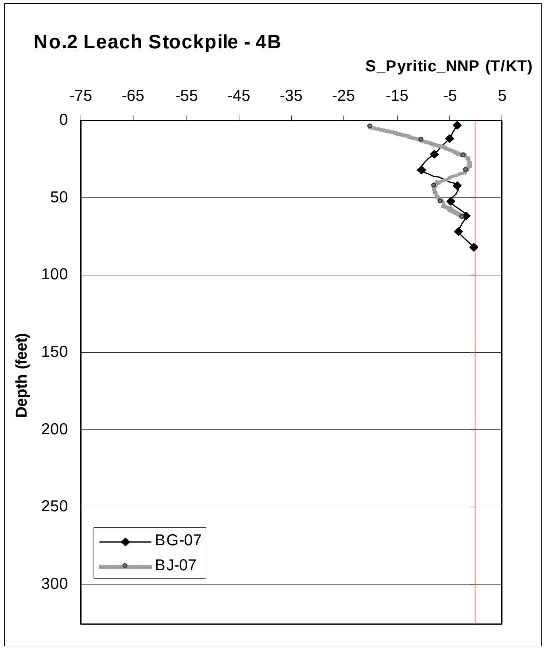

Gettysburg Out-Pit Stockpile

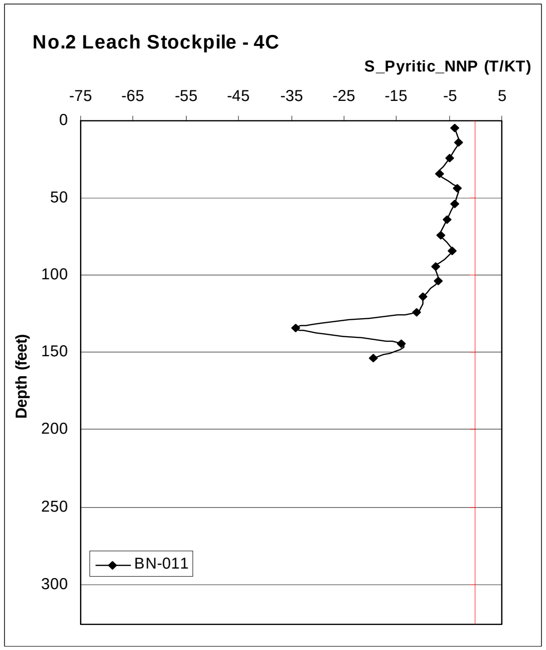

No.3B Stockpile

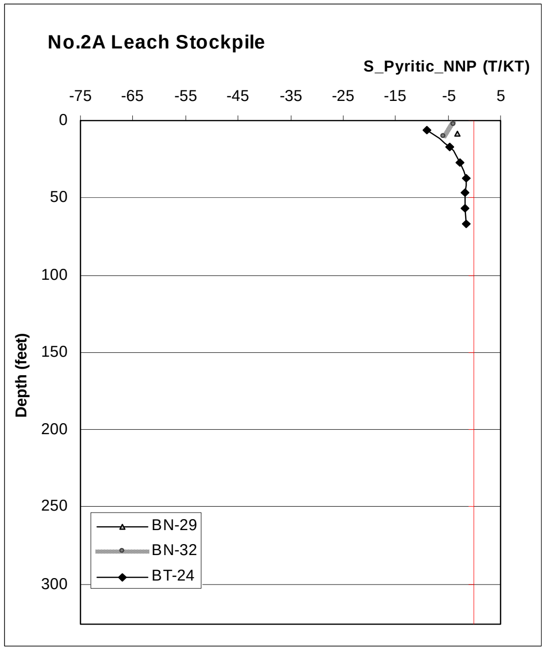

No.1B Leach Stockpile

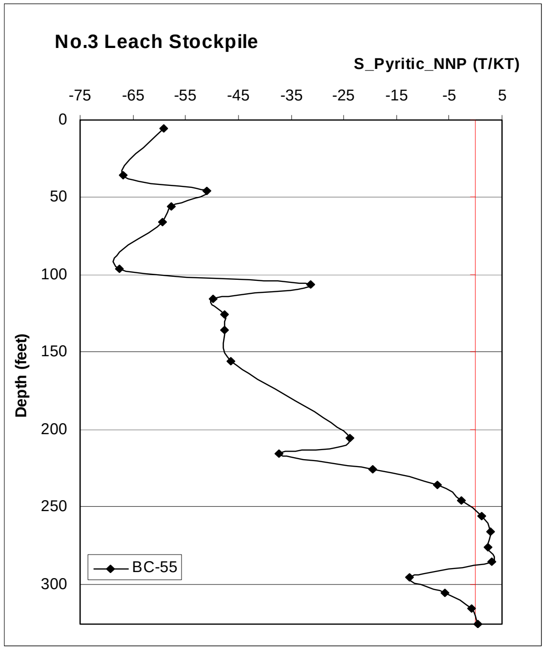

No.2 Leach Stockpile - 2B

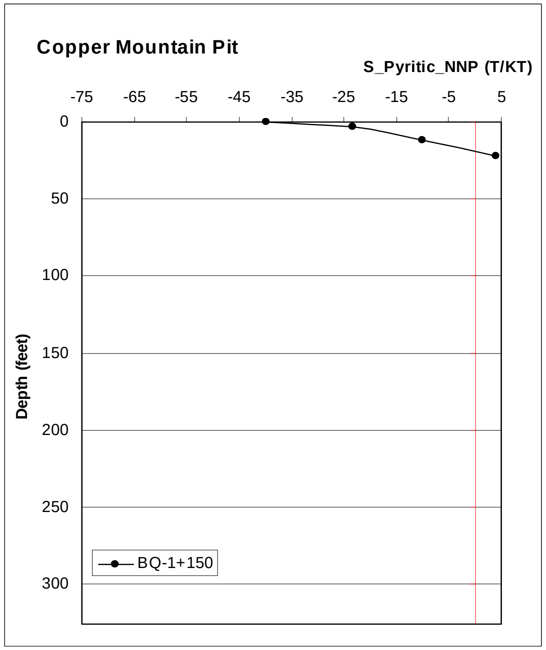

No.2 Leach Stockpile - 2C

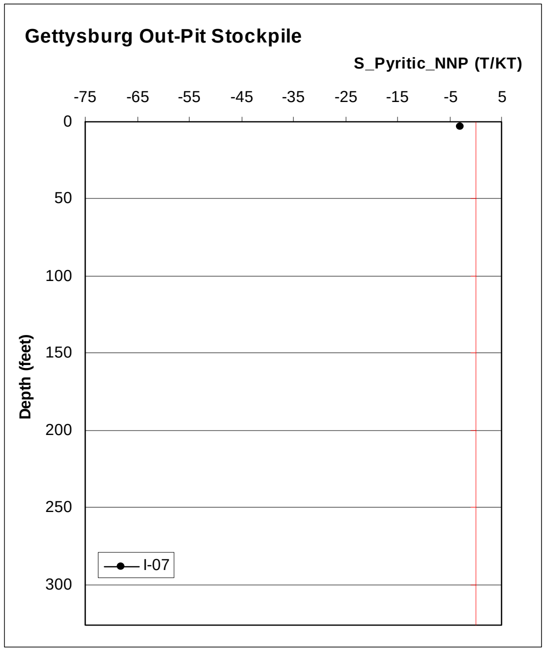

No.2 Leach Stockpile - 4B

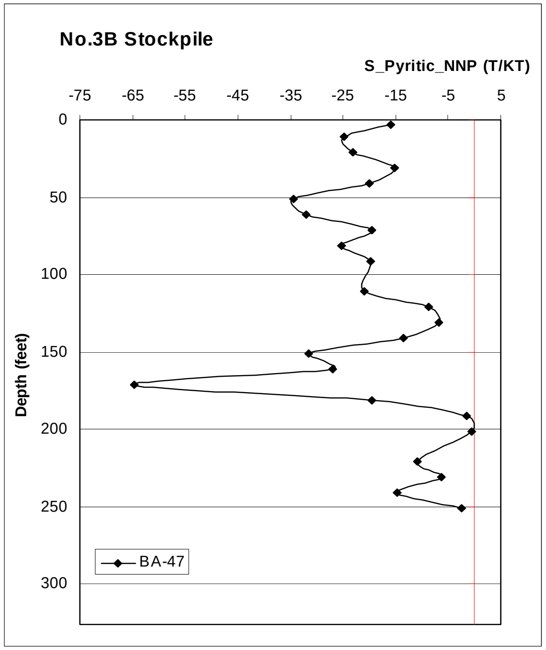

No.2 Leach Stockpile - 4C

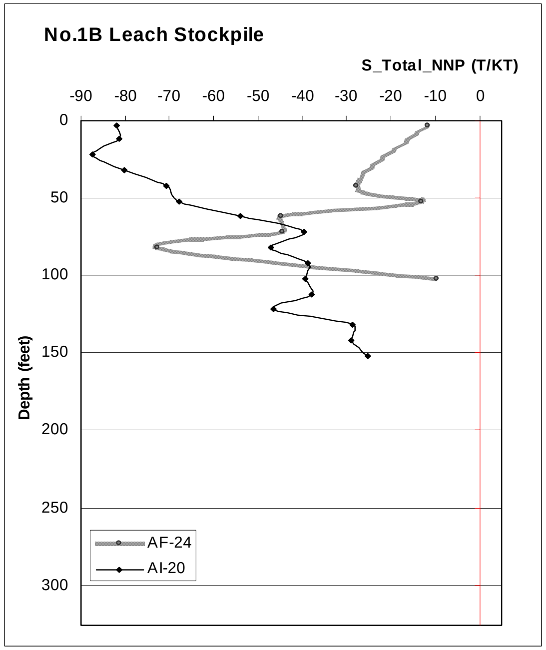

No.2A Leach Stockpile

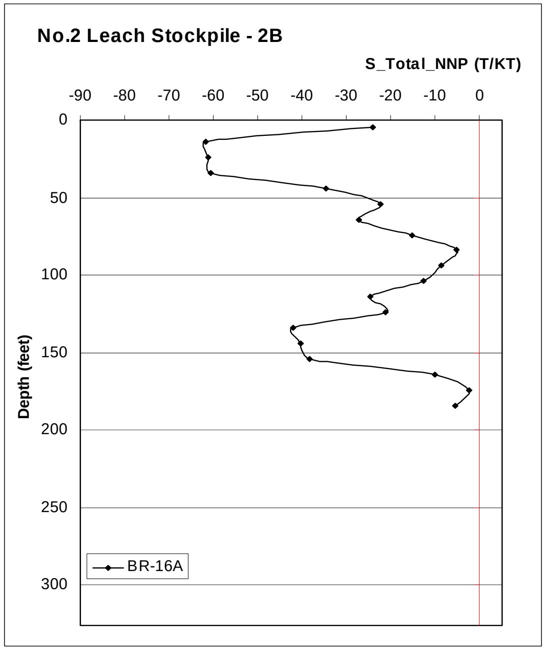

No.3 Leach Stockpile
S_Pyritic_NNP (T/KT)
-75
-65
-55
-45
-35
-25
-15
-5
5
0
50
100
150
200
250
300
Depth (feet)
BC-55

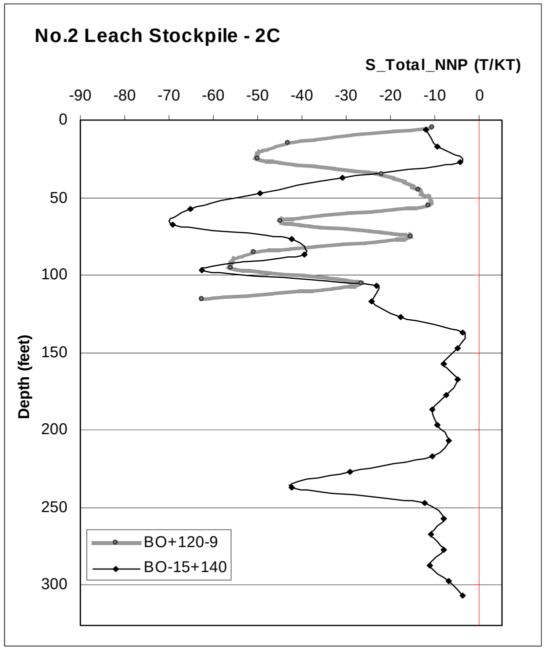

Copper Mountain Pit
S_Pyritic_NNP (T/KT)
-75
-65
-55
-45
-35
-25
-15
-5
5
0
50
100
150
200
250
300
Depth (feet)
BQ-1+150

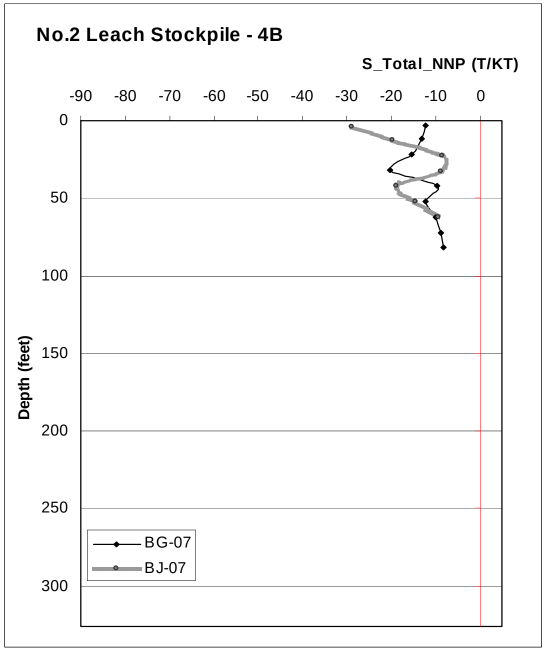

Gettysburg Out-Pit Stockpile
S_Pyritic_NNP (T/KT)
-75
-65
-55
-45
-35
-25
-15
-5
5
0
50
100
150
200
250
300
Depth (feet)
I-07

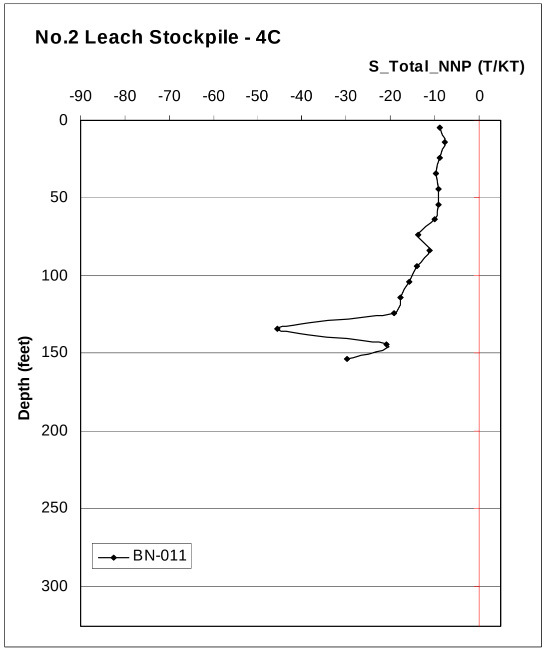

No.3B Stockpile
S_Pyritic_NNP (T/KT)
-75
-65
-55
-45
-35
-25
-15
-5
5
0
50
100
150
200
250
300
Depth (feet)
BA-47

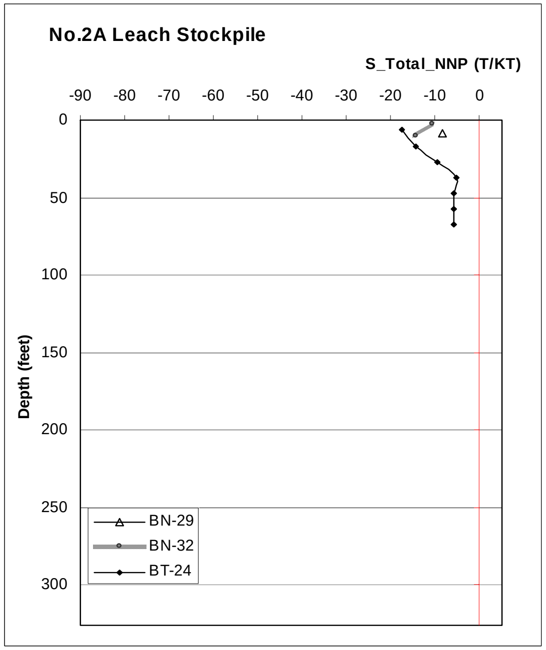

No.1B Leach Stockpile

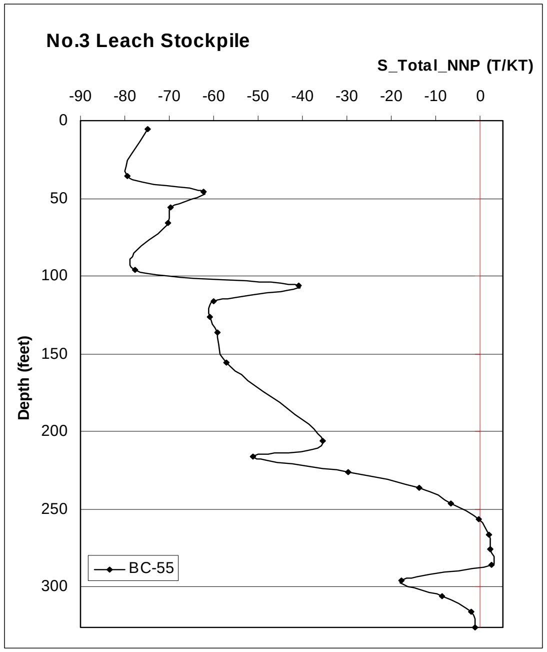

No.2 Leach Stockpile - 2B

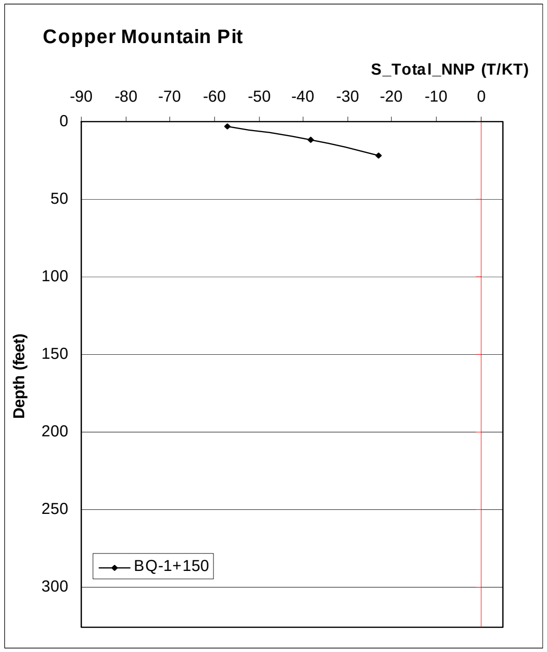

No.2 Leach Stockpile - 2C

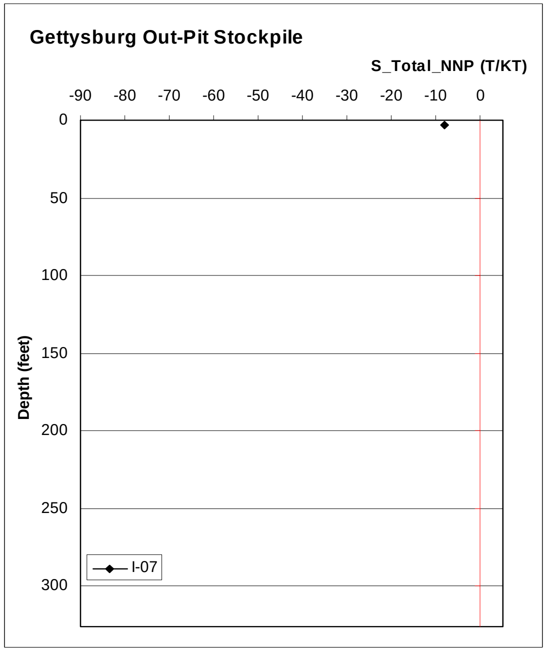

No.2 Leach Stockpile - 4B

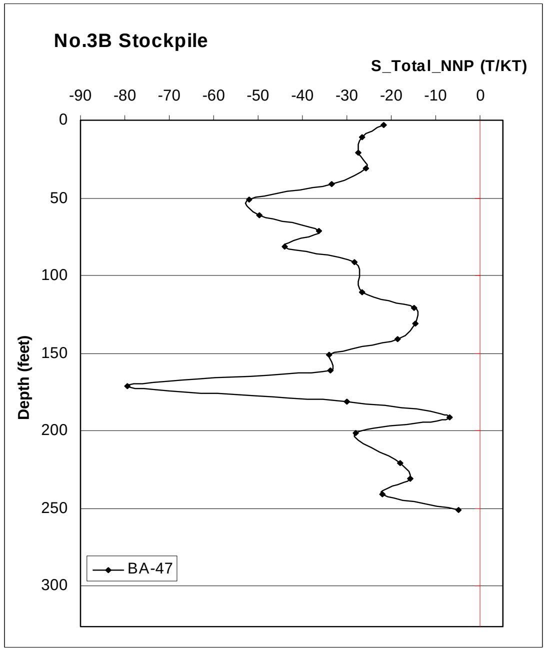

No.2 Leach Stockpile - 4C

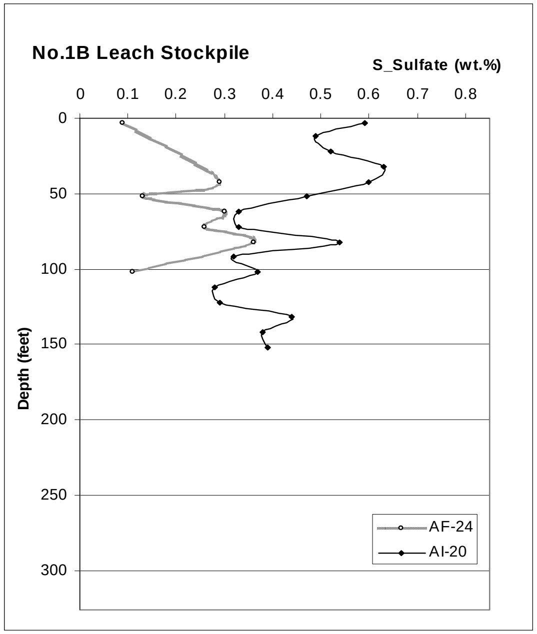

No.2A Leach Stockpile

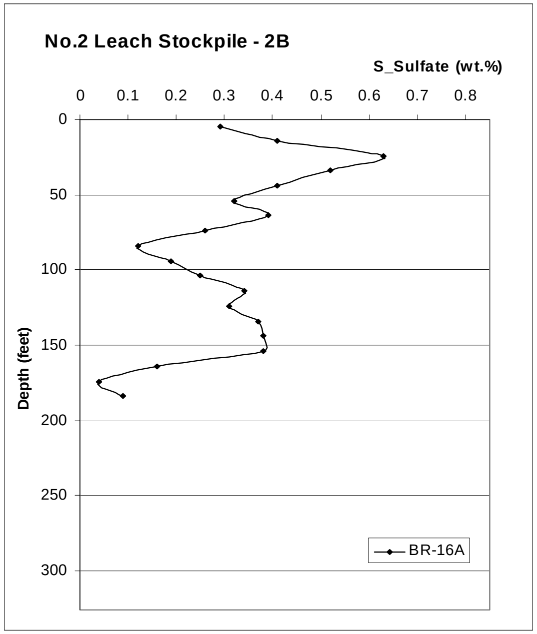

No.3 Leach Stockpile

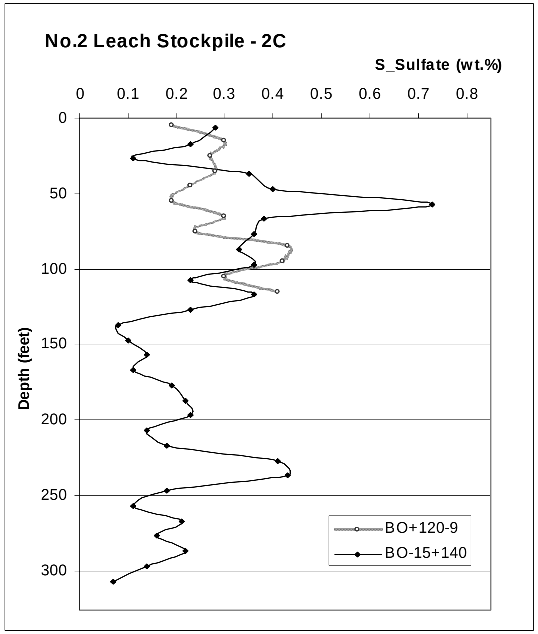

Copper Mountain Pit

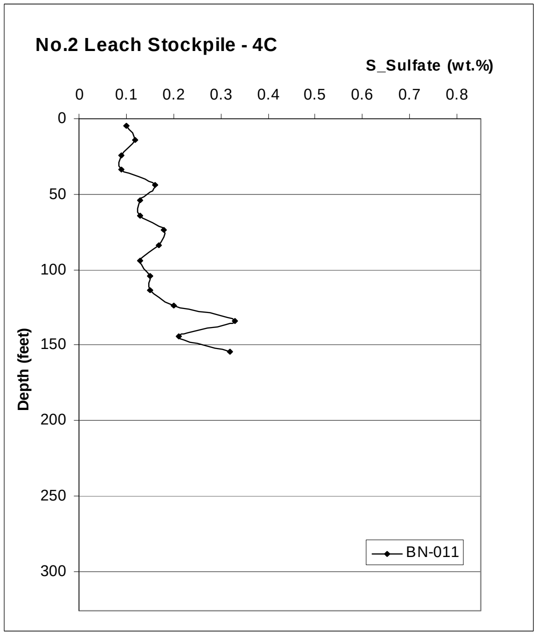

Gettysburg Out-Pit Stockpile

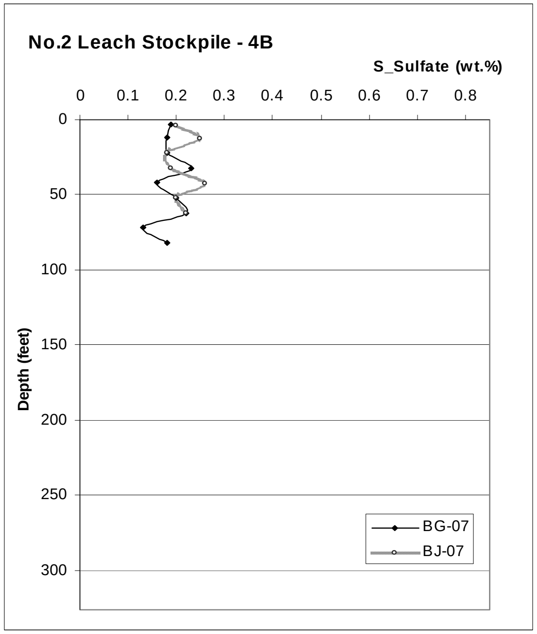

No.3B Stockpile

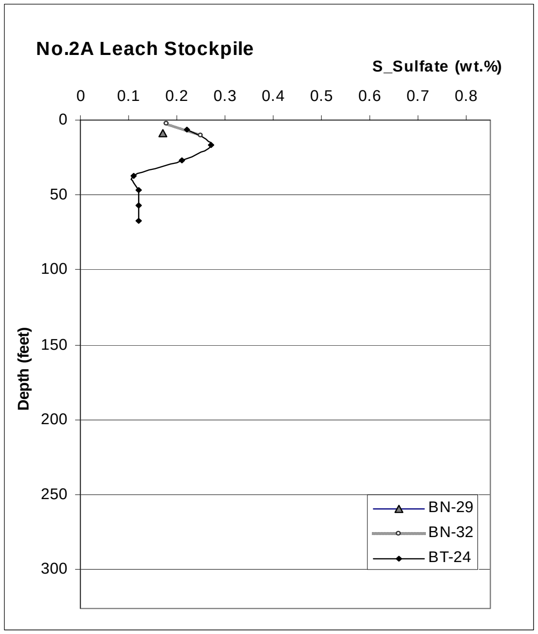

No.1B Leach Stockpile
S_Sulfate (wt.%)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Depth (feet)
0
50
100
150
200
250
300
AF-24
AI-20

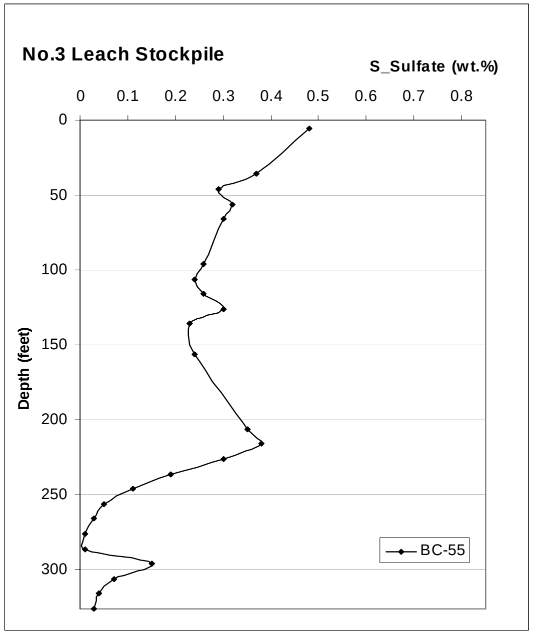

No.2 Leach Stockpile - 2B
S_Sulfate (wt.%)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Depth (feet)
0
50
100
150
200
250
300
BR-16A

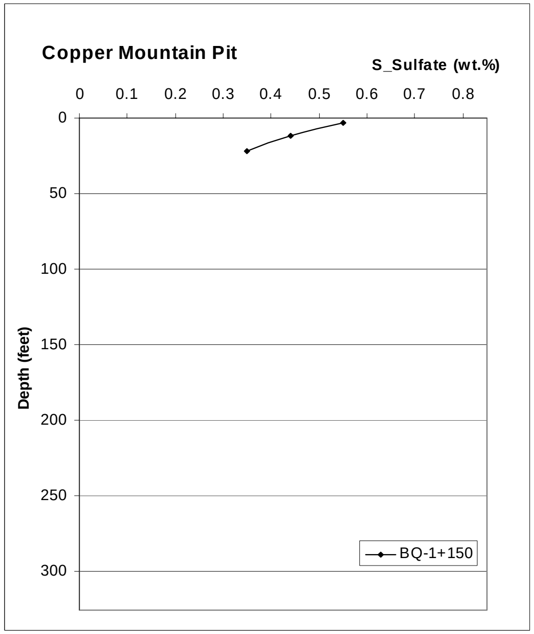

No.2 Leach Stockpile - 2C
S_Sulfate (wt.%)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Depth (feet)
0
50
100
150
200
250
300
BO+120-9
BO-15+140

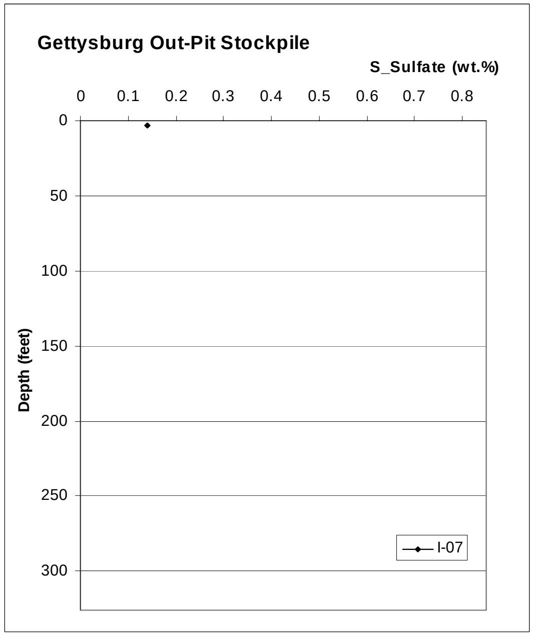

No.2 Leach Stockpile - 4C
S_Sulfate (wt.%)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Depth (feet)
0
50
100
150
200
250
300
BN-011

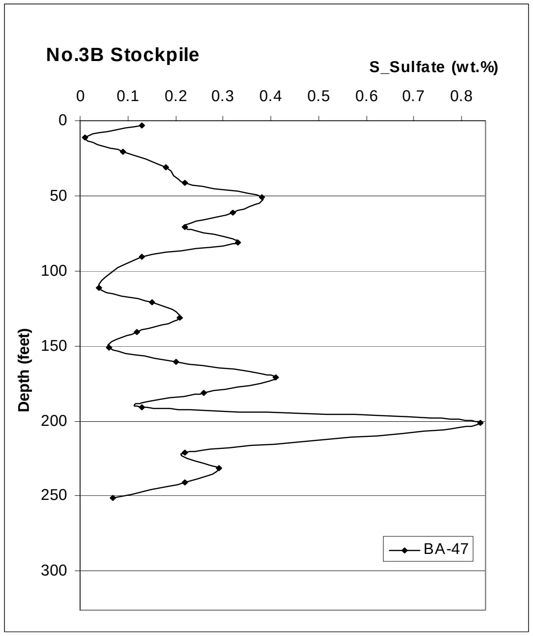

No.2 Leach Stockpile - 4B
S_Sulfate (wt.%)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Depth (feet)
0
50
100
150
200
250
300
BG-07
BJ-07

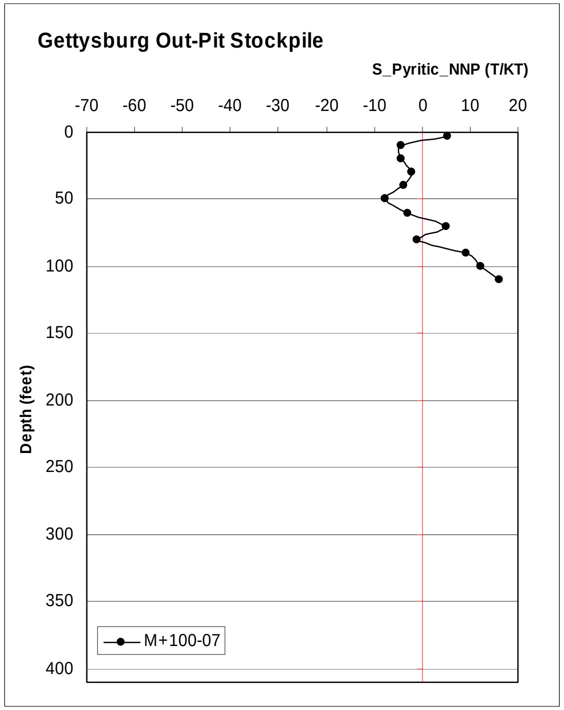

No.2A Leach Stockpile
S_Sulfate (wt.%)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Depth (feet)
0
50
100
150
200
250
300
BN-29
BN-32
BT-24

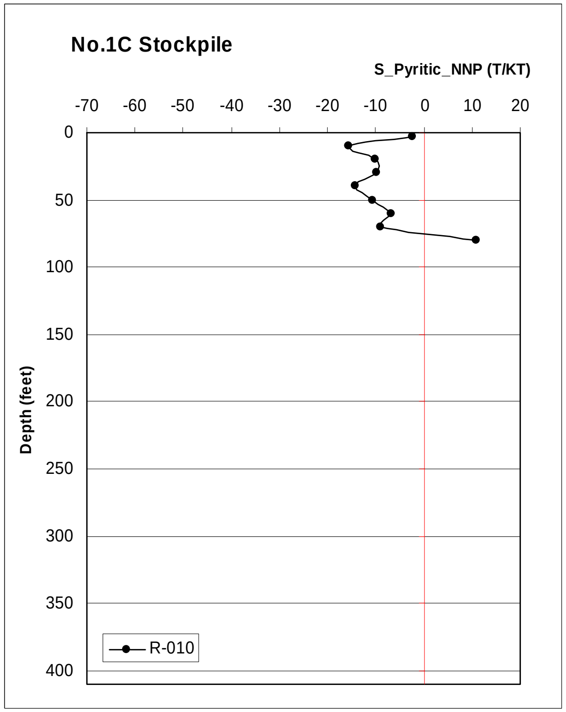

No.3 Leach Stockpile

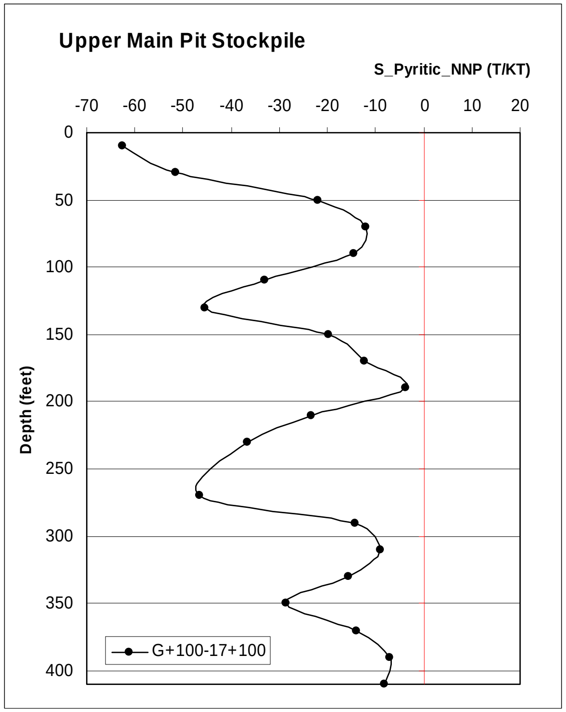

Copper Mountain Pit

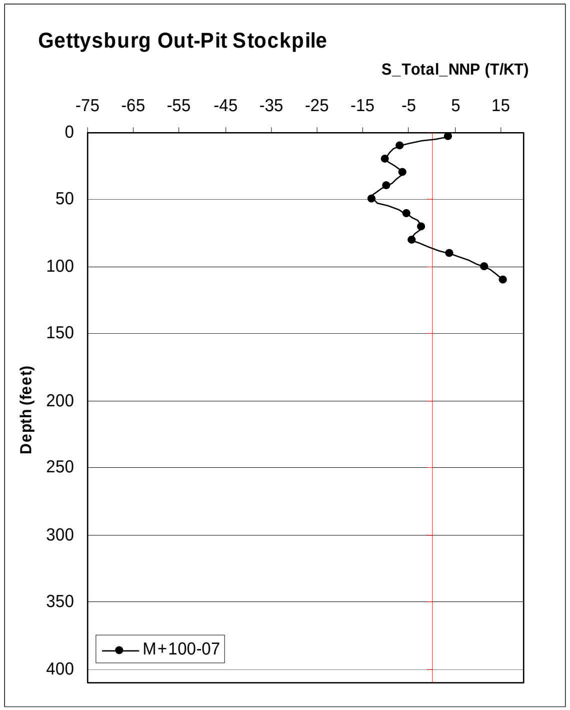

Gettysburg Out-Pit Stockpile

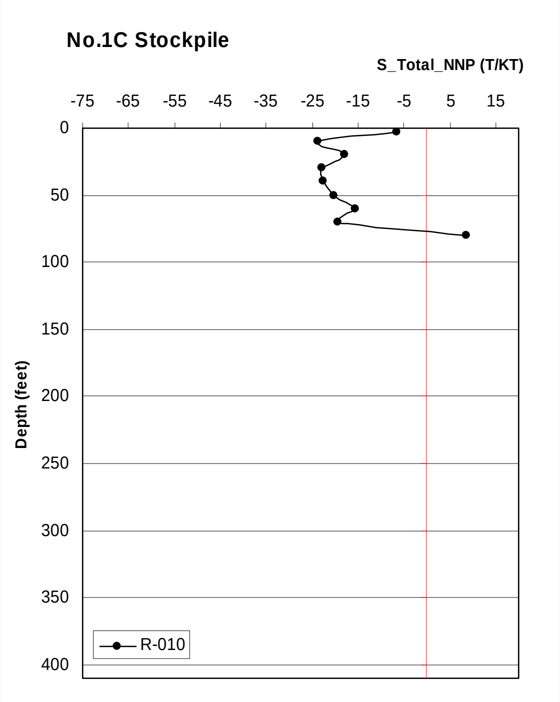

No.3B Stockpile

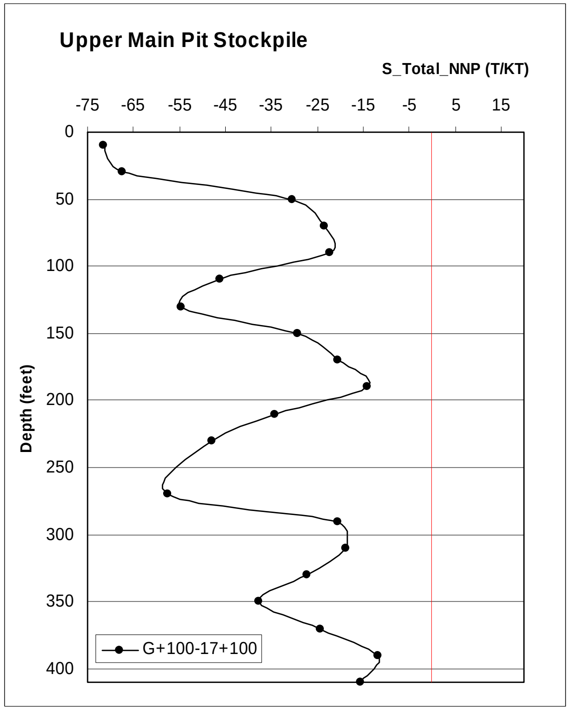

Gettysburg Out-Pit Stockpile

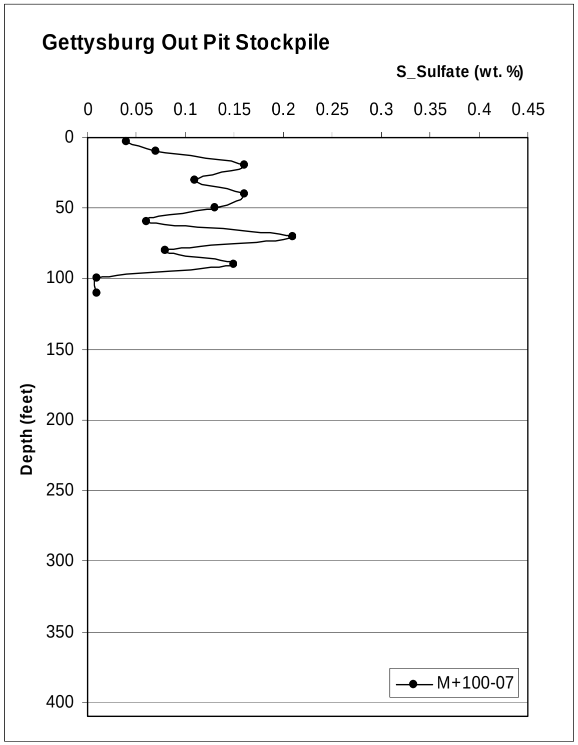

No.1C Stockpile

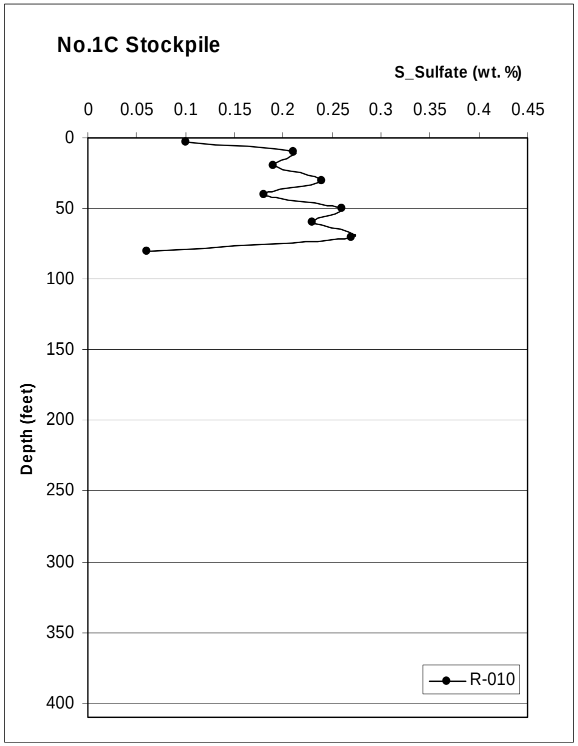

Upper Main Pit Stockpile

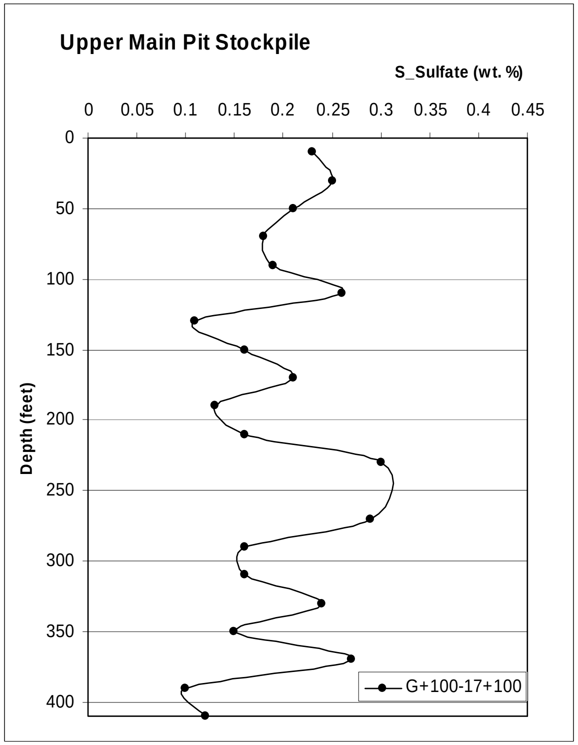

Gettysburg Out-Pit Stockpile
S_Total_NNP (T/KT)
-75
-65
-55
-45
-35
-25
-15
-5
5
15
0
50
100
150
200
250
300
350
400
Depth (feet)
M+100-07

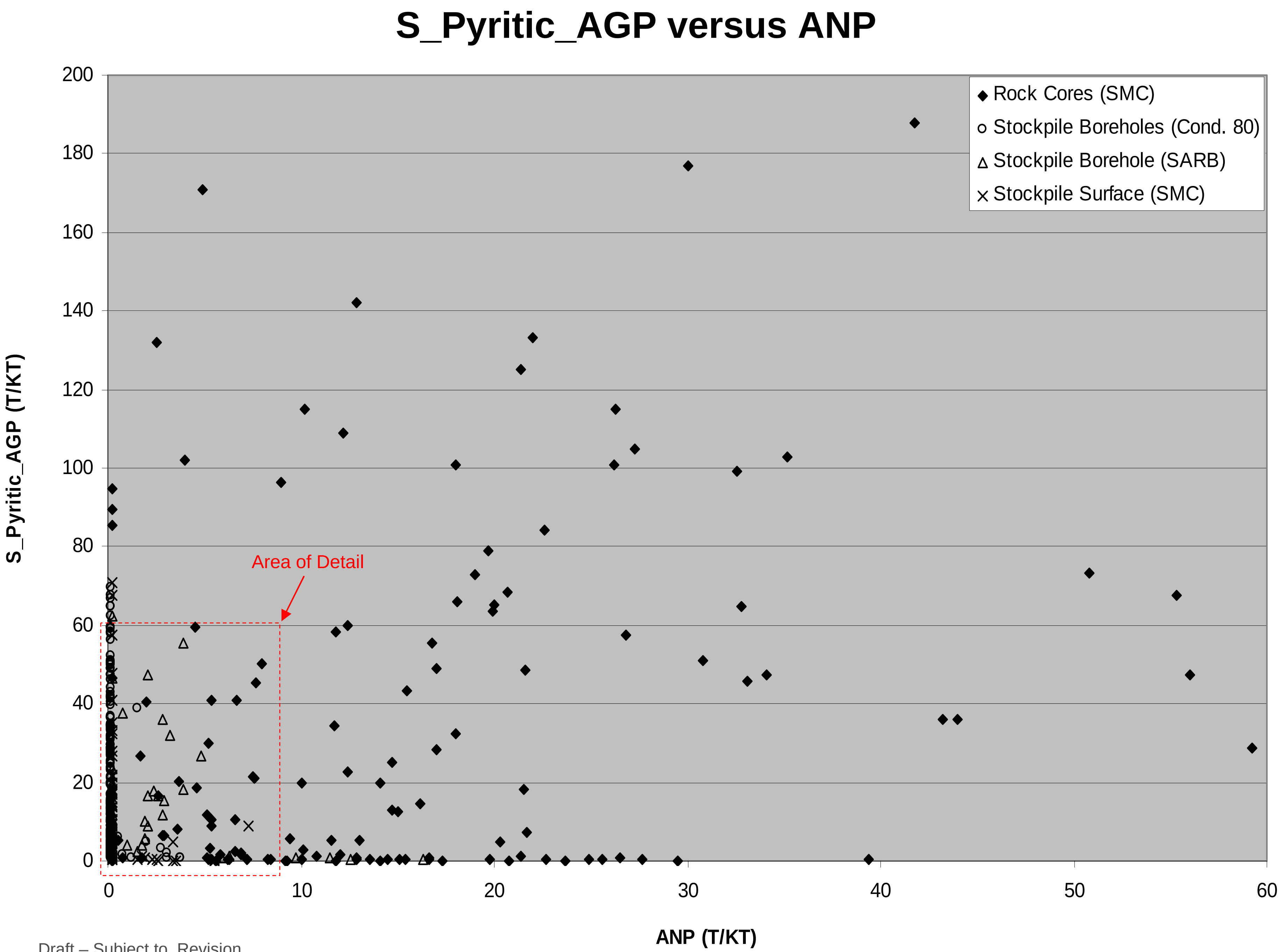

No.1C Stockpile
S_Total_NNP (T/KT)
-75
-65
-55
-45
-35
-25
-15
-5
5
15
0
50
100
150
200
250
300
350
400
Depth (feet)
R-010


Upper Main Pit Stockpile
S_Total_NNP (T/KT)
-75
-65
-55
-45
-35
-25
-15
-5
5
15
0
50
100
150
200
250
300
350
400
Depth (feet)
G+100-17+100


Gettysburg Out Pit Stockpile
S_Sulfate (wt. %)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
Depth (feet)
0
50
100
150
200
250
300
350
400
M+100-07


No.1C Stockpile
S_Sulfate (wt. %)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
Depth (feet)
0
50
100
150
200
250
300
350
400
R-010

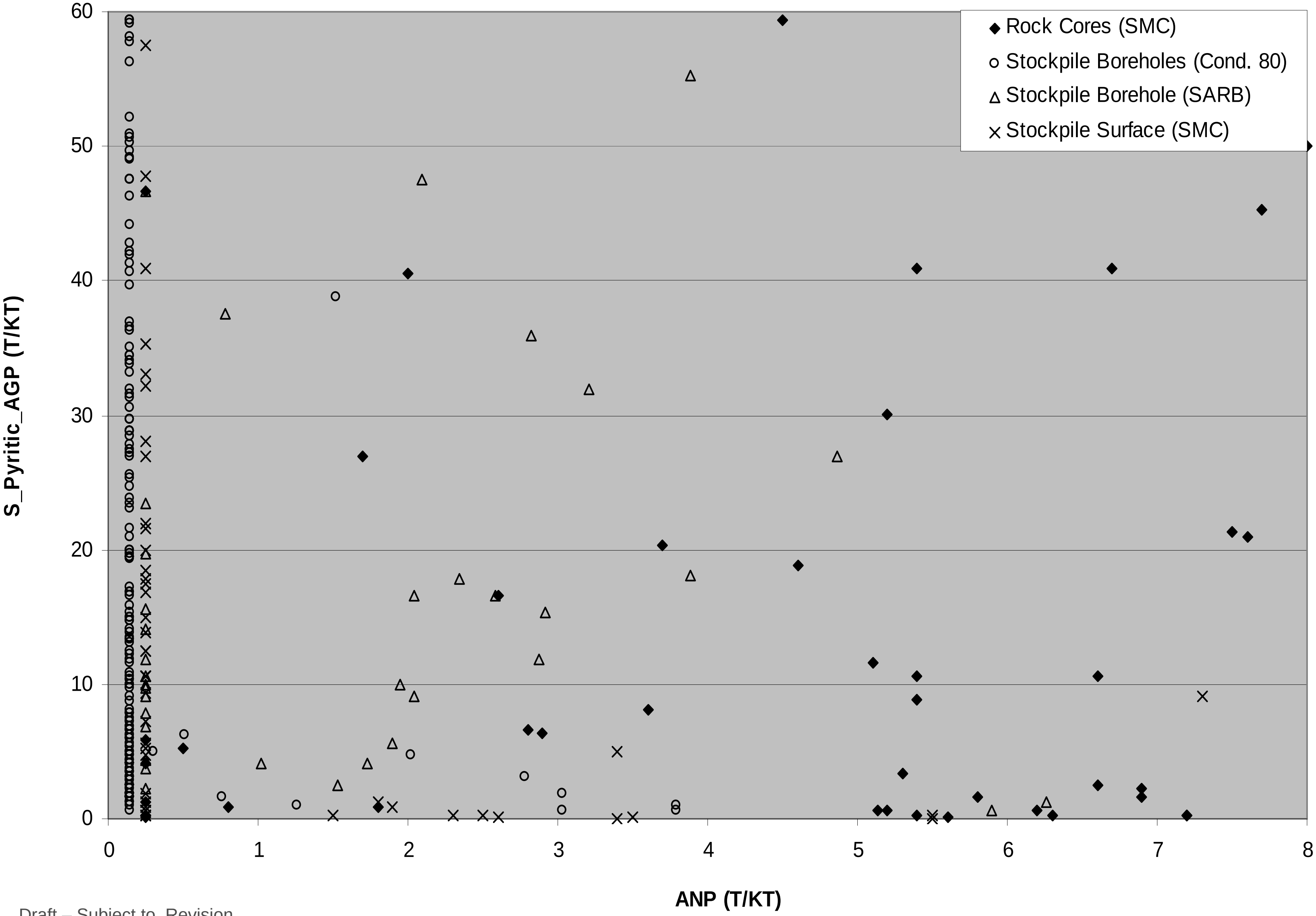

Upper Main Pit Stockpile
S_Sulfate (wt. %)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
Depth (feet)
0
50
100
150
200
250
300
350
400
G+100-17+100



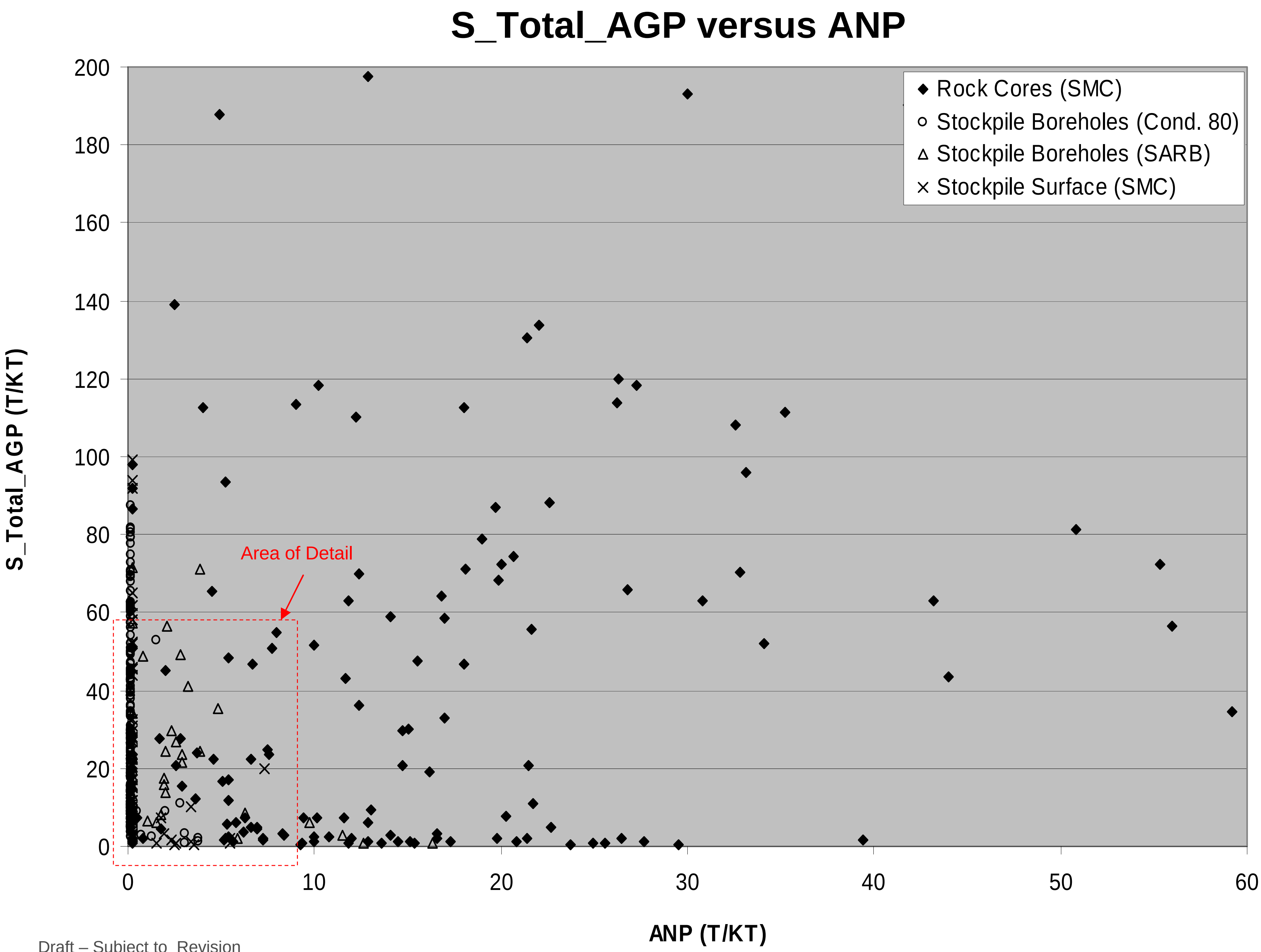
Draft – Subject to Revision

S_Pyritic_AGP versus ANP

(Zoomed-In)

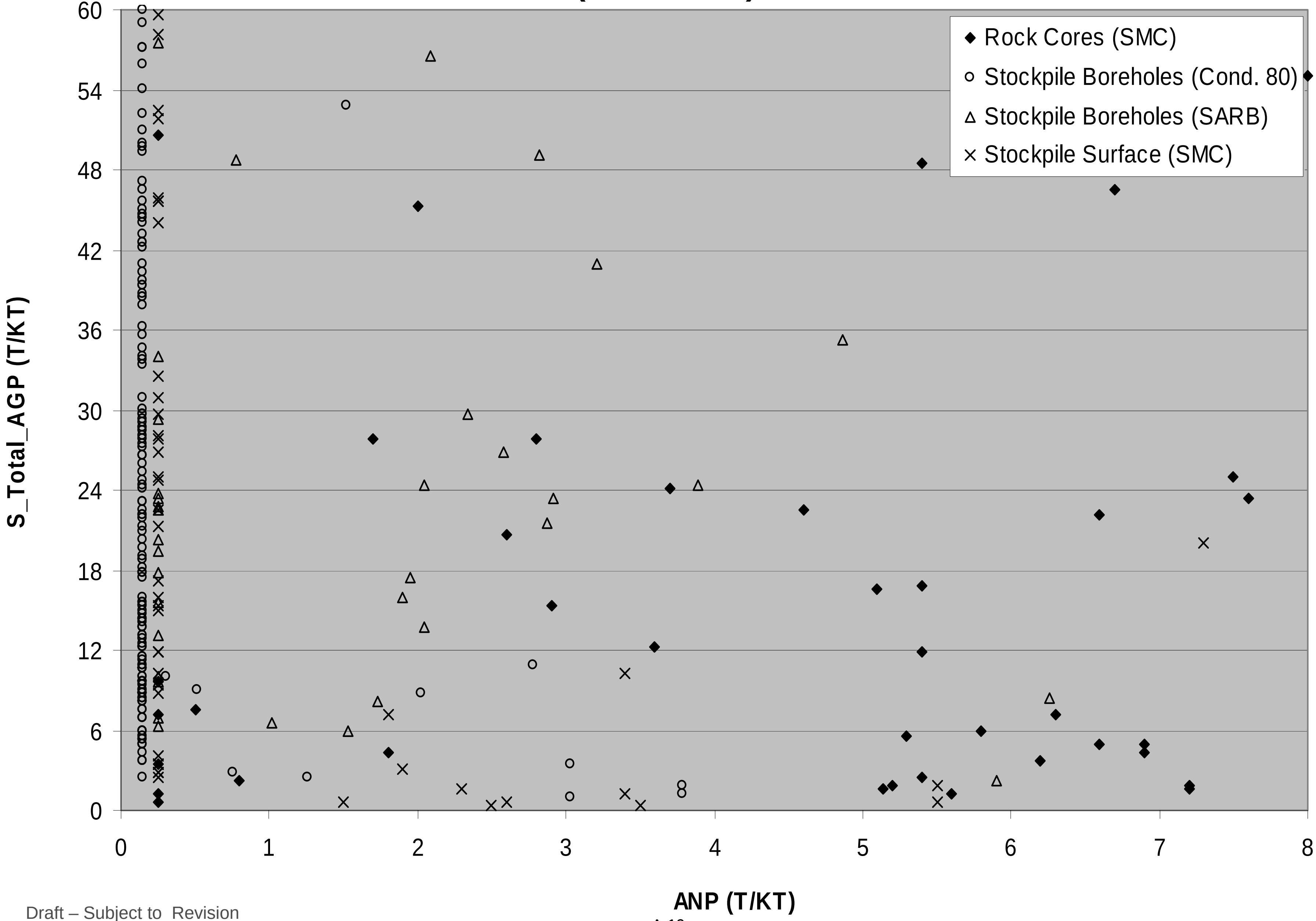


Draft – Subject to Revision


S_Total_AGP versus ANP
S_Total_AGP (T/KT)
200
180
160
140
120
100
80
60
40
20
0
0
10
20
30
40
50
60
ANP (T/KT)
◆ Rock Cores (SMC)
○ Stockpile Boreholes (Cond. 80)
△ Stockpile Boreholes (SARB)
× Stockpile Surface (SMC)
Area of Detail

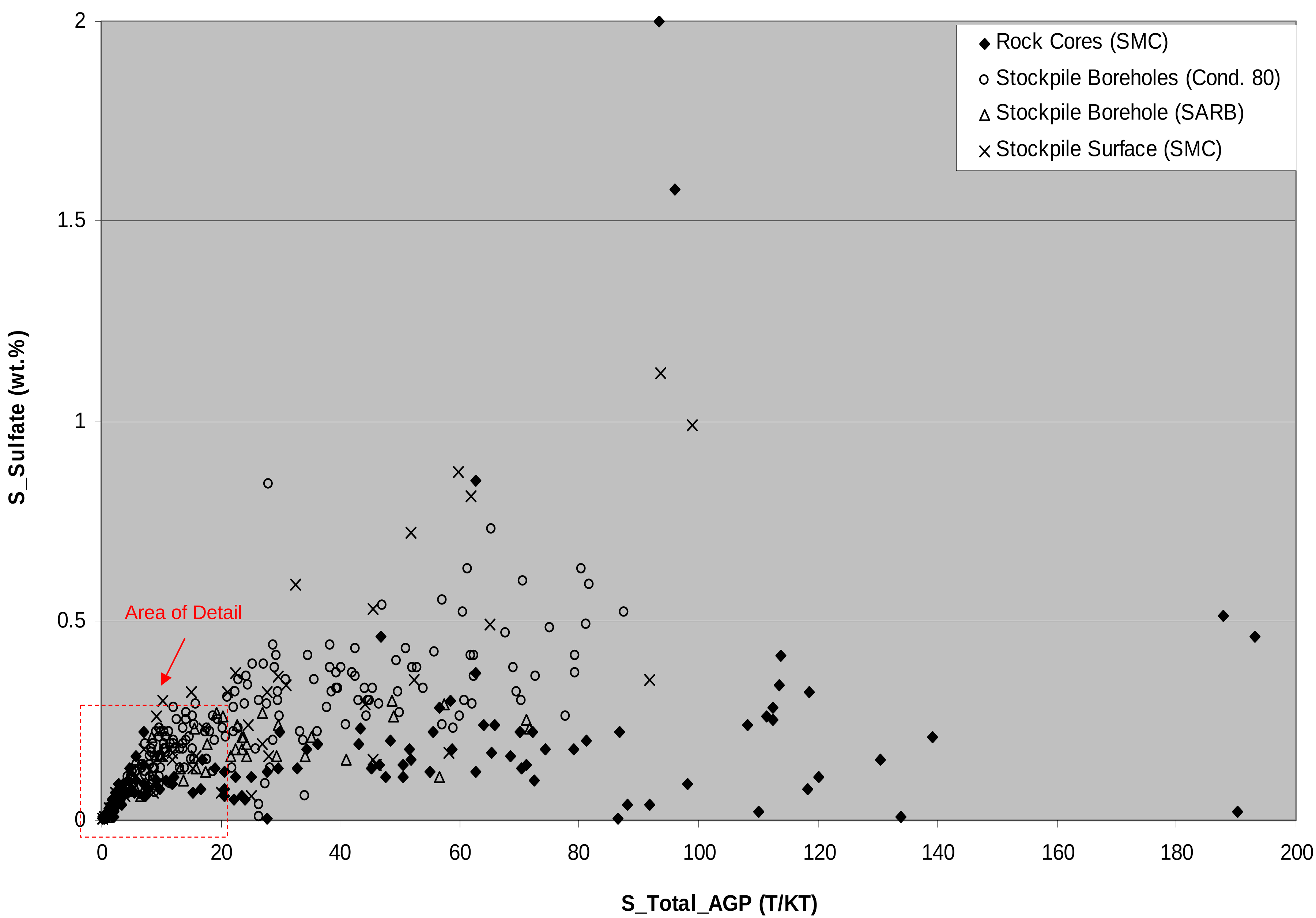
S_Total_AGP versus ANP

(Zoomed-In)



Draft – Subject to Revision

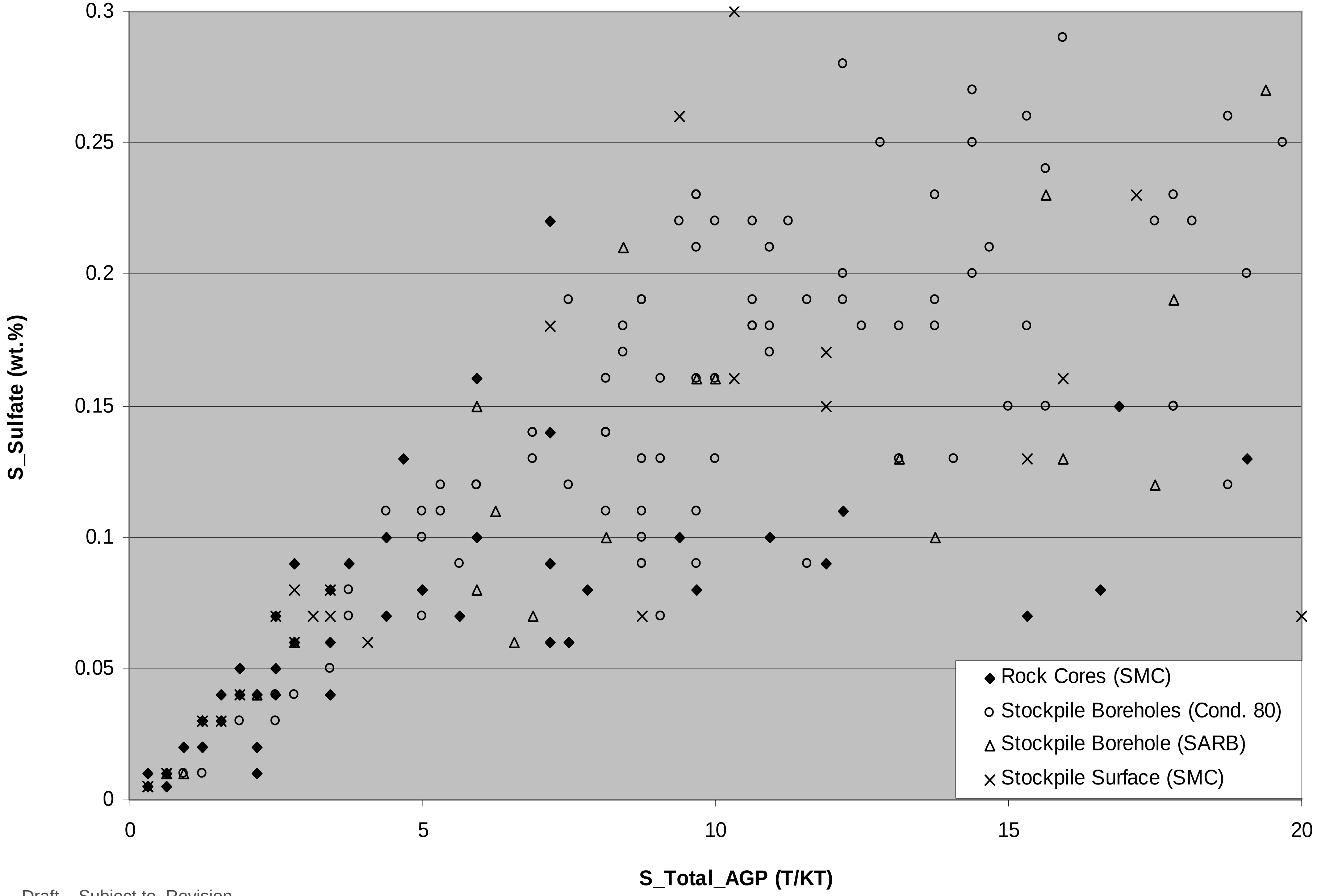
S_Sulfate versus S_Total_AGP

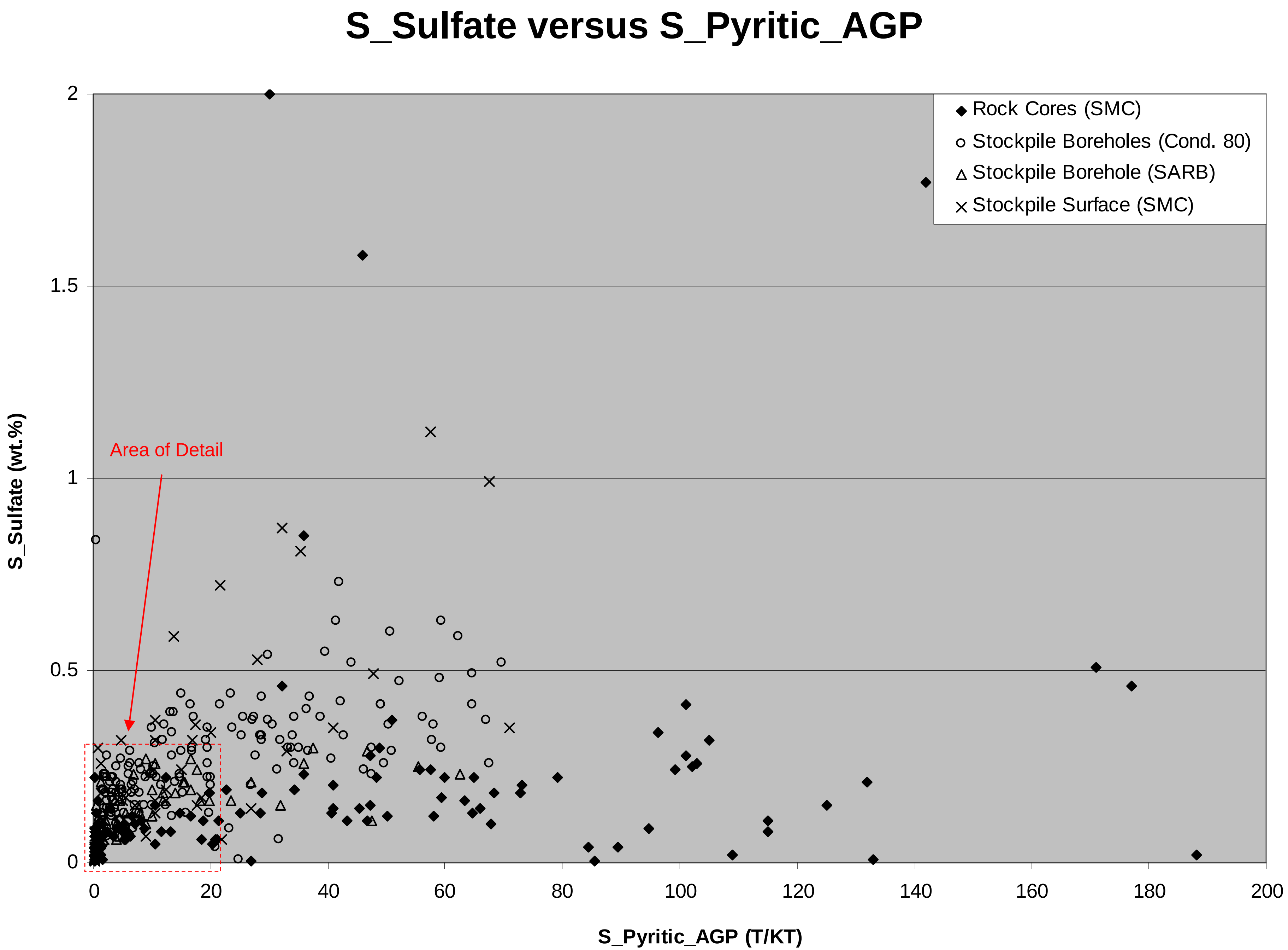


Draft – Subject to Revision

S_Sulfate versus S_Total_AGP

(Zoomed-In)





Draft – Subject to Revision

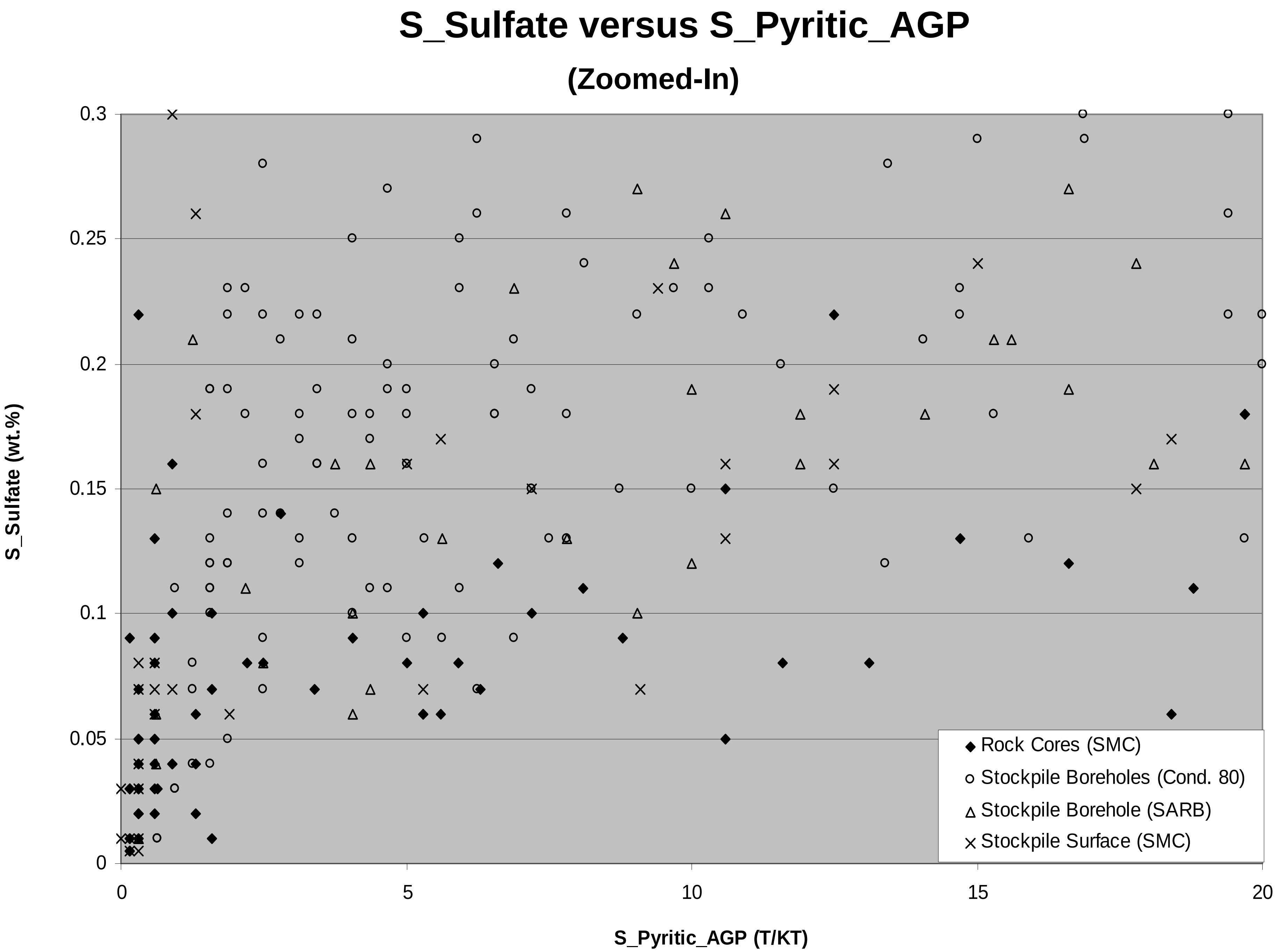

S_Sulfate versus S_Pyritic_AGP
(Zoomed-In)
S_Sulfate (wt.%)
0
0.05
0.1
0.15
0.2
0.25
0.3
0
5
10
15
20
S_Pyritic_AGP (T/KT)
◆ Rock Cores (SMC)
○ Stockpile Boreholes (Cond. 80)
△ Stockpile Borehole (SARB)
× Stockpile Surface (SMC)

Table A-1
ABA Results Summary for Stockpile Borehole Samples

Sample Location	Depth Range (feet bgs)	paste pH (s.u.)	paste EC (microS/cm)	Net Neutralization Potential based on Pyritic S (t/Kt)	Net Neutralization Potential based on Total S (calculated) (t/Kt)	Acid Genrating potential based on Pyritic S (t/Kt)	Acid Genrating potential based on Total S (calculated) (t/Kt)	Acid Neutralization Potential (t/Kt)	S Sulfate (wt %)
AF-24	0-7	5.61	419	-5.63	-11.56	5.63	11.56	<0.3	0.09
AF-24	37-47	4.65	IS	-16.9	-27.81	16.90	27.81	<0.3	0.29
AF-24	47-57	5.77	IS	-7.81	-13.13	7.81	13.13	<0.3	0.13
AF-24	57-67	4.32	IS	-33.8	-44.69	33.80	44.69	<0.3	0.3
AF-24	67-77	4.59	IS	-34.4	-44.38	34.40	44.38	<0.3	0.26
AF-24	77-87	4.24	IS	-58.1	-72.81	58.10	72.81	<0.3	0.36
AF-24	97-107	4.78	IS	-5.94	-9.69	5.94	9.69	<0.3	0.11
AI-20	0-7	4.45	1010	-62.2	-81.88	62.20	81.88	<0.3	0.59
AI-20	7-17	4.48	IS	-64.7	-81.25	64.70	81.25	<0.3	0.49
AI-20	17-27	4.36	IS	-69.7	-87.50	69.70	87.50	<0.3	0.52
AI-20	27-37	4.43	901	-59.4	-80.31	59.40	80.31	<0.3	0.63
AI-20	37-47	4.23	IS	-50.6	-70.63	50.60	70.63	<0.3	0.6
AI-20	47-57	4.29	IS	-52.2	-67.81	52.20	67.81	<0.3	0.47
AI-20	57-67	4.23	IS	-42.8	-54.06	42.80	54.06	<0.3	0.33
AI-20	67-77	4.16	IS	-28.8	-39.69	28.80	39.69	<0.3	0.33
AI-20	77-87	3.7	549	-29.7	-47.19	29.70	47.19	<0.3	0.54
AI-20	87-97	3.85	IS	-28.8	-38.75	28.80	38.75	<0.3	0.32
AI-20	97-107	4.18	IS	-27.2	-39.38	27.20	39.38	<0.3	0.37
AI-20	107-117	4.32	IS	-27.8	-37.81	27.80	37.81	<0.3	0.28
AI-20	117-127	4.28	594	-36.6	-46.56	36.60	46.56	<0.3	0.29
AI-20	127-137	4.41	770	-15	-28.75	15.00	28.75	<0.3	0.44
AI-20	137-147	4.3	736	-17.2	-29.06	17.20	29.06	<0.3	0.38
AI-20	147-157	4.46	546	-13.1	-25.31	13.10	25.31	<0.3	0.39
BA-47	0-6	5.13	IS	-15.9	-21.88	15.90	21.88	<0.3	0.13
BA-47	6-16	5.22	IS	-24.7	-26.56	24.70	26.56	<0.3	0.01
BA-47	16-26	5.46	533	-23.1	-27.50	23.10	27.50	<0.3	0.09
BA-47	26-36	5.25	250	-15.3	-25.94	15.30	25.94	<0.3	0.18
BA-47	36-46	5.09	IS	-20	-33.44	20.00	33.44	<0.3	0.22
BA-47	46-56	4.84	IS	-34.4	-52.19	34.40	52.19	<0.3	0.38
BA-47	56-66	5.07	513	-31.9	-49.69	31.90	49.69	<0.3	0.32
BA-47	66-76	5.18	IS	-19.4	-36.25	19.40	36.25	<0.3	0.22
BA-47	76-86	5.42	IS	-25.3	-44.06	25.30	44.06	<0.3	0.33
BA-47	86-96	5.54	IS	-19.7	-28.44	19.70	28.44	<0.3	0.13
BA-47	106-116	5.61	321	-20.9	-26.56	20.90	26.56	<0.3	0.04
BA-47	116-126	5.97	IS	-8.75	-15.00	8.75	15.00	<0.3	0.15
BA-47	126-136	5.82	IS	-6.88	-14.69	6.88	14.69	<0.3	0.21
BA-47	136-146	5.25	IS	-13.4	-18.75	13.40	18.75	<0.3	0.12
BA-47	146-156	4.63	IS	-31.6	-34.06	31.60	34.06	<0.3	0.06
BA-47	156-166	4.42	IS	-26.9	-33.75	26.90	33.75	<0.3	0.2
BA-47	166-176	4.35	553	-64.7	-79.38	64.70	79.38	<0.3	0.41
BA-47	176-186	5.24	553	-19.4	-30.00	19.40	30.00	<0.3	0.26
BA-47	186-196	6.51	IS	-1.56	-6.88	1.56	6.88	<0.3	0.13
BA-47	196-206	6.53	IS	-0.63	-28.13	0.63	28.13	<0.3	0.84
BA-47	216-226	5.28	815	-10.9	-18.13	10.90	18.13	<0.3	0.22
BA-47	226-236	5.66	IS	-6.25	-15.94	6.25	15.94	<0.3	0.29
BA-47	236-246	5.36	718	-14.7	-22.19	14.70	22.19	<0.3	0.22
BA-47	246-256	6.95	IS	-2.5	-5.00	2.50	5.00	<0.3	0.07
BC-55	0-11	4.96	IS	-59.1	-75.00	59.10	75.00	<0.3	0.48
BC-55	31-41	4.16	931	-66.9	-79.38	66.90	79.38	<0.3	0.37
BC-55	41-51	4.96	IS	-50.9	-62.19	50.90	62.19	<0.3	0.29
BC-55	51-61	4.95	IS	-57.8	-69.69	57.80	69.69	<0.3	0.32
BC-55	61-71	5.33	IS	-59.4	-70.31	59.40	70.31	<0.3	0.3
BC-55	91-101	4.86	IS	-67.5	-77.81	67.50	77.81	<0.3	0.26
BC-55	101-111	5.45	IS	-31.3	-40.94	31.30	40.94	<0.3	0.24
BC-55	111-121	4.8	IS	-49.7	-60.00	49.70	60.00	<0.3	0.26
BC-55	121-131	5.17	IS	-47.5	-60.94	47.50	60.94	<0.3	0.3
BC-55	131-141	5.05	IS	-47.5	-59.06	47.50	59.06	<0.3	0.23
BC-55	151-161	4.99	IS	-46.3	-57.19	46.30	57.19	<0.3	0.24
BC-55	201-211	5.14	IS	-23.8	-35.63	23.80	35.63	<0.3	0.35
BC-55	211-221	5.24	IS	-37.2	-51.29	38.80	52.81	1.52	0.38
BC-55	221-231	6.51	IS	-19.4	-29.69	19.40	29.69	<0.3	0.3
BC-55	231-241	6.53	900	-7.19	-13.75	7.19	13.75	<0.3	0.19
BC-55	241-251	5.28	IS	-2.67	-6.73	4.69	8.75	2.02	0.11
BC-55	251-261	5.66	IS	1.15	-0.41	1.88	3.44	3.03	0.05
BC-55	261-271	5.36	IS	2.85	1.92	0.94	1.88	3.79	0.03
BC-55	271-281	6.95	IS	2.4	2.09	0.63	0.94	3.03	0.01
BC-55	281-291	4.96	350	3.16	2.54	0.63	1.25	3.79	0.01
BC-55	291-301	4.16	397	-12.5	-17.81	12.50	17.81	<0.3	0.15
BC-55	301-311	4.96	278	-5.74	-8.55	6.25	9.06	0.51	0.07
BC-55	311-321	4.95	275	-0.8	-2.05	1.56	2.81	0.76	0.04
BC-55	321-331	5.33	204	0.32	-1.24	0.94	2.50	1.26	0.03
BG-07	0-7	4.86	502	-3.44	-12.19	3.44	12.19	<0.3	0.19
BG-07	7-17	5.45	642	-5	-13.13	5.00	13.13	<0.3	0.18
BG-07	17-27	4.8	633	-7.81	-15.31	7.81	15.31	<0.3	0.18
BG-07	27-37	5.17	836	-10.3	-20.31	10.30	20.31	<0.3	0.23
BG-07	37-47	5.05	811	-3.44	-9.69	3.44	9.69	<0.3	0.16
BG-07	47-57	4.99	1100	-4.69	-12.19	4.69	12.19	<0.3	0.2
BG-07	57-67	5.14	1210	-1.88	-10.00	1.88	10.00	<0.3	0.22
BG-07	67-77	5.14	692	-3.13	-8.75	3.13	8.75	<0.3	0.13
BG-07	77-87	6.16	163	-0.35	-8.16	3.13	10.94	2.78	0.18

Table A-1
ABA Results Summary for Stockpile Borehole Samples

Sample Location	Depth Range (feet bgs)	paste pH (s.u.)	paste EC (microS/cm)	Net Neutralization Potential based on Pyritic S (t/Kt)	Net Neutralization Potential based on Total S (calculated) (t/Kt)	Acid Genrating potential based on Pyritic S (t/Kt)	Acid Genrating potential based on Total S (calculated) (t/Kt)	Acid Neutralization Potential (t/Kt)	S Sulfate (wt %)
BJ-07	0-7.3	5.2	IS	-20	-28.75	20.00	28.75	<0.3	0.2
BJ-07	7.3-17.3	5.19	IS	-10.3	-19.69	10.30	19.69	<0.3	0.25
BJ-07	17.3-27.3	4.54	IS	-2.19	-8.44	2.19	8.44	<0.3	0.18
BJ-07	27.3-37.3	4.01	IS	-1.88	-8.75	1.88	8.75	<0.3	0.19
BJ-07	37.3-47.3	5.04	IS	-7.81	-18.75	7.81	18.75	<0.3	0.26
BJ-07	47.3-57.3	4.89	IS	-6.56	-14.38	6.56	14.38	<0.3	0.2
BJ-07	57.3-67.3	4.84	IS	-2.5	-9.38	2.50	9.38	<0.3	0.22
BN-011	0-9	6.25	IS	-4.06	-8.75	4.06	8.75	<0.3	0.1
BN-011	9-19	7.16	IS	-3.13	-7.50	3.13	7.50	<0.3	0.12
BN-011	19-29	6.27	IS	-5	-8.75	5.00	8.75	<0.3	0.09
BN-011	29-39	6.09	229	-6.88	-9.69	6.88	9.69	<0.3	0.09
BN-011	39-49	5.6	252	-3.44	-9.06	3.44	9.06	<0.3	0.16
BN-011	49-59	6.18	IS	-4.06	-9.06	4.06	9.06	<0.3	0.13
BN-011	59-69	6.02	IS	-5.31	-10.00	5.31	10.00	<0.3	0.13
BN-011	69-79	6.1	294	-6.56	-13.75	6.56	13.75	<0.3	0.18
BN-011	79-89	6.28	IS	-4.38	-10.94	4.38	10.94	<0.3	0.17
BN-011	89-99	6.29	254	-7.5	-14.06	7.50	14.06	<0.3	0.13
BN-011	99-109	6.33	272	-7.19	-15.63	7.19	15.63	<0.3	0.15
BN-011	109-119	6.04	321	-10	-17.81	10.00	17.81	<0.3	0.15
BN-011	119-129	4.95	IS	-11.56	-19.06	11.56	19.06	<0.3	0.2
BN-011	129-139	4.97	IS	-34.1	-45.63	34.06	45.63	<0.3	0.33
BN-011	139-149	5.06	IS	-14.1	-20.94	14.06	20.94	<0.3	0.21
BN-011	149-159	4.27	IS	-19.4	-29.69	19.38	29.69	<0.3	0.32
BN-29	0-17	5.18	IS	-3.13	-8.44	3.13	8.44	<0.3	0.17
BN-32	0-5	6.13	IS	-4.06	-10.63	4.06	10.63	<0.3	0.18
BN-32	5-15	5.77	IS	-5.94	-14.38	5.94	14.38	<0.3	0.25
BO+120-9	0-10	5.28	IS	-4.69	-10.63	4.69	10.63	<0.3	0.19
BO+120-9	10-20	4.89	IS	-33.1	-43.13	33.13	43.13	<0.3	0.3
BO+120-9	20-30	4.85	722	-40.6	-50.00	40.63	50.00	<0.3	0.27
BO+120-9	30-40	5.36	736	-13.4	-22.19	13.44	22.19	<0.3	0.28
BO+120-9	40-50	4.97	IS	-5.94	-13.75	5.94	13.75	<0.3	0.23
BO+120-9	50-60	4.85	IS	-5	-11.56	5.00	11.56	<0.3	0.19
BO+120-9	60-70	4.83	IS	-35	-45.00	35.00	45.00	<0.3	0.3
BO+120-9	70-80	5.1	IS	-8.13	-15.63	8.13	15.63	<0.3	0.24
BO+120-9	80-90	4.21	IS	-36.9	-50.94	36.88	50.94	<0.3	0.43
BO+120-9	90-100	4.43	IS	-42.2	-55.94	42.19	55.94	<0.3	0.42
BO+120-9	100-110	4.61	IS	-16.9	-26.56	16.88	26.56	<0.3	0.3
BO+120-9	110-120	4.84	IS	-49.1	-62.50	49.06	62.50	<0.3	0.41
BO-15+140	0-12	4.44	629	-2.5	-12.19	2.50	12.19	<0.3	0.28
BO-15+140	12-22	4.59	1040	-1.88	-9.69	1.88	9.69	<0.3	0.23
BO-15+140	22-32	4.91	IS	-0.94	-4.38	0.94	4.38	<0.3	0.11
BO-15+140	32-42	4.3	IS	-19.4	-30.94	19.40	30.94	<0.3	0.35
BO-15+140	42-52	4.06	IS	-36.3	-49.38	36.30	49.38	<0.3	0.4
BO-15+140	52-62	3.96	1550	-41.9	-65.31	41.90	65.31	<0.3	0.73
BO-15+140	62-72	4.16	IS	-56.3	-69.06	56.30	69.06	<0.3	0.38
BO-15+140	72-82	4.22	IS	-30.6	-42.50	30.60	42.50	<0.3	0.36
BO-15+140	82-92	4.23	IS	-28.4	-39.38	28.40	39.38	<0.3	0.33
BO-15+140	92-102	4.11	IS	-50.3	-62.50	50.30	62.50	<0.3	0.36
BO-15+140	102-112	4.43	1030	-14.7	-23.13	14.70	23.13	<0.3	0.23
BO-15+140	112-122	4.18	IS	-12.2	-24.38	12.20	24.38	<0.3	0.36
BO-15+140	122-132	4.48	IS	-9.69	-17.81	9.69	17.81	<0.3	0.23
BO-15+140	132-142	4.76	946	-1.25	-3.75	1.25	3.75	<0.3	0.08
BO-15+140	142-152	4.97	IS	-1.56	-5.00	1.56	5.00	<0.3	0.1
BO-15+140	152-162	4.98	IS	-3.75	-8.13	3.75	8.13	<0.3	0.14
BO-15+140	162-172	4.96	1130	-1.56	-5.00	1.56	5.00	<0.3	0.11
BO-15+140	172-182	4.69	IS	-1.56	-7.50	1.56	7.50	<0.3	0.19
BO-15+140	182-192	4.69	IS	-3.13	-10.63	3.13	10.63	<0.3	0.22
BO-15+140	192-202	4.6	1200	-2.19	-9.69	2.19	9.69	<0.3	0.23
BO-15+140	202-212	4.97	IS	-2.5	-6.88	2.50	6.88	<0.3	0.14
BO-15+140	212-222	5.53	965	-4.38	-10.63	4.38	10.63	<0.3	0.18
BO-15+140	222-232	4.74	IS	-16.6	-29.38	16.60	29.38	<0.3	0.41
BO-15+140	232-242	4.65	1630	-28.8	-42.50	28.80	42.50	<0.3	0.43
BO-15+140	242-252	5.16	933	-6.56	-12.50	6.56	12.50	<0.3	0.18
BO-15+140	252-262	5.51	IS	-4.38	-8.13	4.38	8.13	<0.3	0.11
BO-15+140	262-272	5.22	IS	-4.06	-10.94	4.06	10.94	<0.3	0.21
BO-15+140	272-282	5.34	IS	-2.5	-8.13	2.50	8.13	<0.3	0.16
BO-15+140	282-292	5.3	1160	-3.44	-11.25	3.44	11.25	<0.3	0.22
BO-15+140	292-302	4.55	IS	-1.88	-6.88	1.88	6.88	<0.3	0.14
BO-15+140	302-312	4.84	796	-1.25	-3.75	1.25	3.75	<0.3	0.07
BQ-1+150	0-7	4.21	IS	-39.7	-57.19	39.70	57.19	<0.3	0.55
BQ-1+150	7-17	4.06	IS	-23.4	-38.44	23.40	38.44	<0.3	0.44
BQ-1+150	17-27	4.32	IS	-10	-23.13	10.00	23.13	<0.3	0.35

Table A-1
ABA Results Summary for Stockpile Borehole Samples

Sample Location	Depth Range (feet bgs)	paste pH (s.u.)	paste EC (microS/cm)	Net Neutralization Potential based on Pyritic S (t/Kt)	Net Neutralization Potential based on Total S (calculated) (t/Kt)	Acid Genrating potential based on Pyritic S (t/Kt)	Acid Genrating potential based on Total S (calculated) (t/Kt)	Acid Neutralization Potential (t/Kt)	S Sulfate (wt %)
BR-16A	0-9	4.43	IS	-15	-24.06	15.00	24.06	<0.3	0.29
BR-16A	9-19	4.36	IS	-49.1	-61.88	49.10	61.88	<0.3	0.41
BR-16A	19-29	4.5	IS	-41.3	-61.25	41.30	61.25	<0.3	0.63
BR-16A	29-39	4.28	IS	-44.1	-60.63	44.10	60.63	<0.3	0.52
BR-16A	39-49	4.46	IS	-21.6	-34.69	21.60	34.69	<0.3	0.41
BR-16A	49-59	4.49	IS	-11.9	-22.50	11.90	22.50	<0.3	0.32
BR-16A	59-69	4.69	IS	-13.8	-27.19	13.80	27.19	<0.3	0.39
BR-16A	69-79	4.94	IS	-6.25	-15.31	6.25	15.31	<0.3	0.26
BR-16A	79-89	5.38	IS	-1.56	-5.31	1.56	5.31	<0.3	0.12
BR-16A	89-99	5.42	IS	-1.56	-8.75	1.56	8.75	<0.3	0.19
BR-16A	99-109	5.48	IS	-4.06	-12.81	4.06	12.81	<0.3	0.25
BR-16A	109-119	4.64	IS	-13.4	-24.69	13.40	24.69	<0.3	0.34
BR-16A	119-129	4.86	IS	-10.6	-21.25	10.60	21.25	<0.3	0.31
BR-16A	129-139	4.74	IS	-29.7	-42.19	29.70	42.19	<0.3	0.37
BR-16A	139-149	4.68	IS	-27.5	-40.31	27.50	40.31	<0.3	0.38
BR-16A	149-159	4.62	IS	-25.6	-38.44	25.60	38.44	<0.3	0.38
BR-16A	159-169	5.58	IS	-5	-10.00	5.00	10.00	0.3	0.16
BR-16A	169-179	6.43	IS	-1.25	-2.50	1.25	2.50	<0.3	0.04
BR-16A	179-189	6.17	IS	-2.5	-5.63	2.50	5.63	<0.3	0.09
BT-24	0-12	5.02	IS	-9.06	-17.50	9.06	17.50	<0.3	0.22
BT-24	12-22	5.49	IS	-4.69	-14.38	4.69	14.38	<0.3	0.27
BT-24	22-32	6.33	433	-2.81	-9.69	2.81	9.69	<0.3	0.21
BT-24	32-42	6.54	IS	-1.56	-5.31	1.56	5.31	<0.3	0.11
BT-24	42-52	6.5	IS	-1.88	-5.94	1.88	5.94	<0.3	0.12
BT-24	52-62	6.55	IS	-1.88	-5.94	1.88	5.94	<0.3	0.12
BT-24	62-72	6.16	IS	-1.56	-5.94	1.56	5.94	<0.3	0.12
I-07	0-6	6.39	328	-2.81	-8.13	2.81	8.13	<0.3	0.14

Notes:
IS = Insufficient Sample

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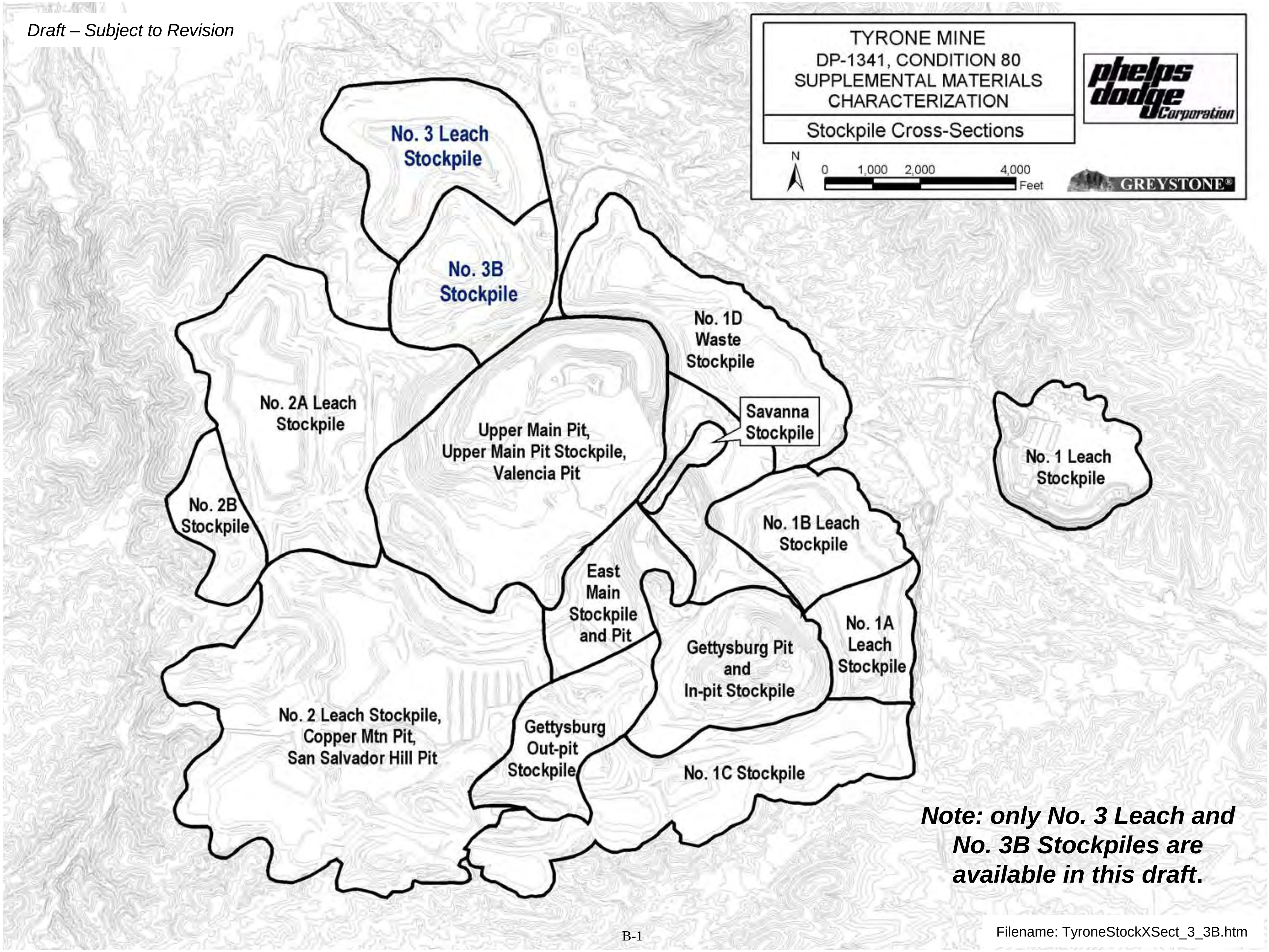
TYRONE MINE
DP-1341, CONDITION 80
SUPPLEMENTAL MATERIALS
CHARACTERIZATION

Stockpile Cross-Sections



Note: only No. 3 Leach and No. 3B Stockpiles are available in this draft.

Filename: TyroneStockXSect_3_3B.htm

Data

This set of stockpile cross-sections for Tyrone Mine was assembled from PDTI Engineering department contour maps and other historical topographic data sets depicting lift and re-mining activity at Tyrone Mine (DBS&A. 1997a, b).

Cross-sections were created for all pits and stockpiles along a 500-foot by 500-foot grid on East-West and North-South lines.
Each cross-section line shows the surface topography from pre-mine to present conditions at specific historical mining periods.

For each cross-section, the historical surfaces are displayed as follows:
* The under-dump surface is displayed for all cross-sections.
* The pre-mine surface is displayed if it differs from the under-dump surface.
* The 2004 surface is displayed for all cross-sections.
* From 1973 through 2002, only those stockpile surfaces that differ from the prior time-period are shown, and the 2002 surface must also differ from 2004 to be shown.

For a given surface to be defined as significantly different from another surface, 10 percent of the elevation data points must differ by 10 feet or more. This approach improves the visual clarity in the profile graphs by omitting small elevation changes between the historical surfaces.

This electronic dataset also contains mineral assemblage data for individual stockpiles. These data were taken from the April 1997 Tyrone Preliminary Materials Characterization report, and are presented herein as pie charts of percentages of mineral assemblage by stockpile.

This draft dataset contains example cross sections for the No. 3 Leach Stockpile and the No. 3B Stockpile. The final report will contain the profile graphs for all stockpiles and pits .

References

DBS&A. 1997a. *Preliminary Materials Characterization, Tyrone Mine Closure/Closeout.* Prepared for Phelps Dodge Tyrone, Inc. Tyrone, New Mexico. Apirl 30.

DBS&A. 1997b. *Supplemental Materials Characterization Study, Tyrone Mine Closure/Closeout.* Prepared for Phelps Dodge Tyrone, Inc. Tyrone, New Mexico.

No. 3 Leach Stockpile Cross-Sections (500-foot grid)

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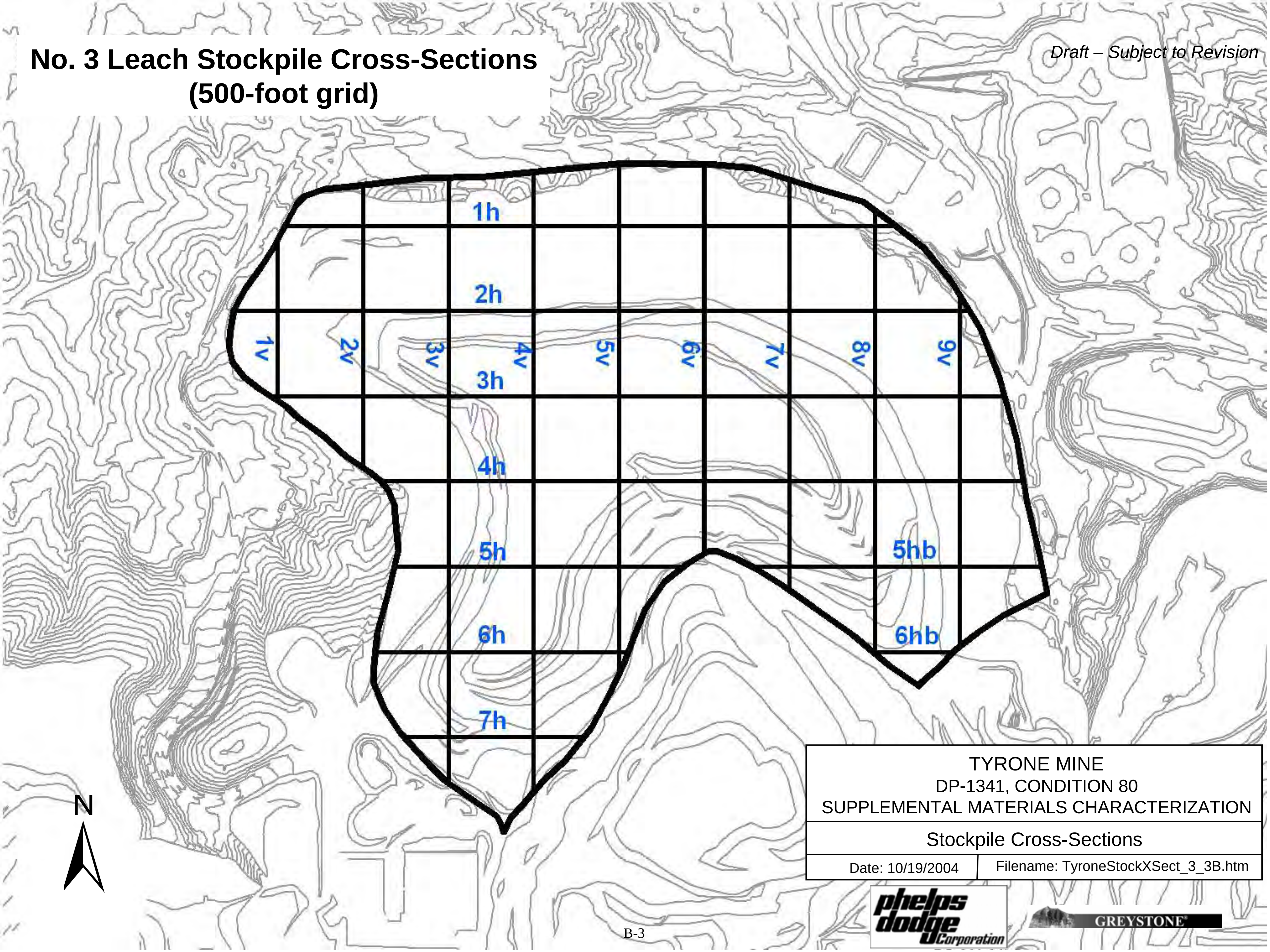

TYRONE MINE
DP-1341, CONDITION 80
SUPPLEMENTAL MATERIALS CHARACTERIZATION

Stockpile Cross-Sections

Date: 10/19/2004 | Filename: TyroneStockXSect_3_3B.htm

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Tyrone Cross Section No3Leach_1h

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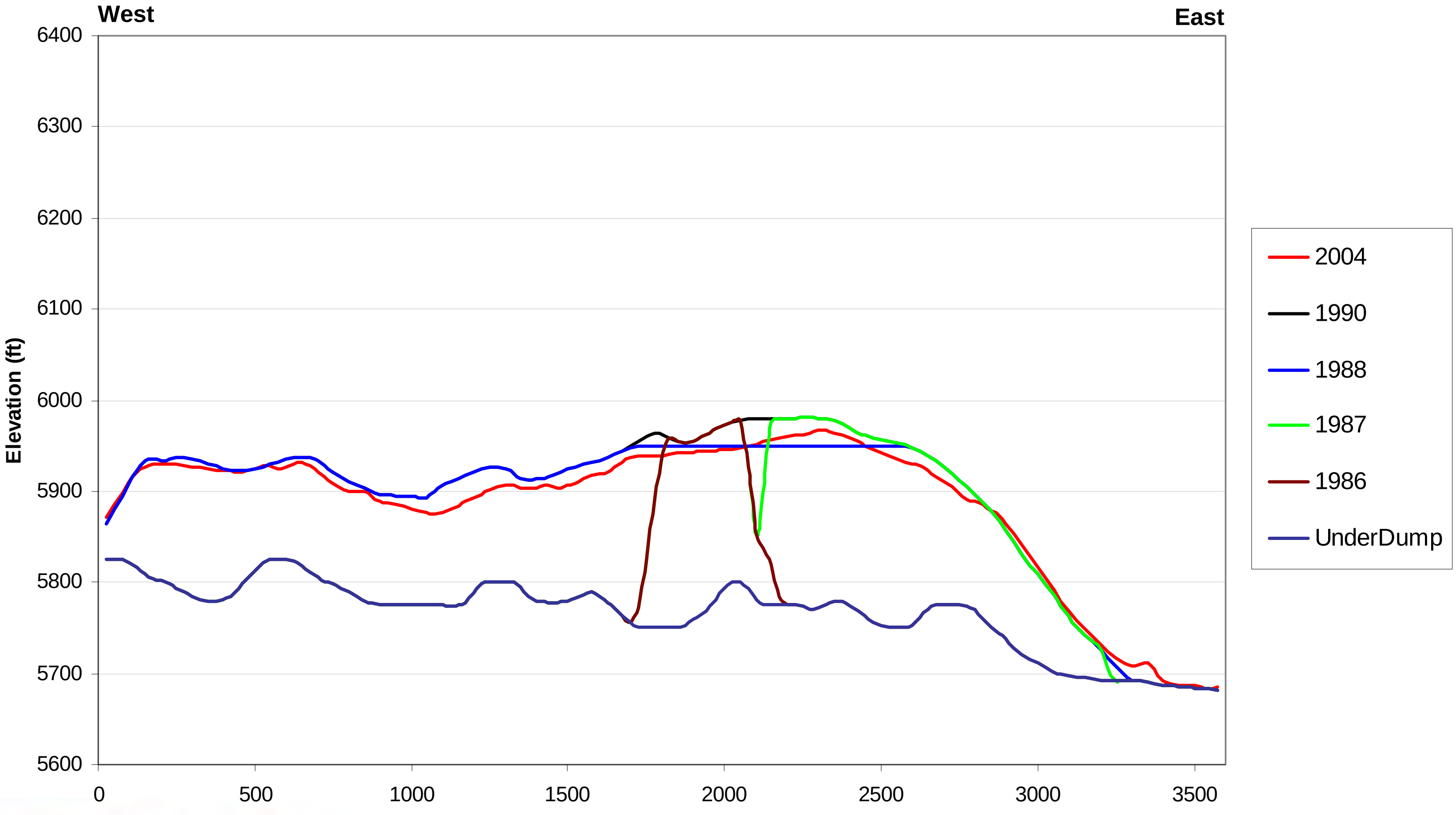

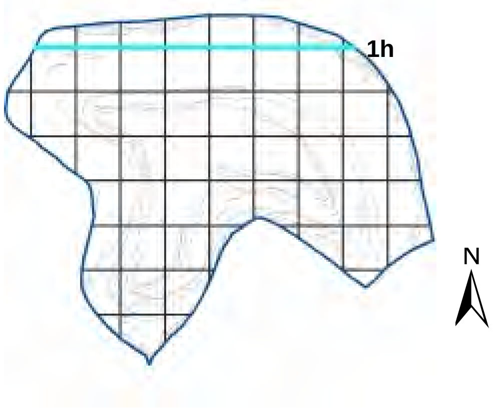

No. 3 Leach Stockpile

TYRONE MINE DP-1341, CONDITION 80 SUPPLEMENTAL MATERIALS CHARACTERIZATION	
Stockpile Cross-Sections	
Date: 10/19/2004	Filename: TyroneStockXSection_3_3B.htm

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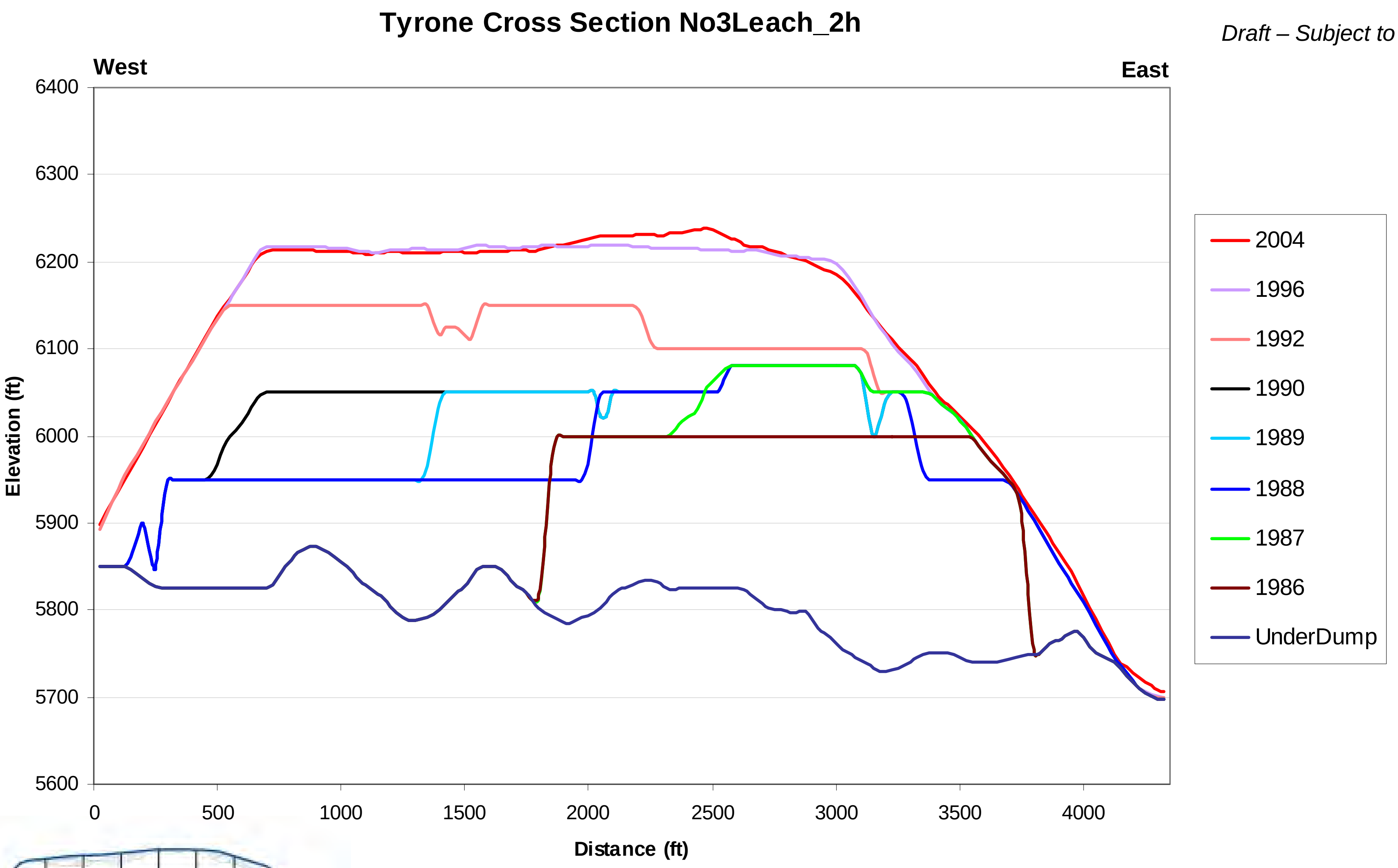

No. 3 Leach Stockpile

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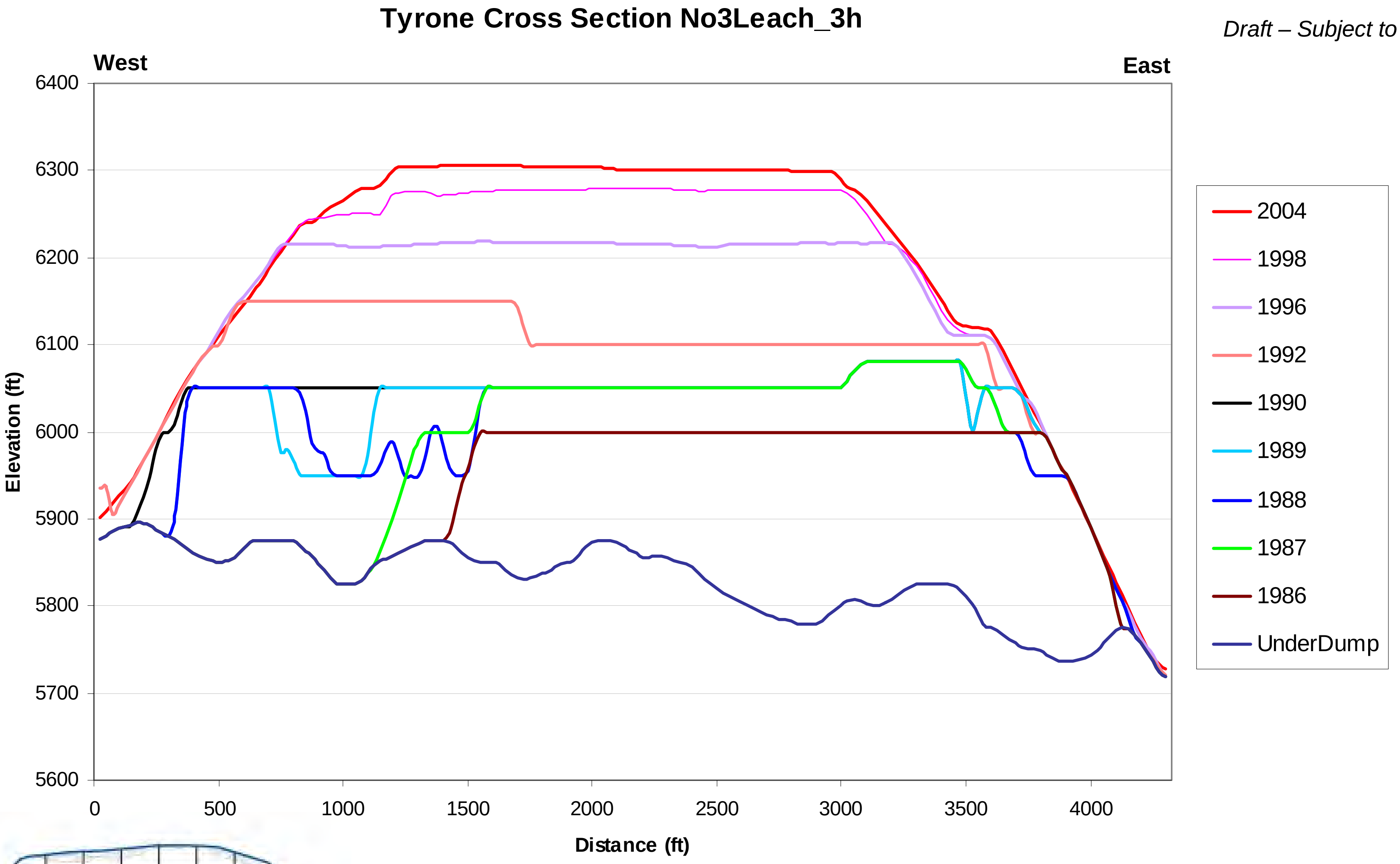

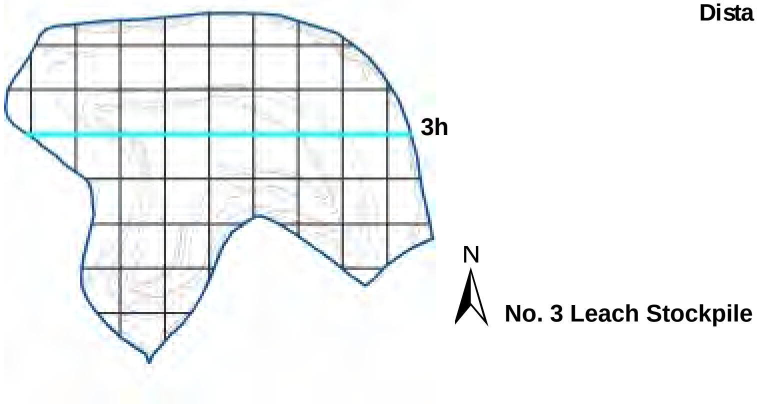

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Stockpile Cross-Sections	
Date: 10/19/2004	Filename: TyroneStockXSection_3_3B.htm

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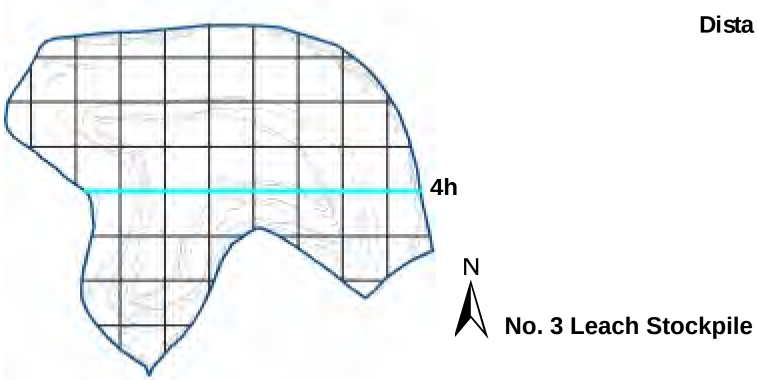
Tyrone Cross Section No3Leach_4h



TYRONE MINE
DP-1341, CONDITION 80
SUPPLEMENTAL MATERIALS CHARACTERIZATION

Stockpile Cross-Sections

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Tyrone Cross Section No3Leach_5h

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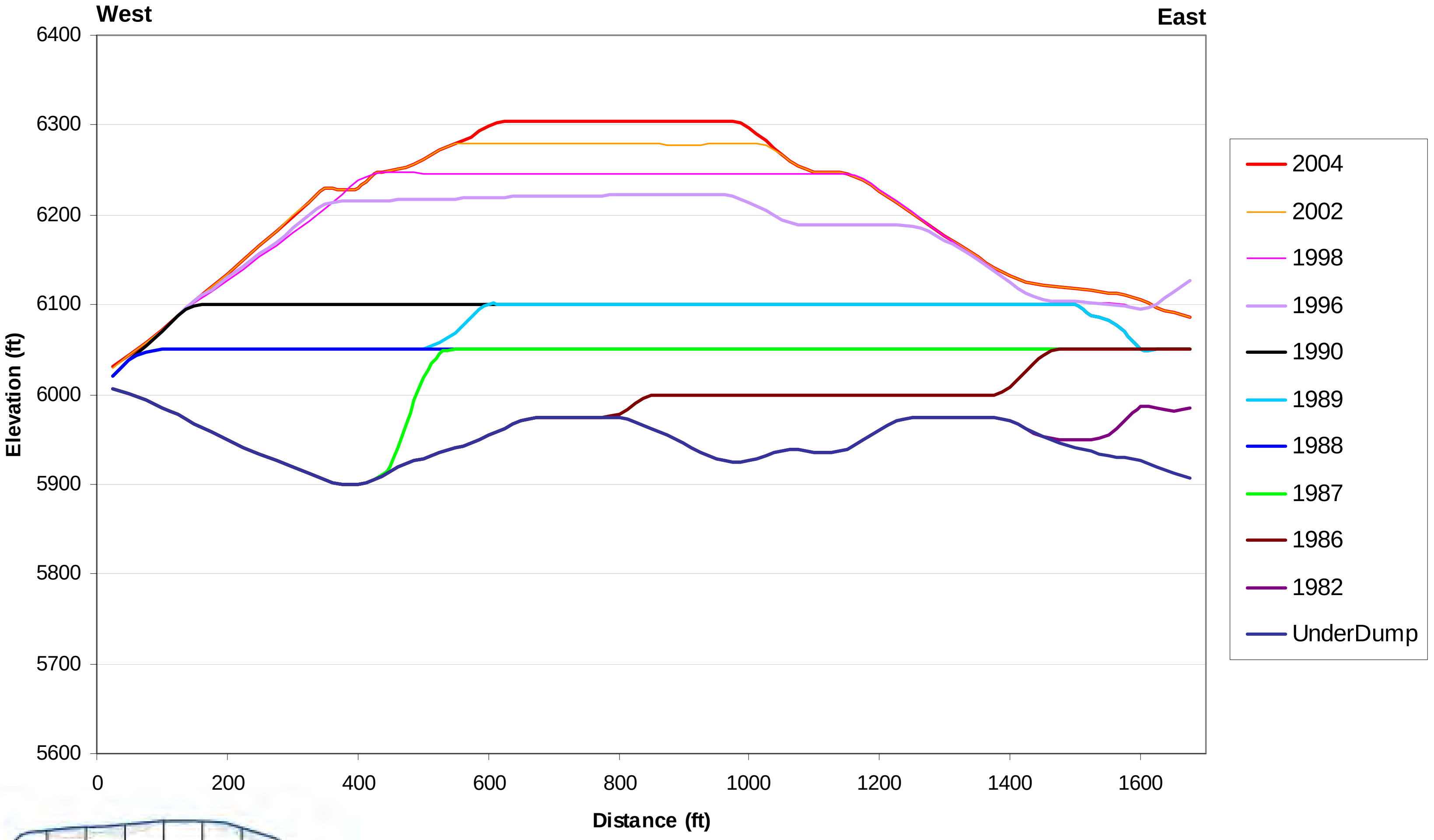

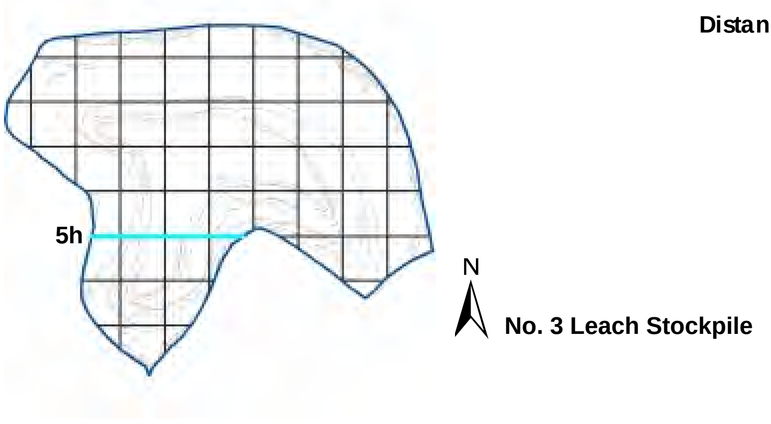

TYRONE MINE
DP-1341, CONDITION 80
SUPPLEMENTAL MATERIALS CHARACTERIZATION

Stockpile Cross-Sections

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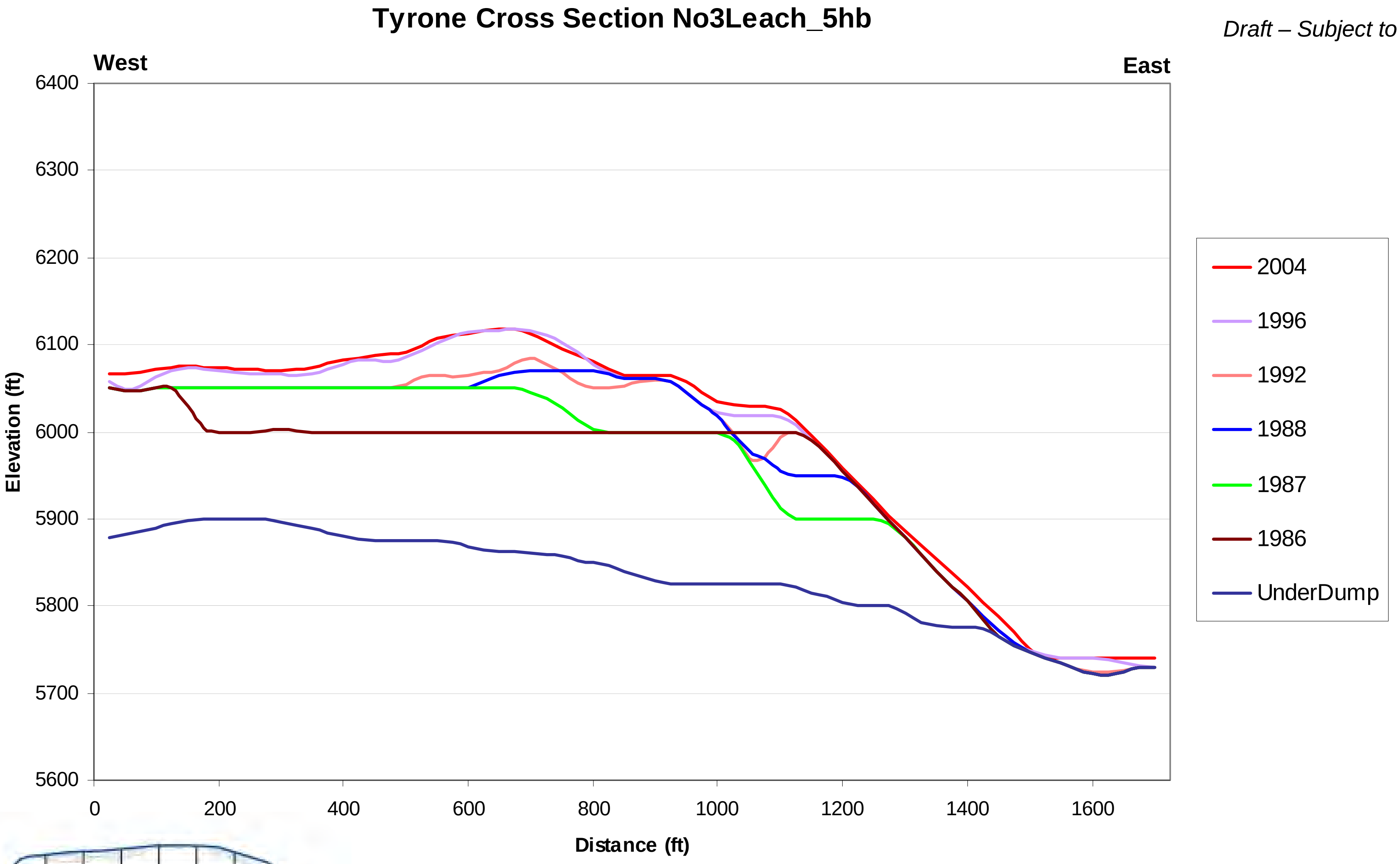

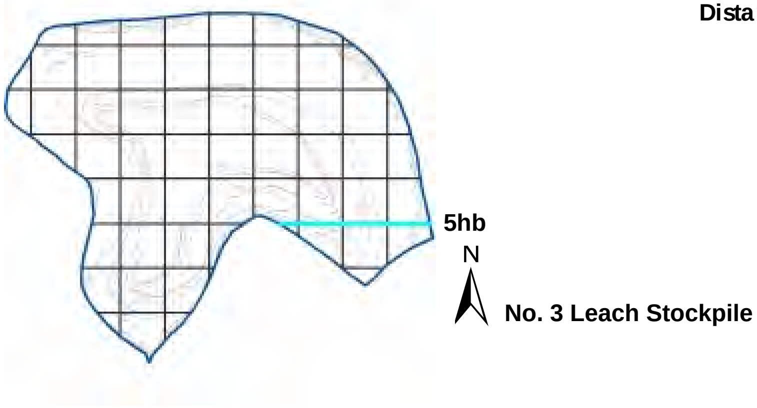

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Stockpile Cross-Sections	
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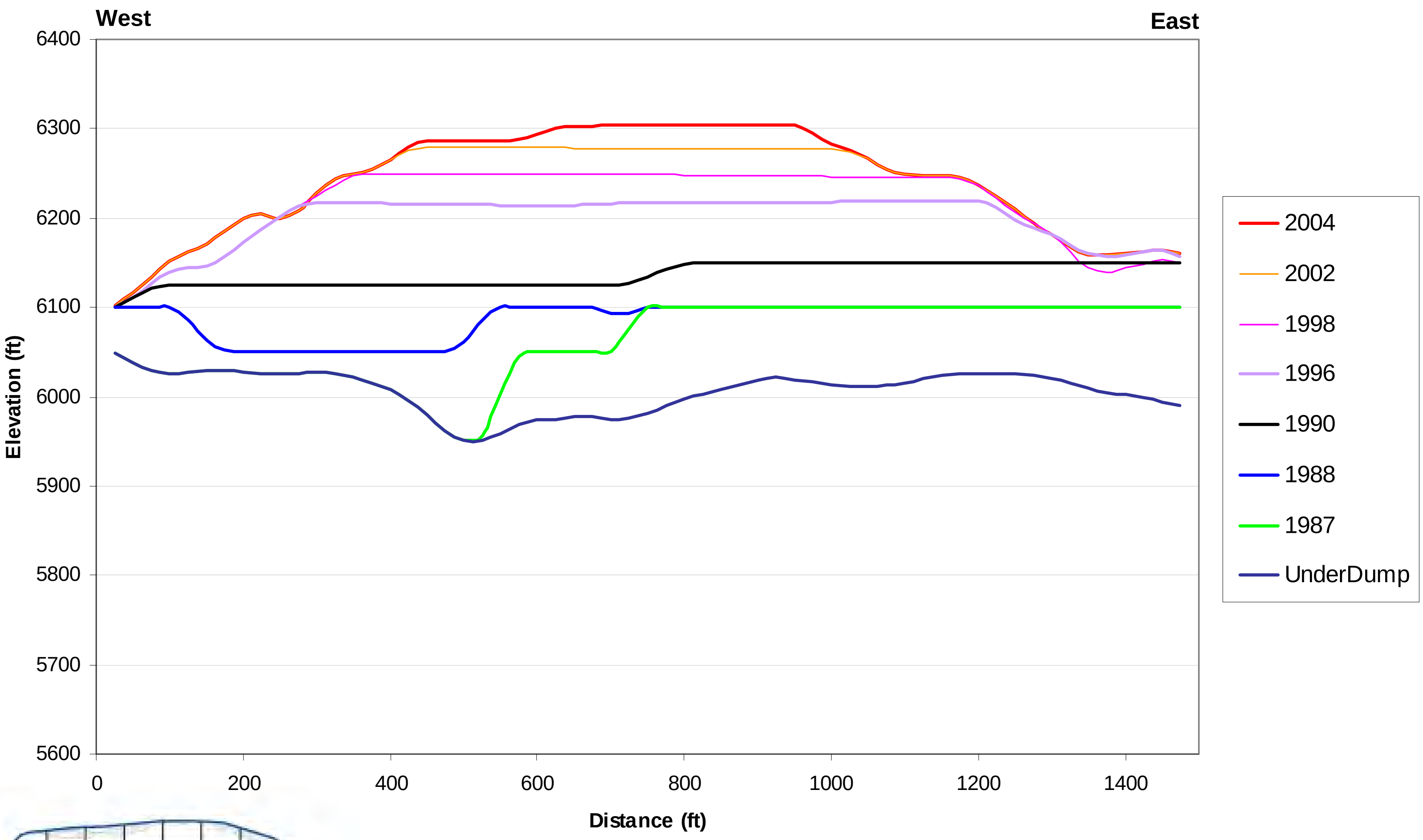

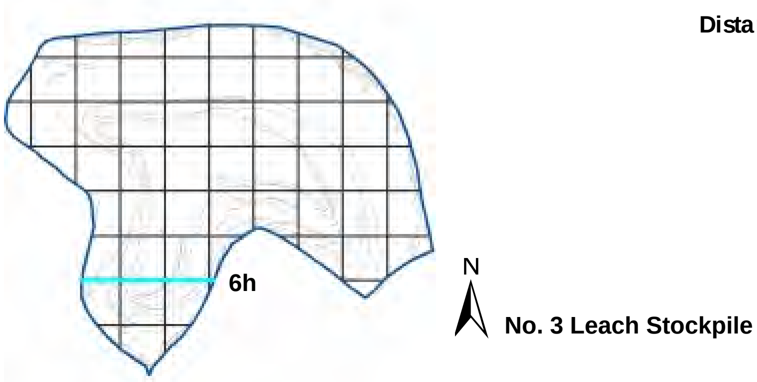

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Stockpile Cross-Sections	
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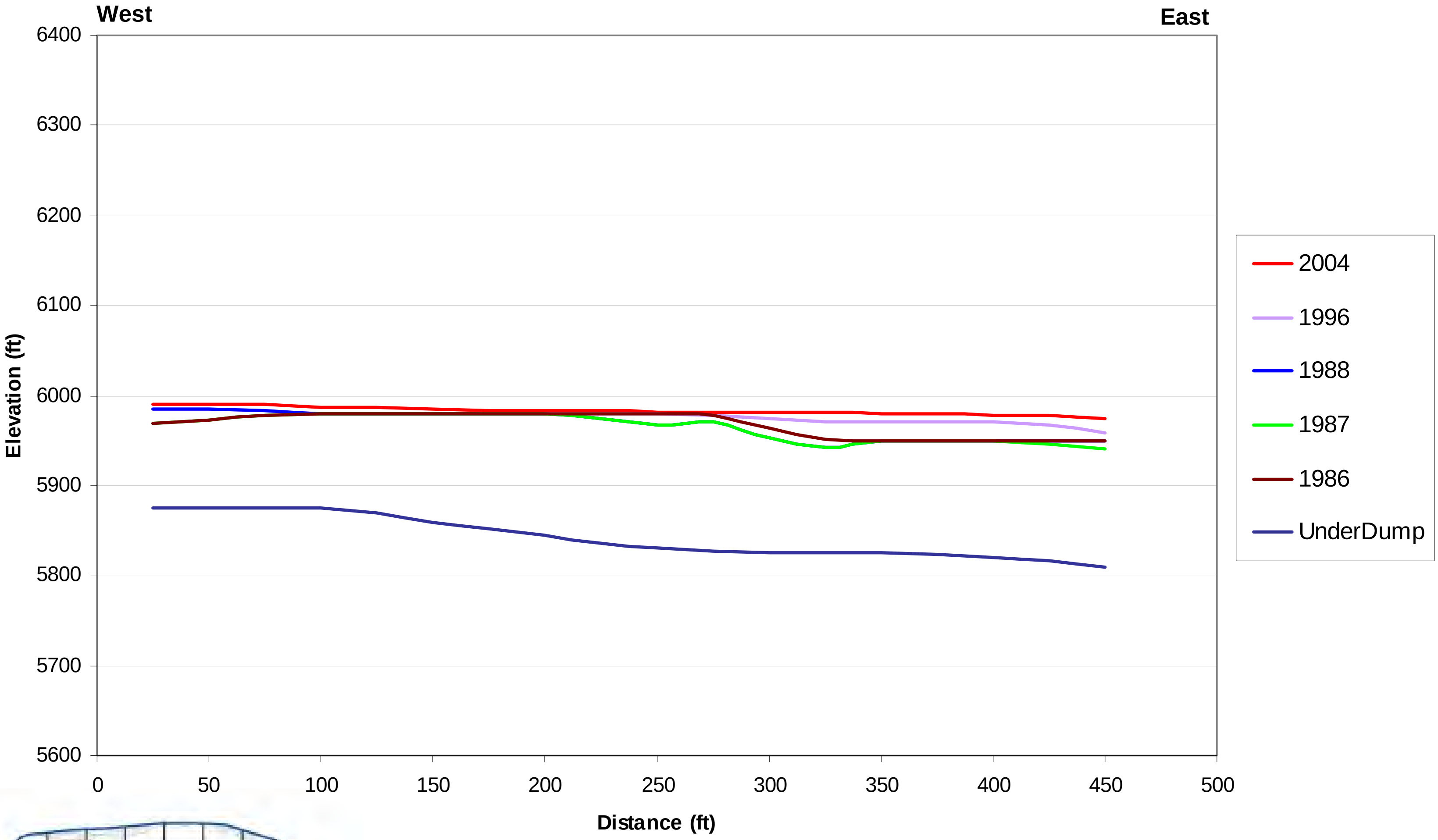

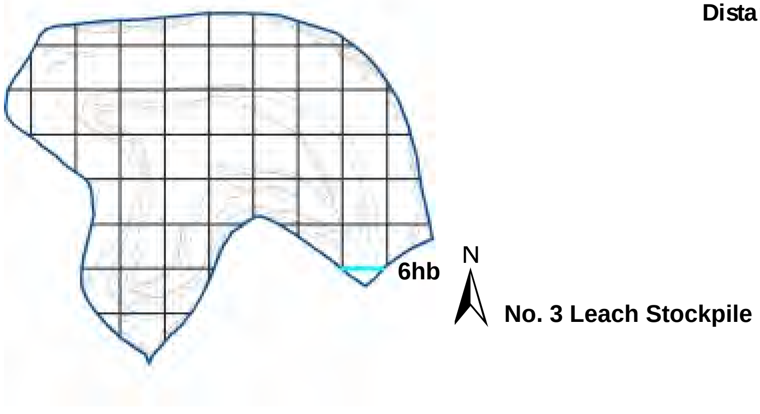

TYRONE MINE
DP-1341, CONDITION 80
SUPPLEMENTAL MATERIALS CHARACTERIZATION

Stockpile Cross-Sections

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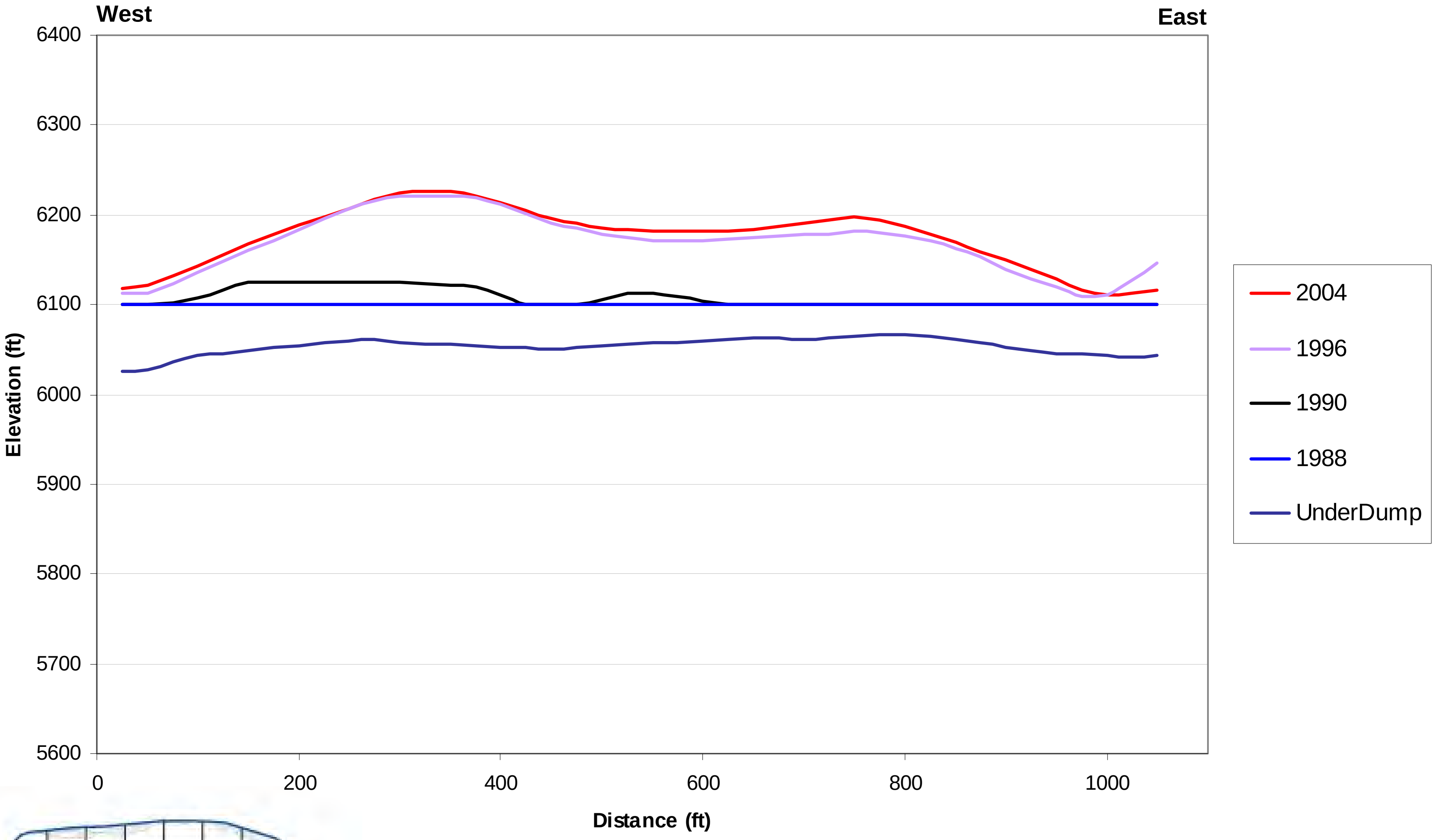
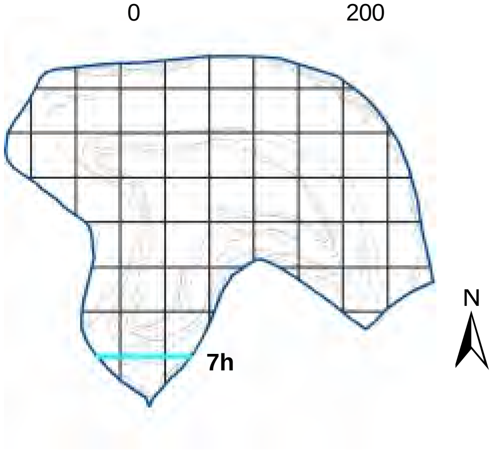
Tyrone Cross Section No3Leach_7h





No. 3 Leach Stockpile

TYRONE MINE
DP-1341, CONDITION 80
SUPPLEMENTAL MATERIALS CHARACTERIZATION

Stockpile Cross-Sections

Date: 10/19/2004	Filename: TyroneStockXSection_3_3B.htm

Tyrone Cross Section No3Leach_1v

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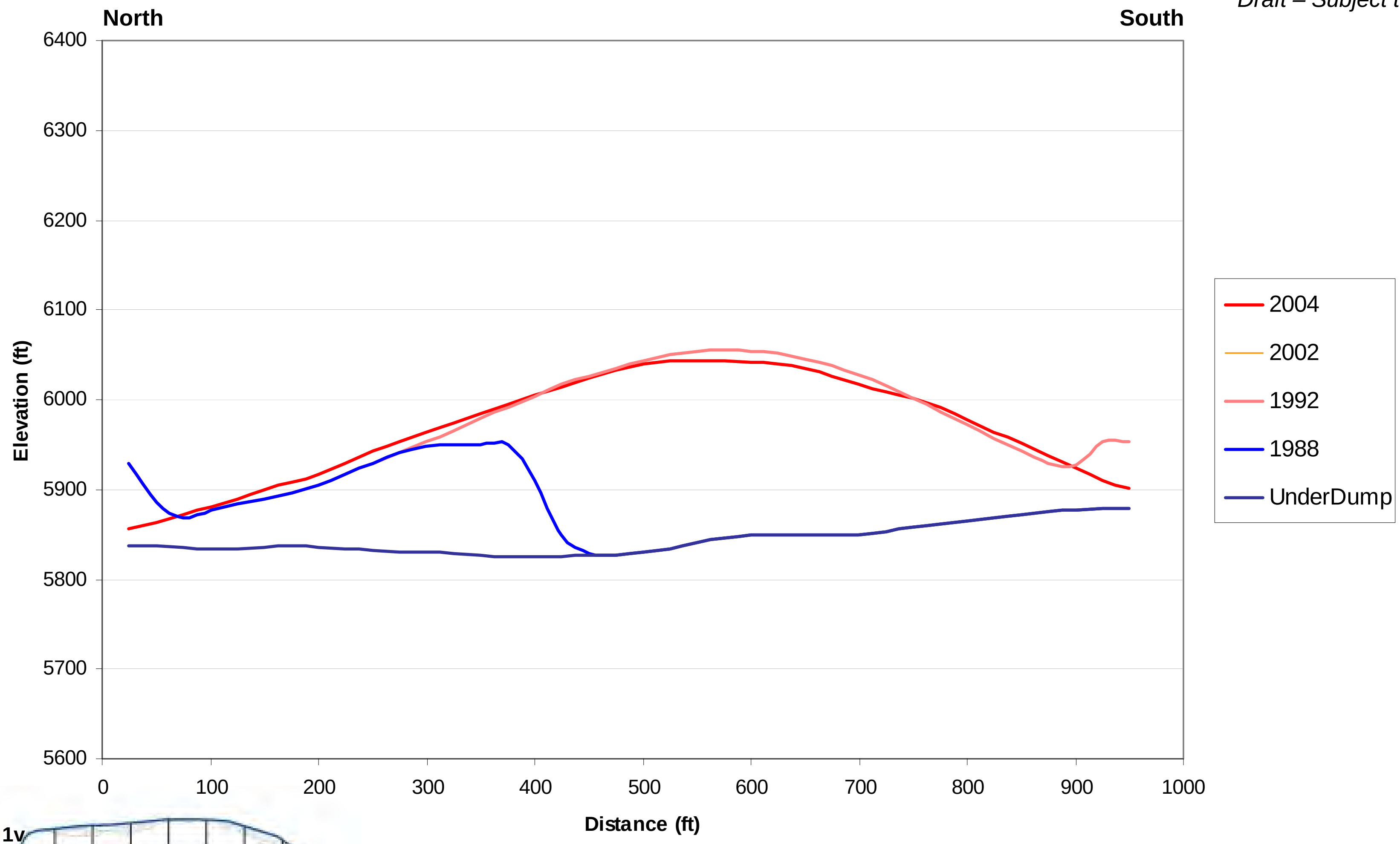

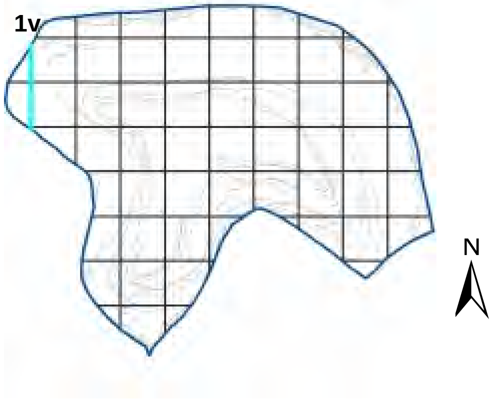

No. 3 Leach Stockpile

TYRONE MINE
DP-1341, CONDITION 80
SUPPLEMENTAL MATERIALS CHARACTERIZATION

Stockpile Cross-Sections

Date: 10/19/2004	Filename: TyroneStockXSection_3_3B.htm

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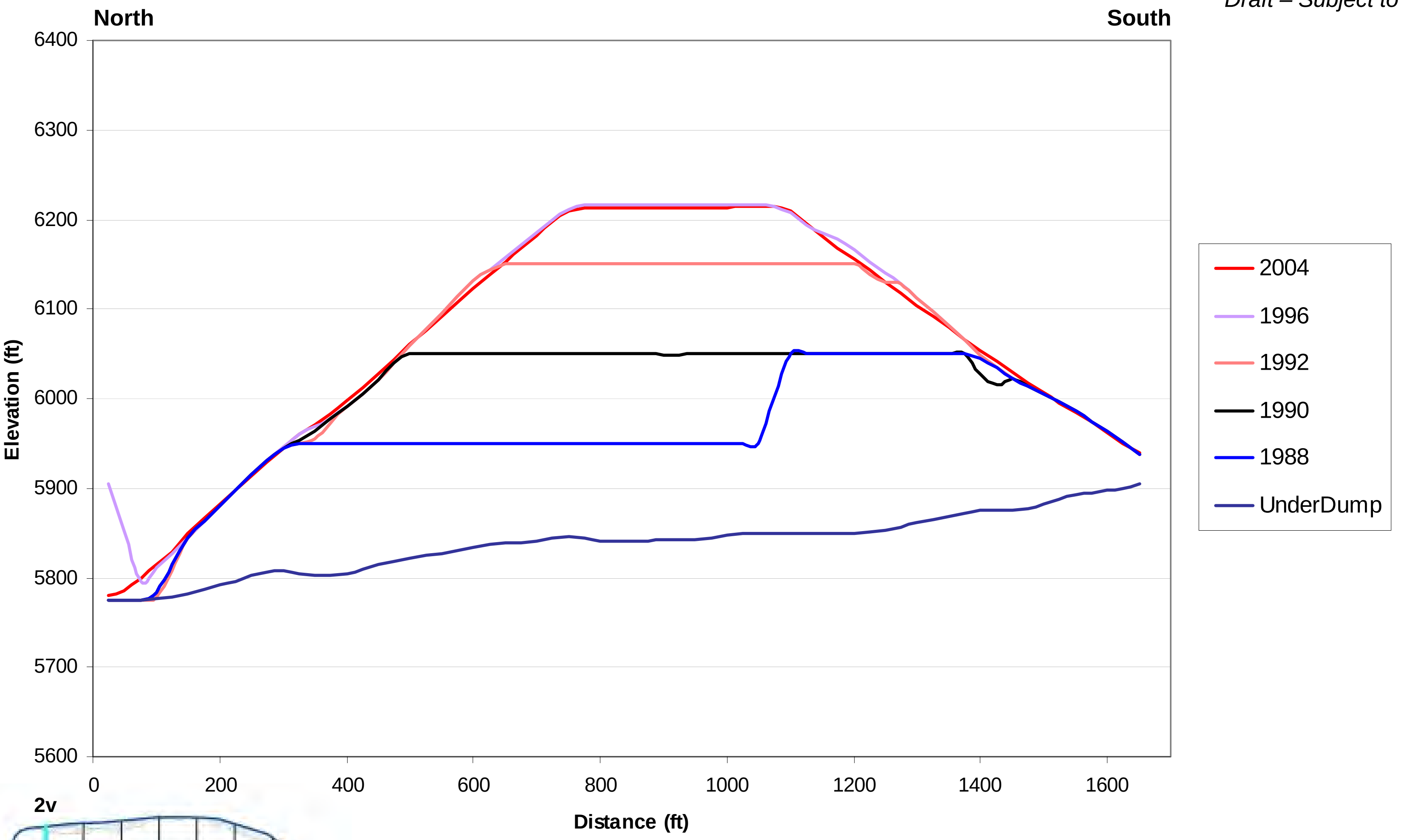
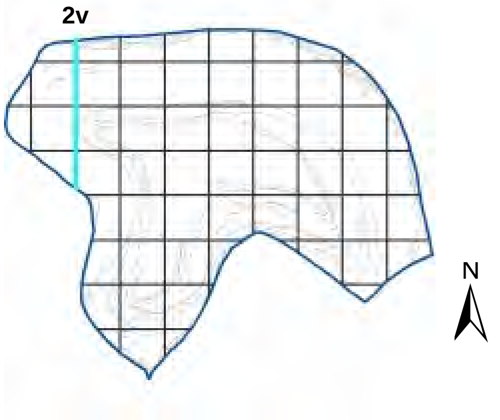
Tyrone Cross Section No3Leach_2v





No. 3 Leach Stockpile

TYRONE MINE
DP-1341, CONDITION 80
SUPPLEMENTAL MATERIALS CHARACTERIZATION

Stockpile Cross-Sections

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Tyrone Cross Section No3Leach_3v

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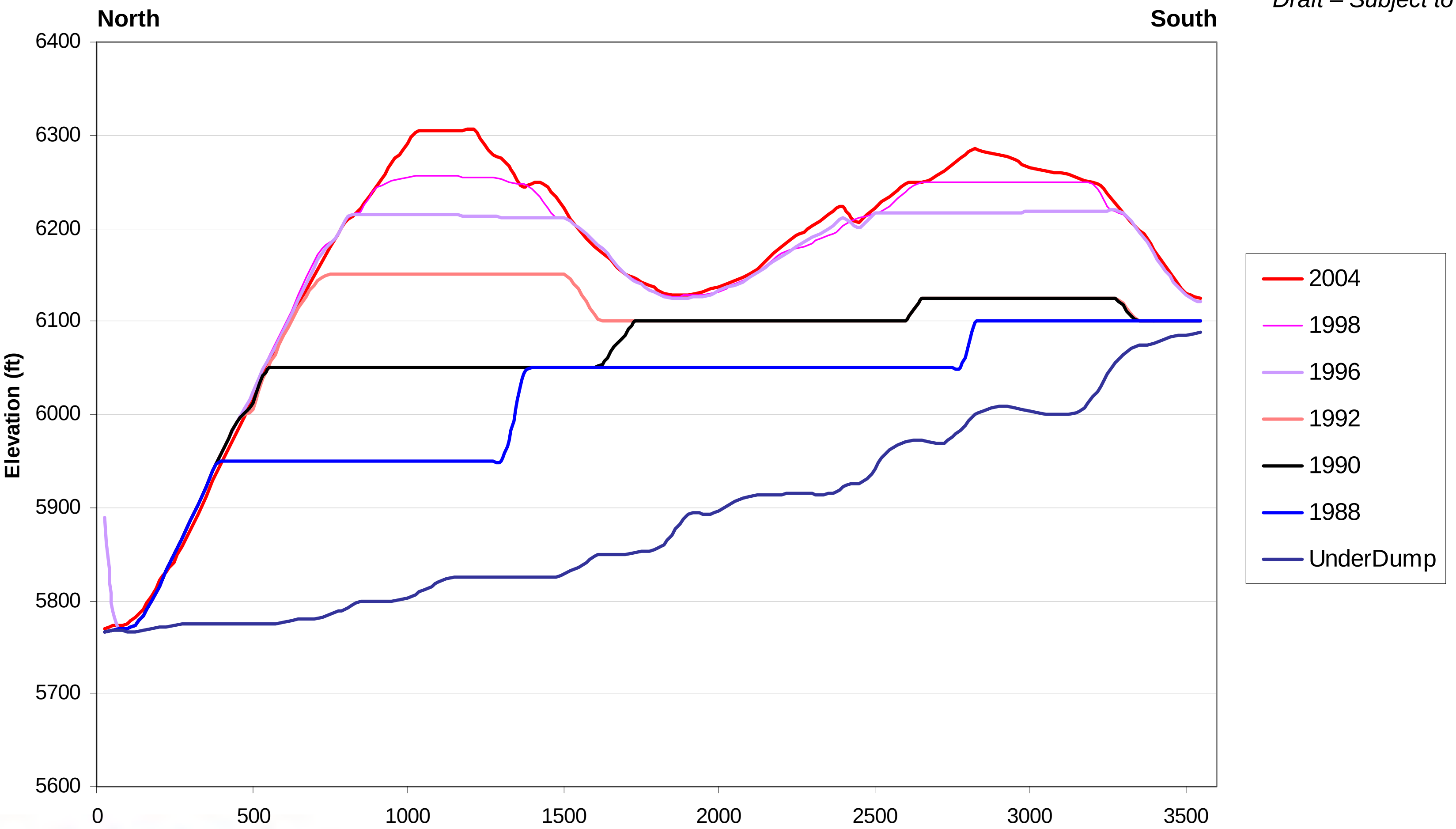

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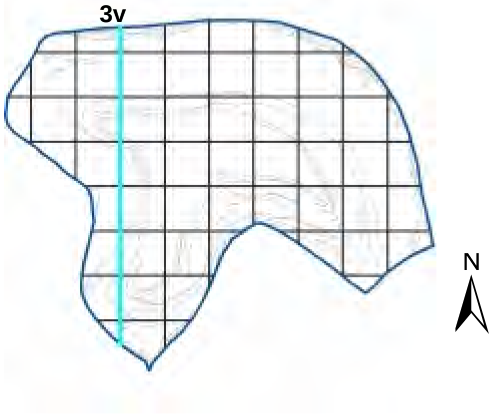

No. 3 Leach Stockpile

TYRONE MINE DP-1341, CONDITION 80 SUPPLEMENTAL MATERIALS CHARACTERIZATION	
Stockpile Cross-Sections	
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Tyrone Cross Section No3Leach_4v

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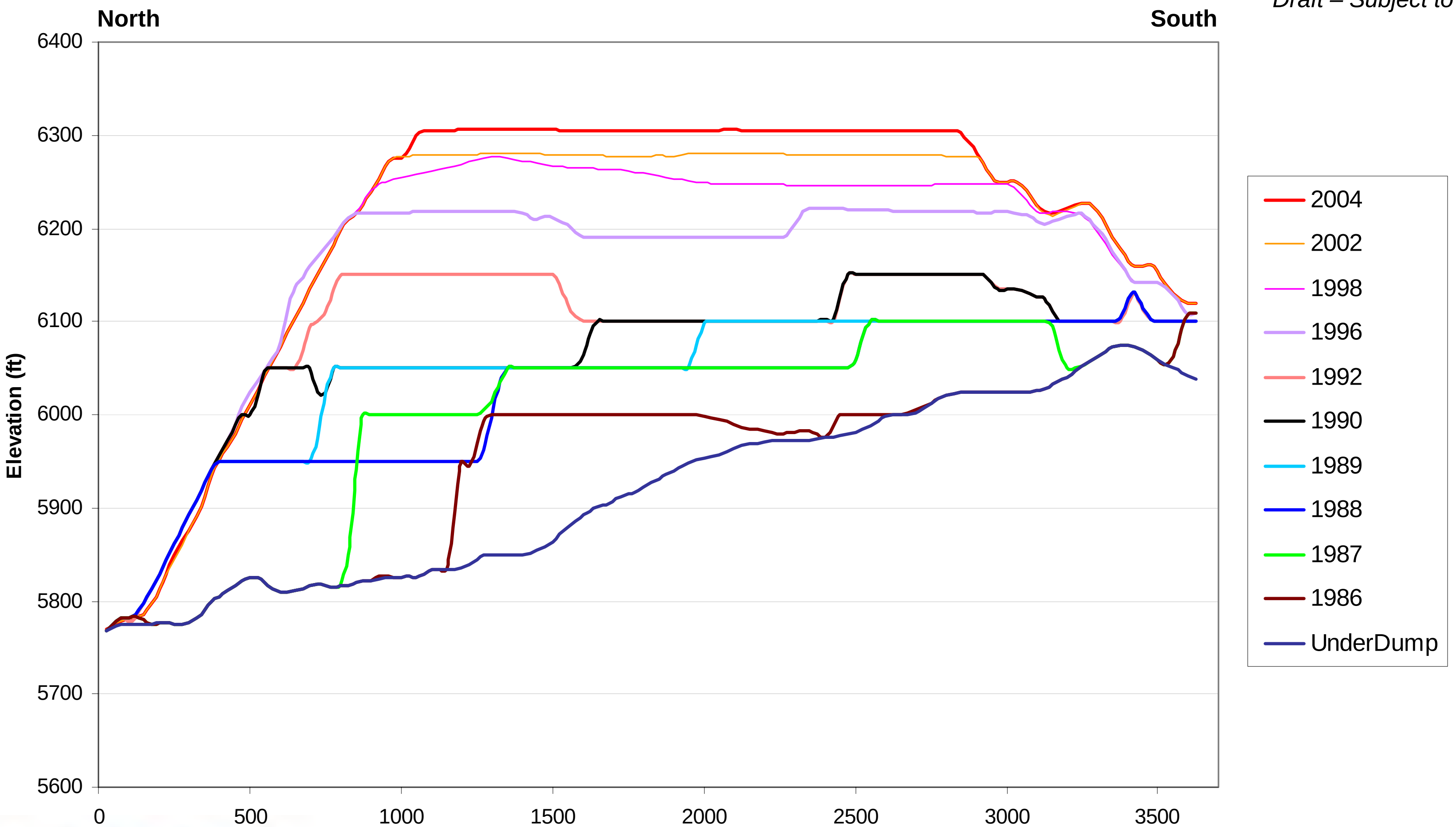

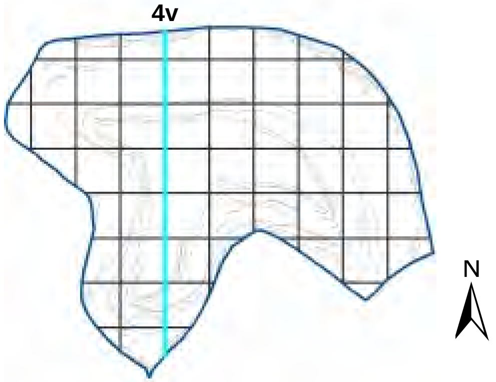

No. 3 Leach Stockpile

TYRONE MINE DP-1341, CONDITION 80 SUPPLEMENTAL MATERIALS CHARACTERIZATION
Stockpile Cross-Sections

Date: 10/19/2004 | Filename: TyroneStockXSection_3_3B.htm

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Tyrone Cross Section No3Leach_5v

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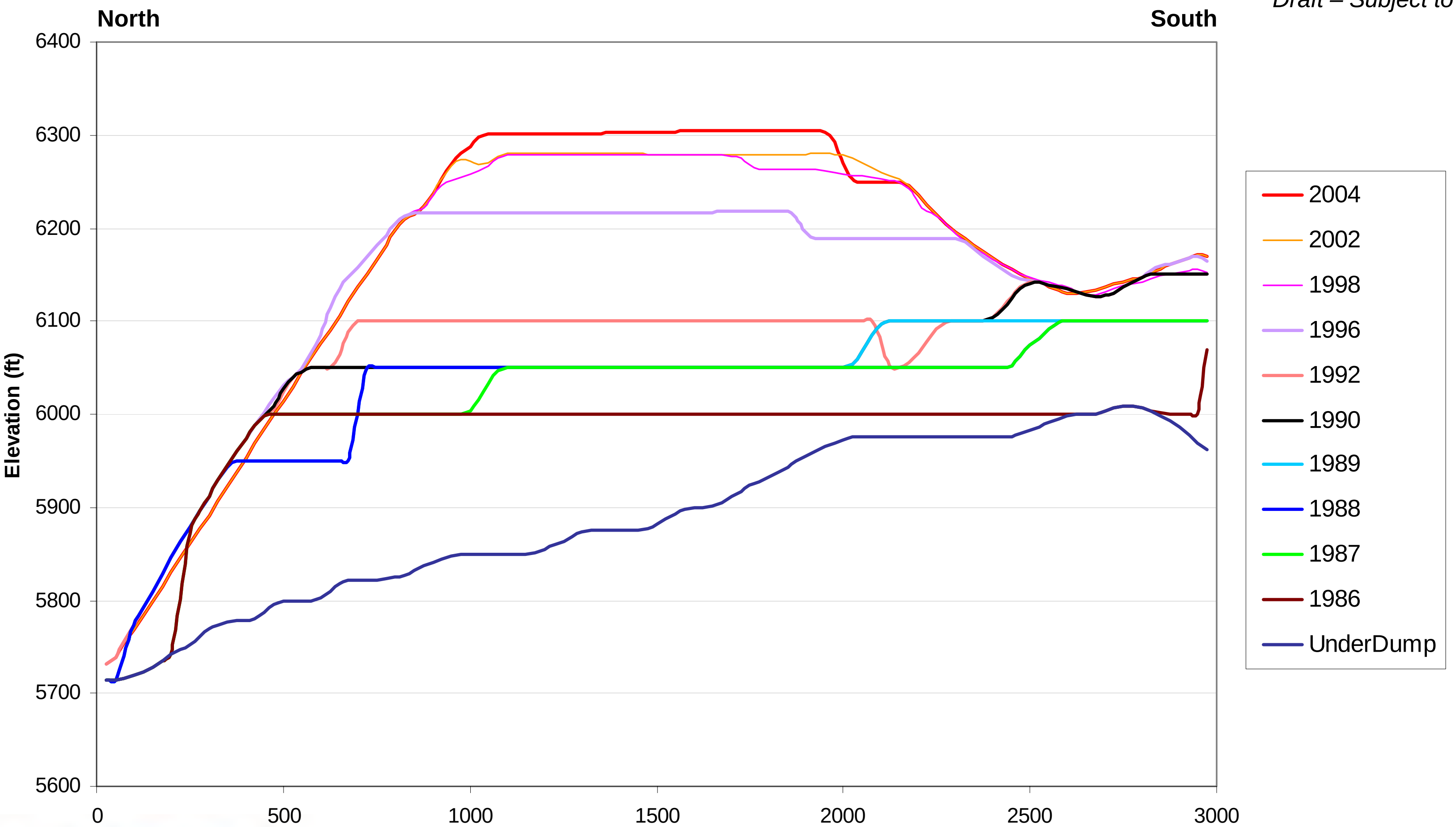

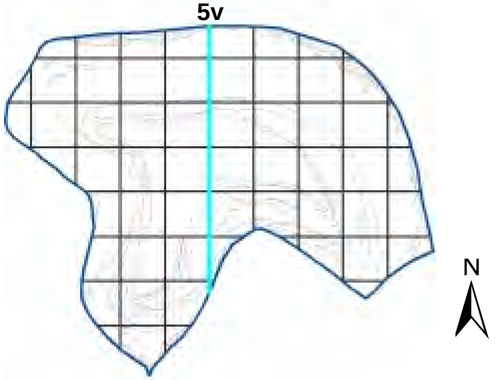

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Stockpile Cross-Sections	
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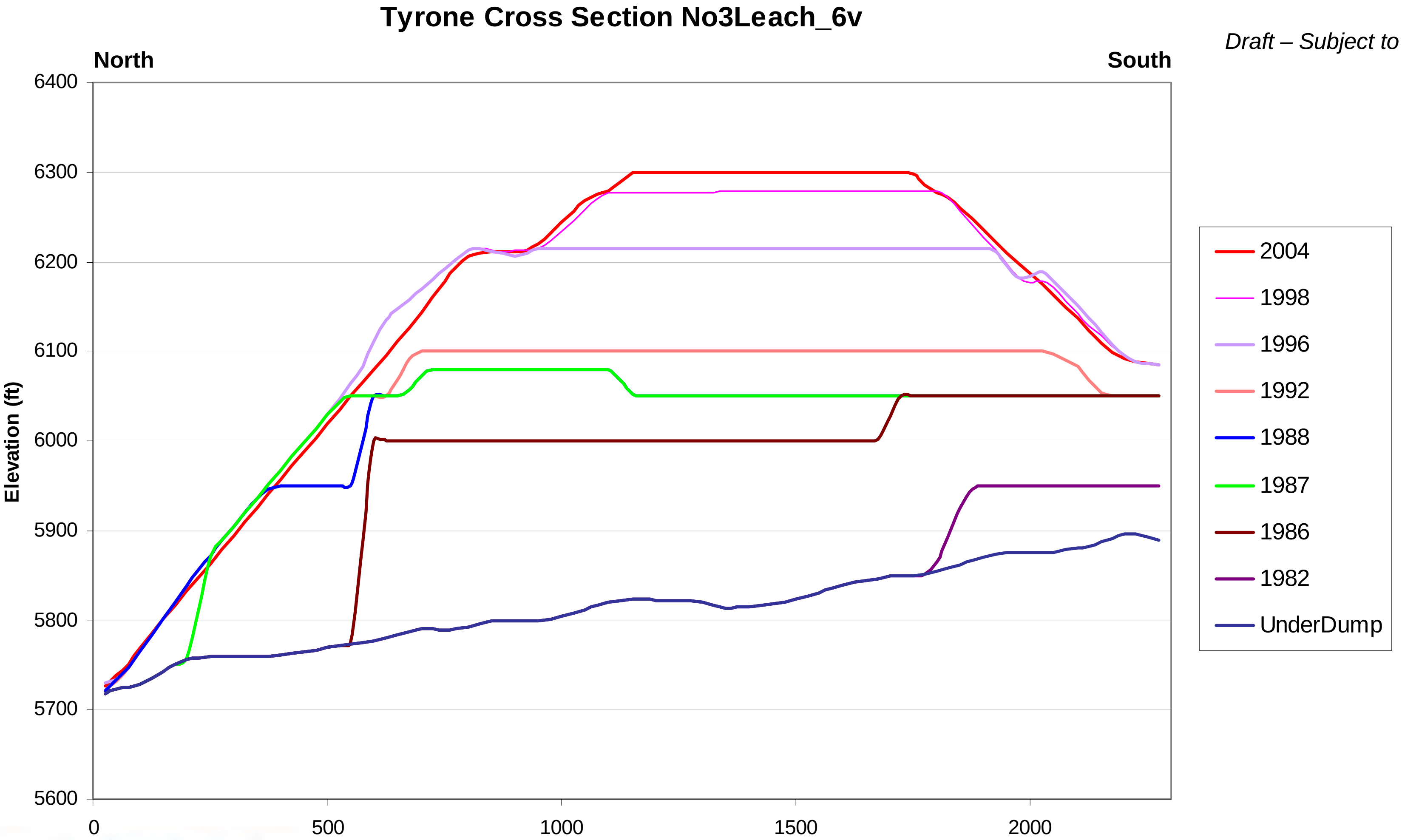

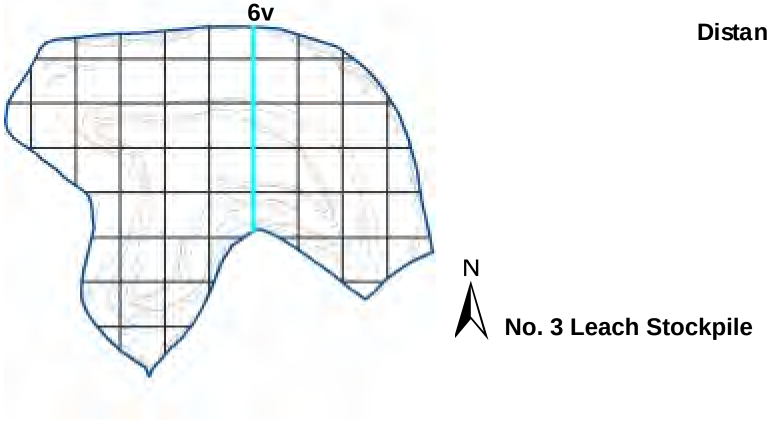

TYRONE MINE
DP-1341, CONDITION 80
SUPPLEMENTAL MATERIALS CHARACTERIZATION

Stockpile Cross-Sections

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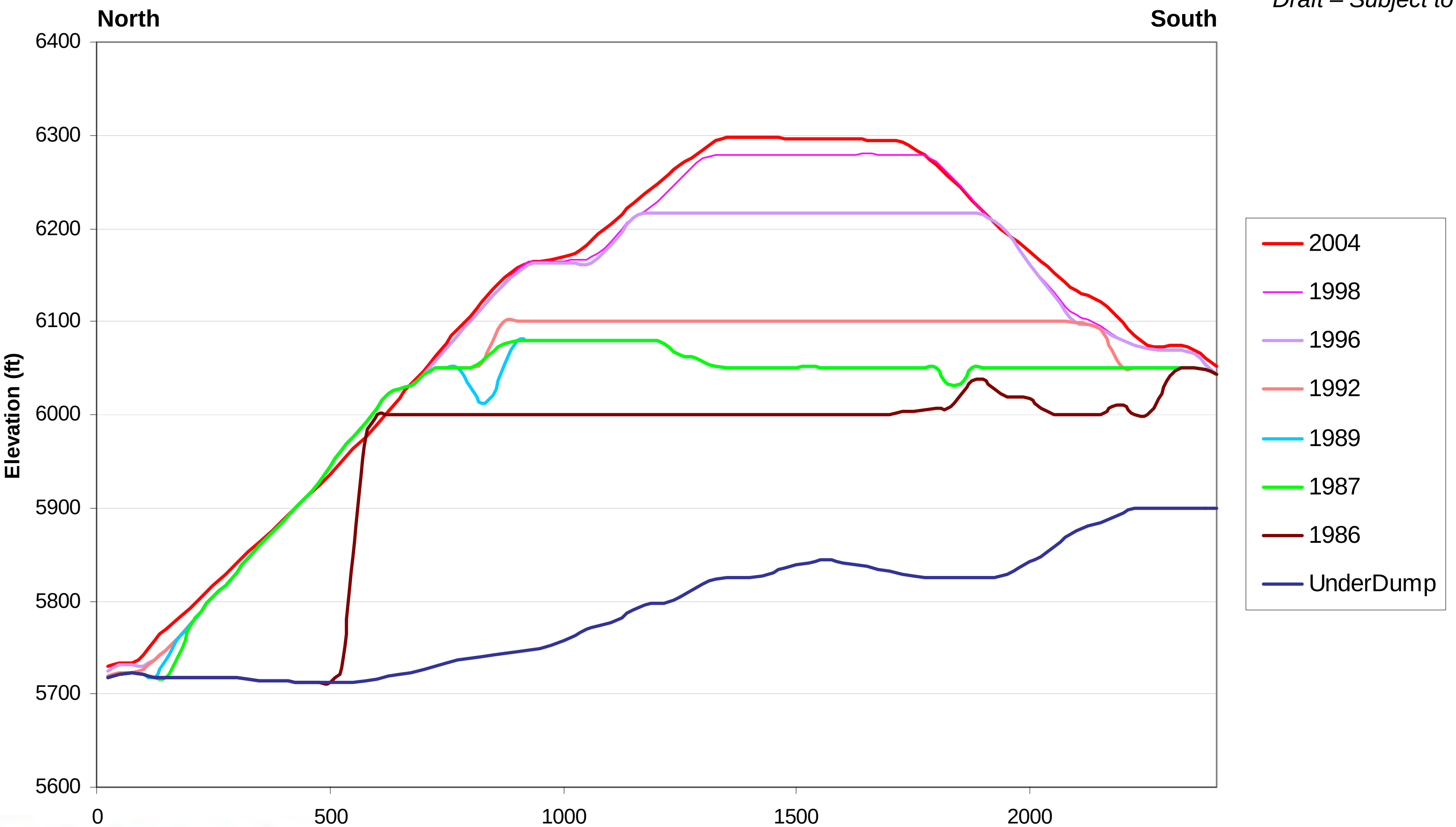

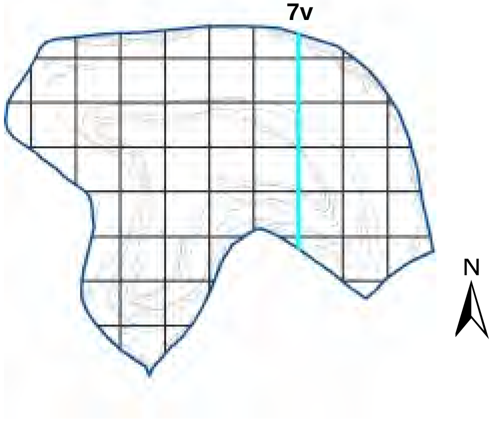

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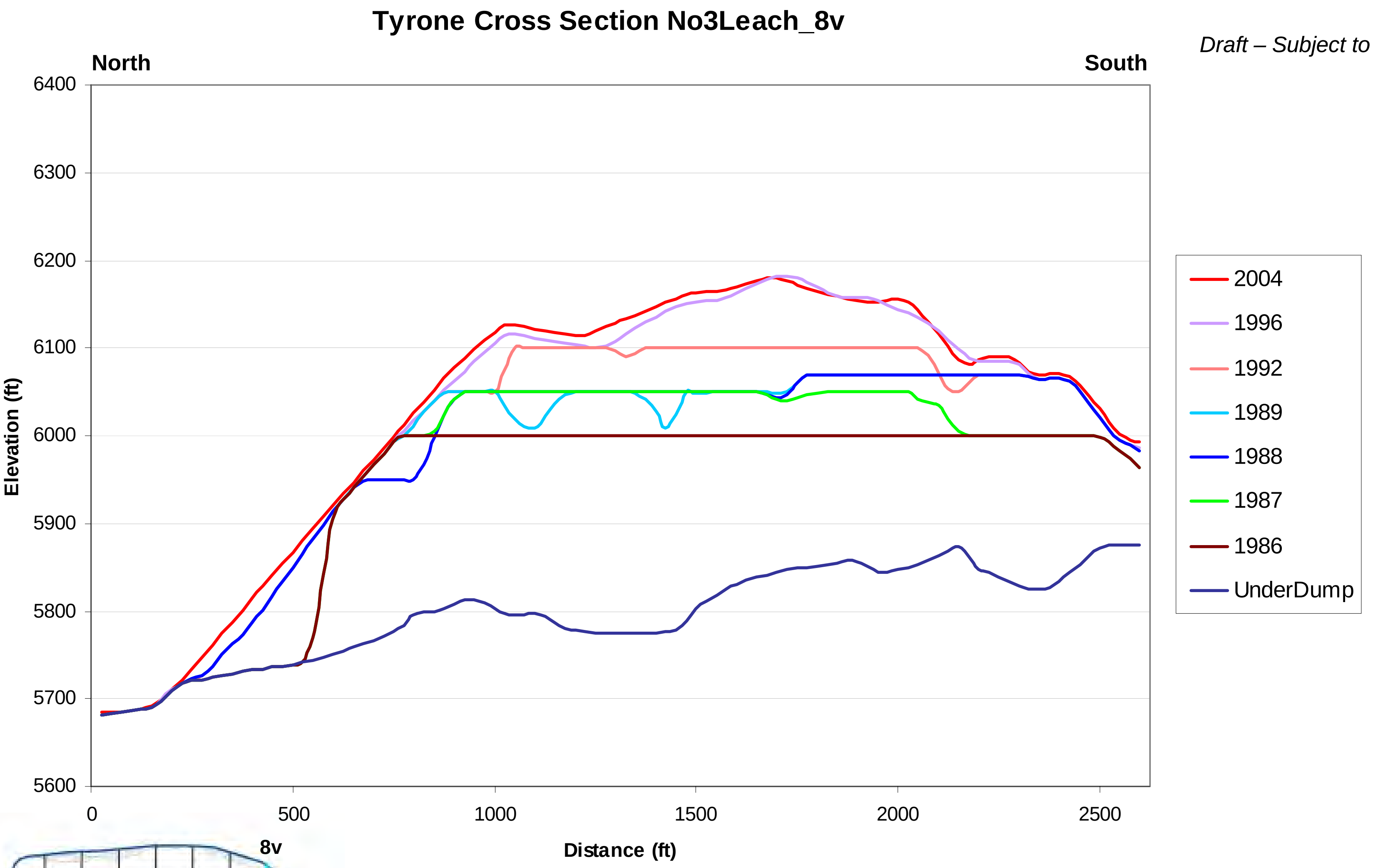
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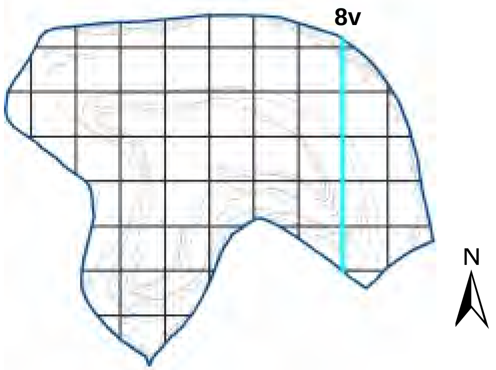

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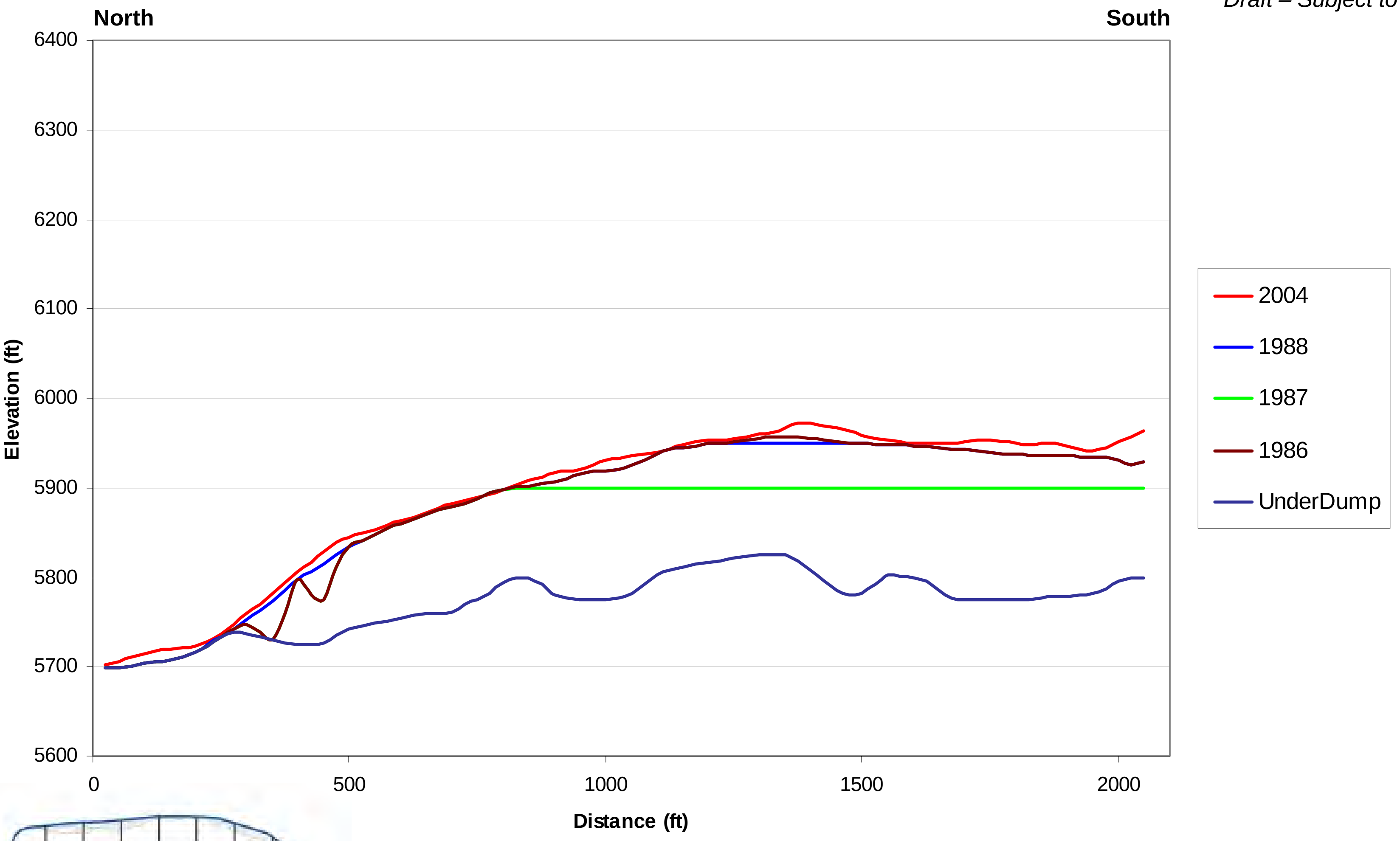

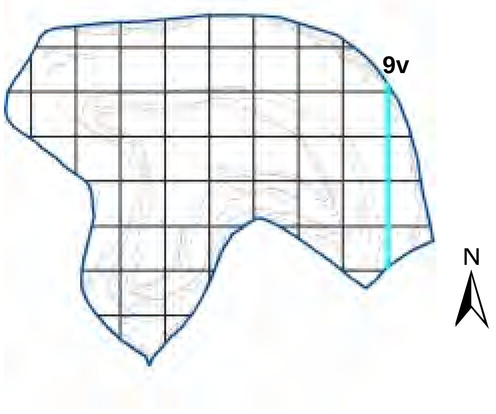

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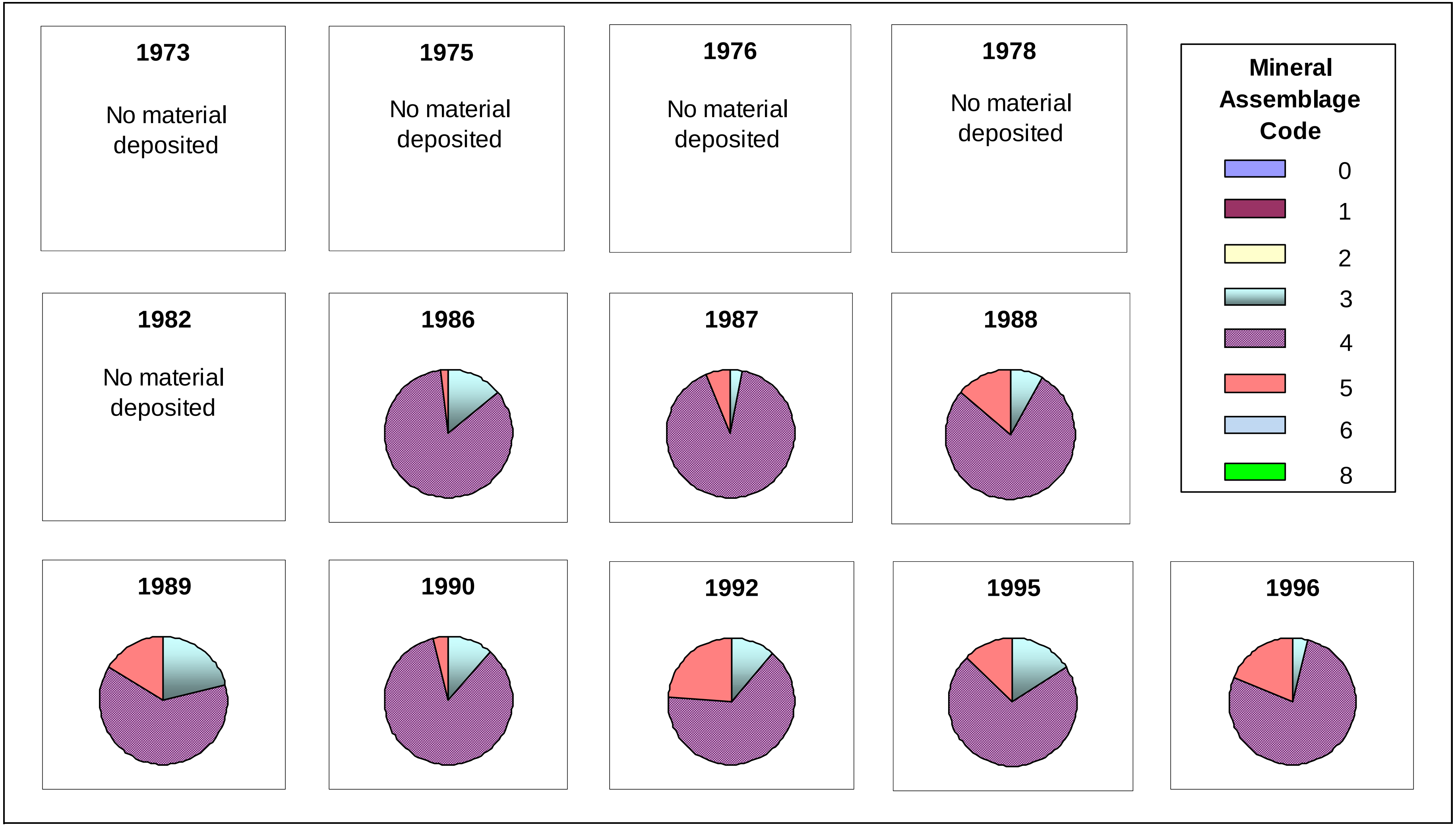

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Stockpile Cross-Sections

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No. 3B Stockpile Cross-Sections (500-foot grid)

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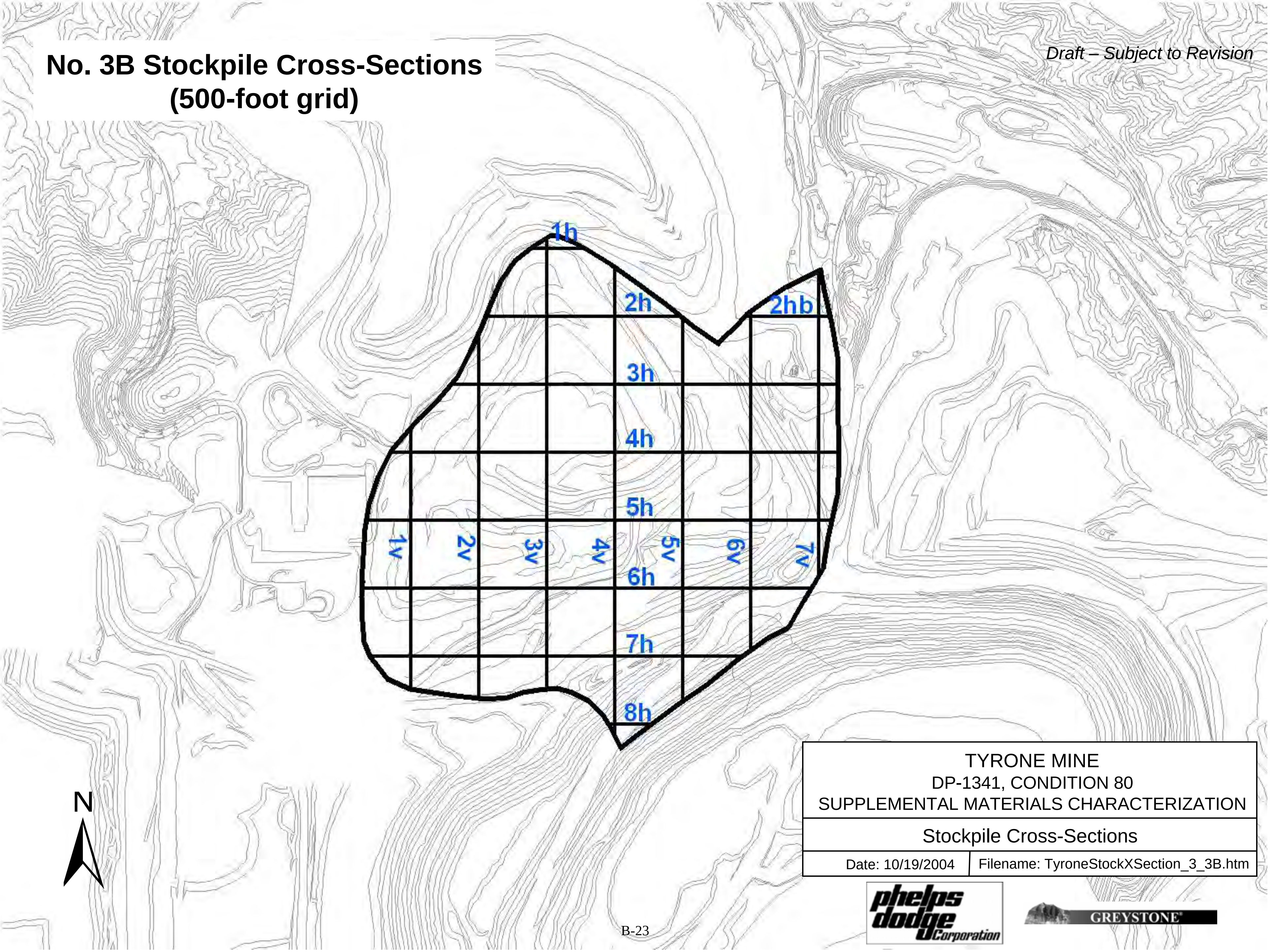

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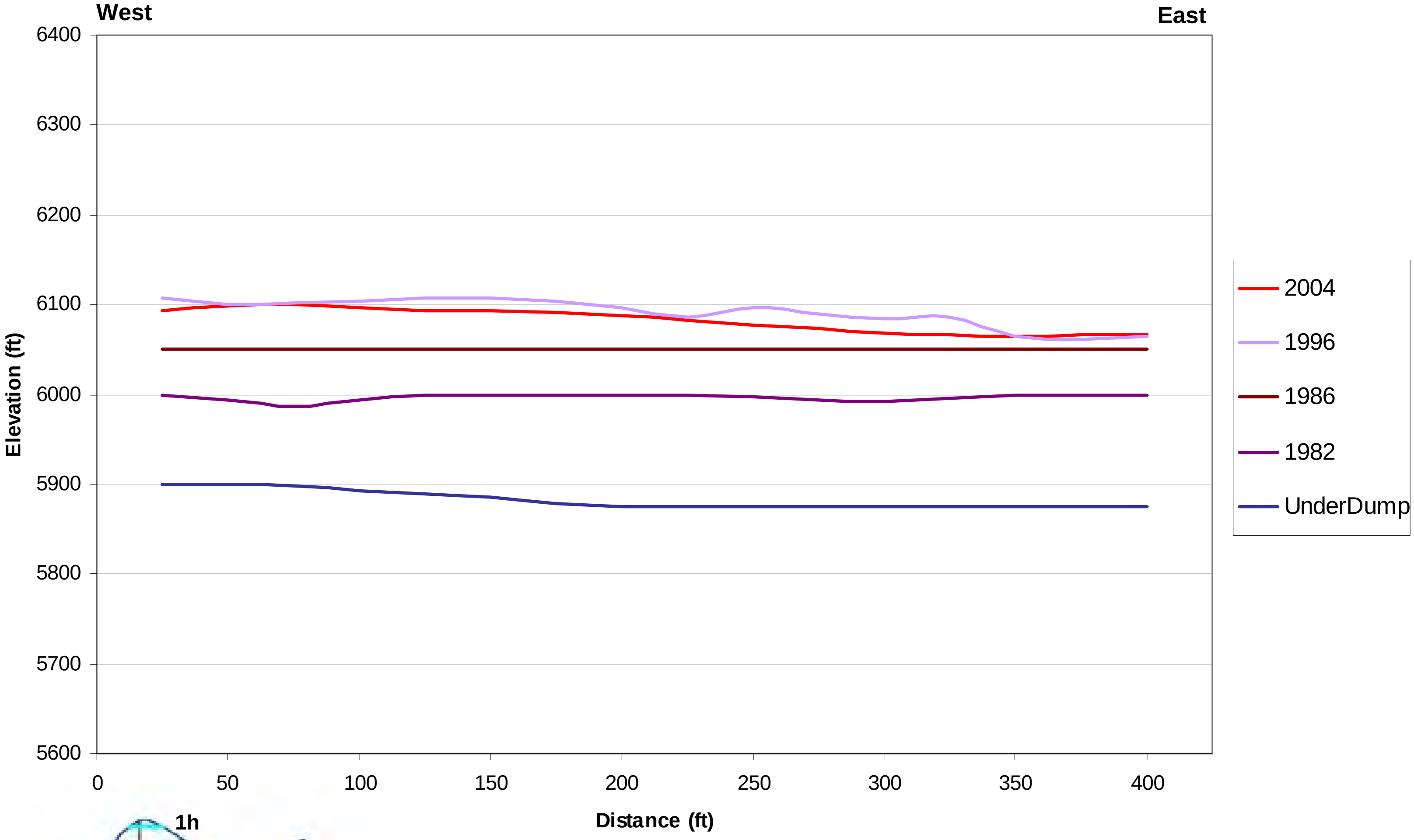
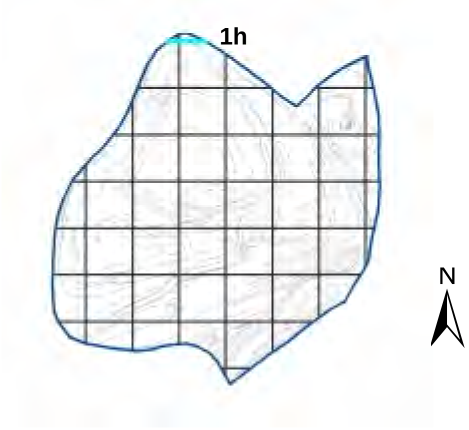
Tyrone Cross Section No3B_1h





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TYRONE MINE DP-1341, CONDITION 80 SUPPLEMENTAL MATERIALS CHARACTERIZATION
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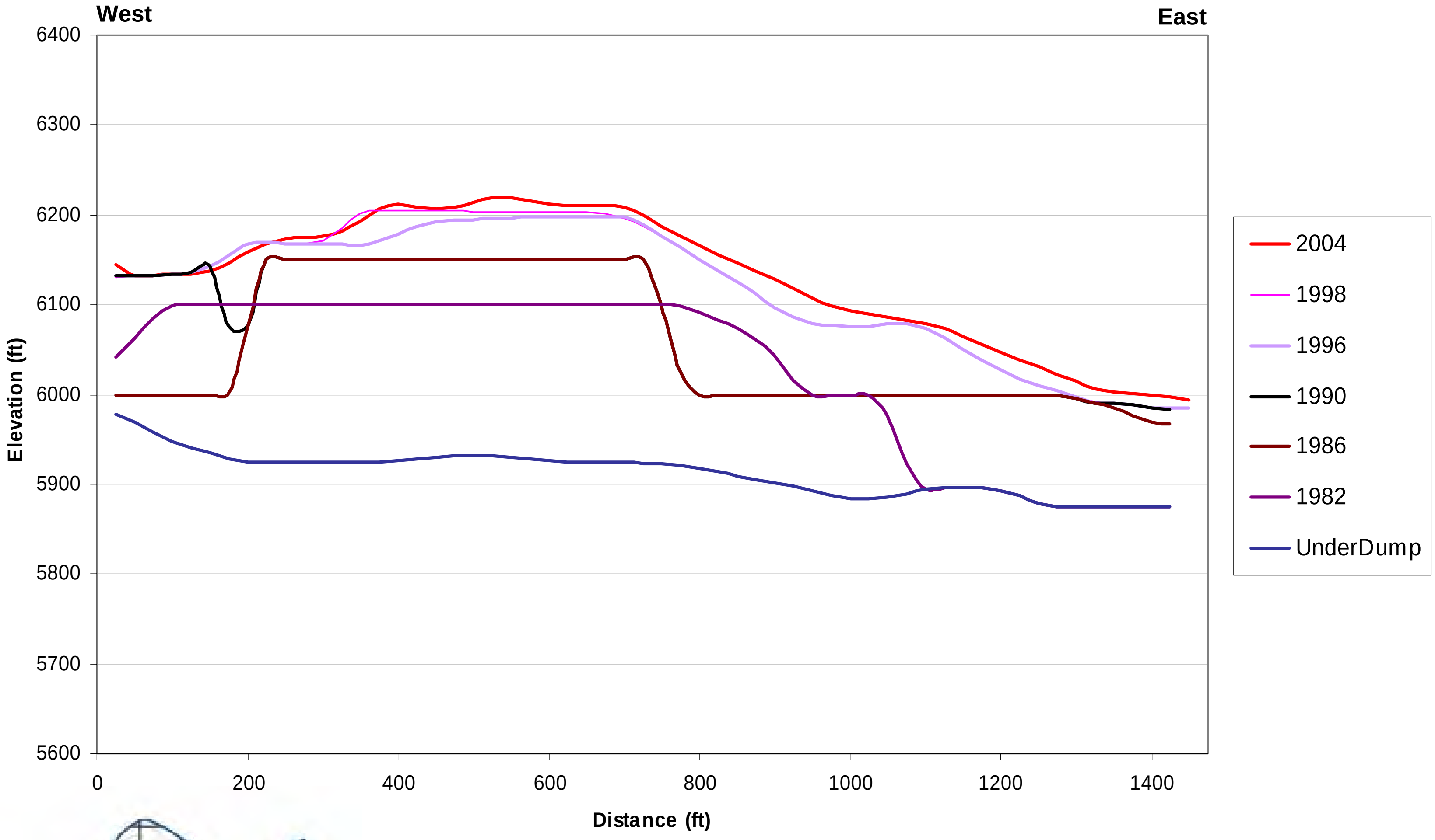

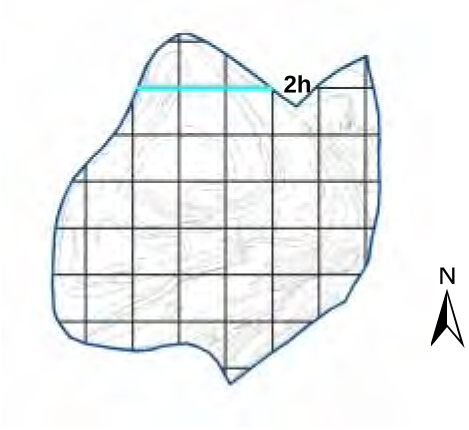

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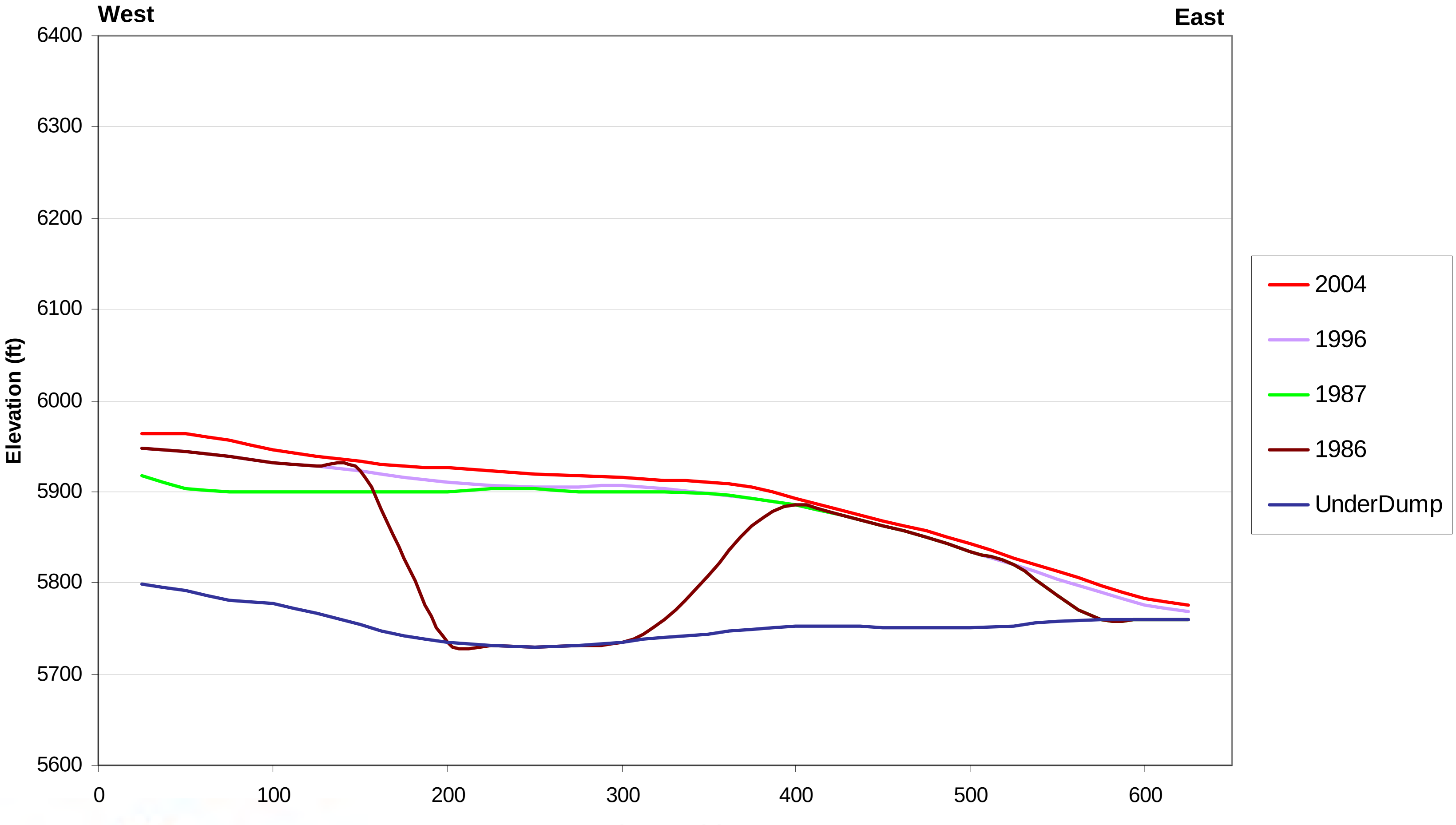

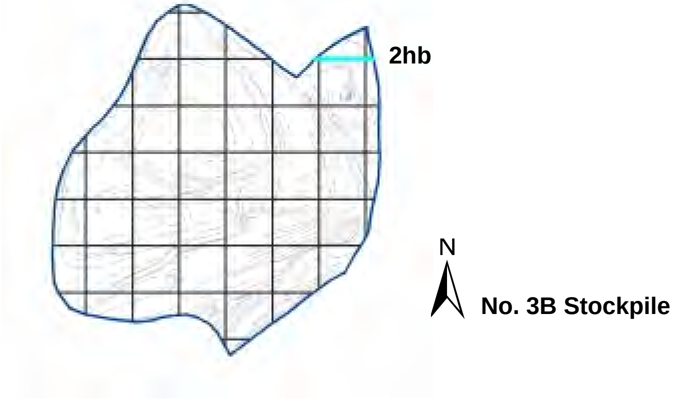

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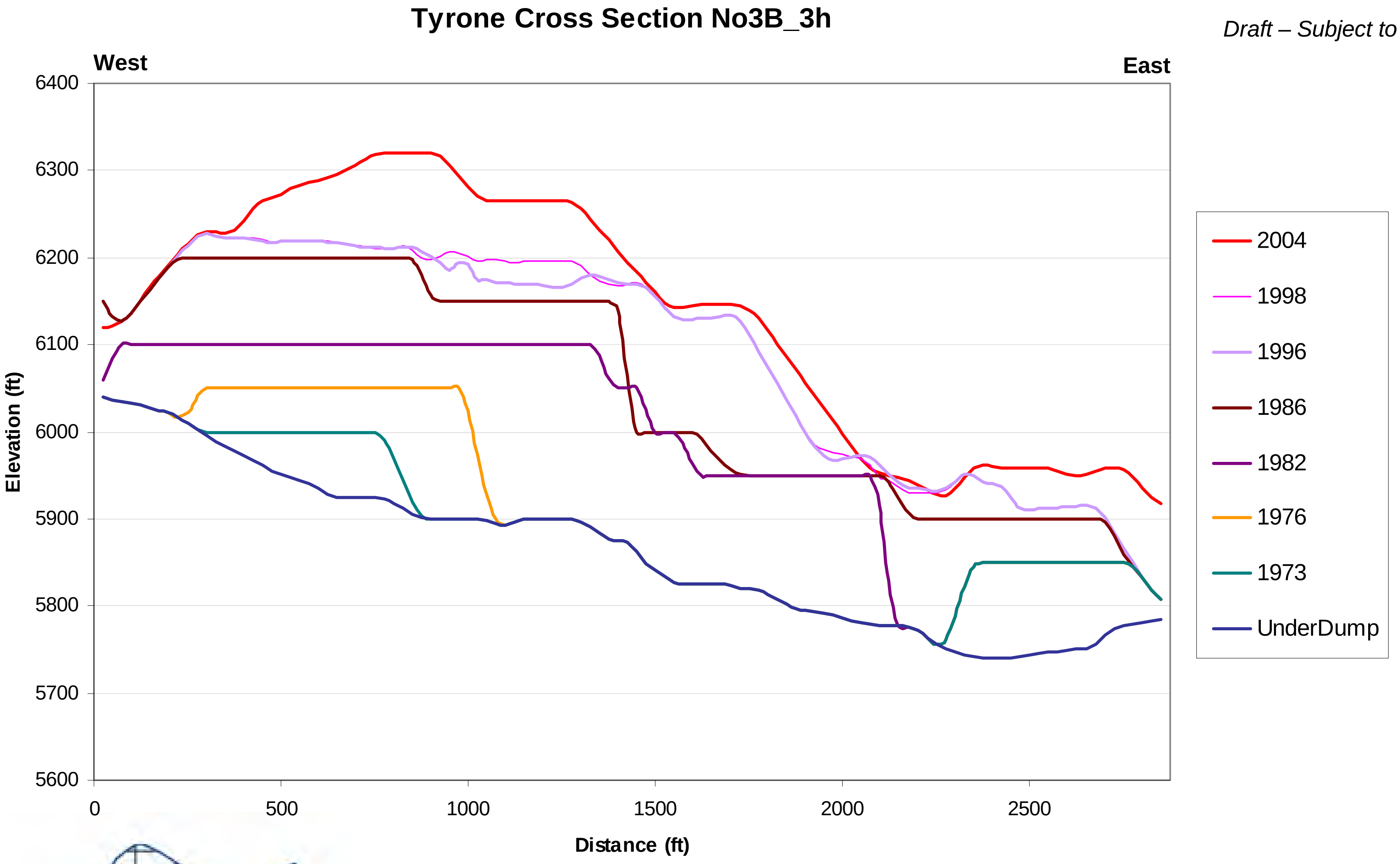

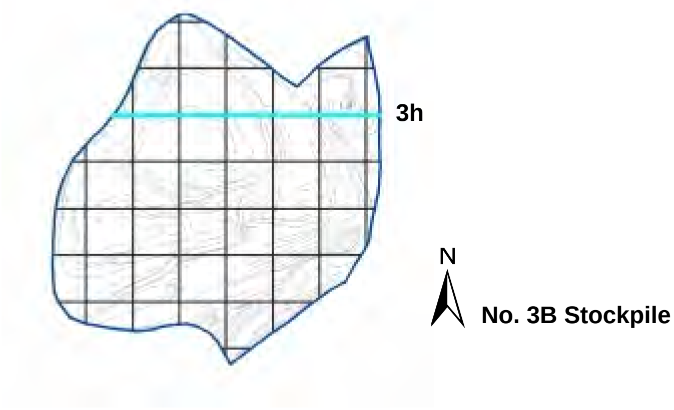

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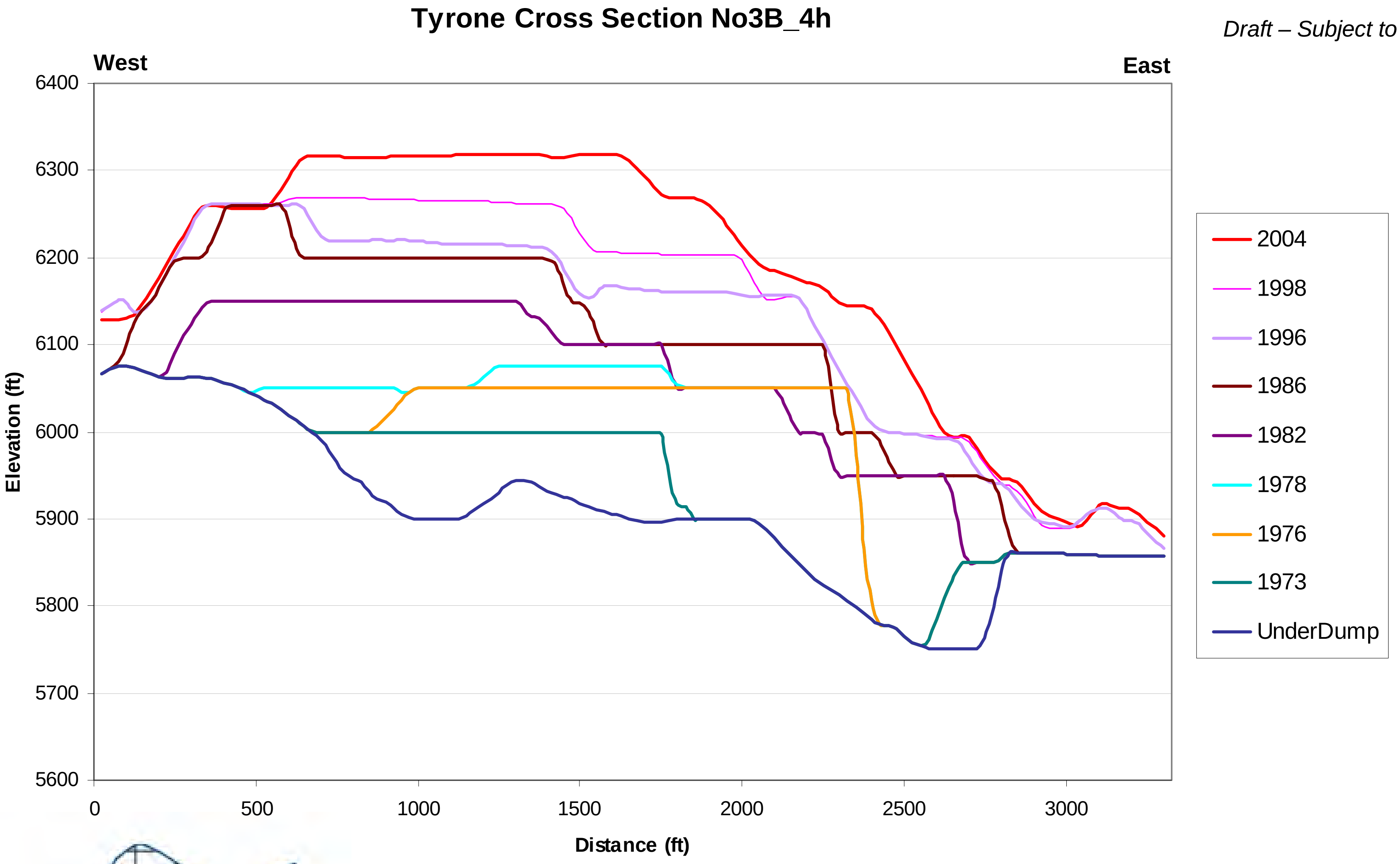

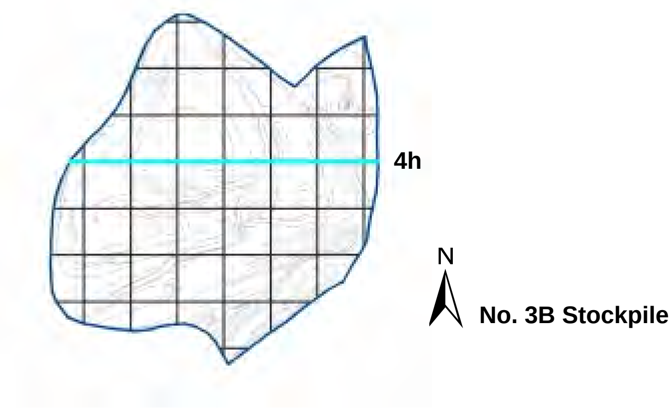

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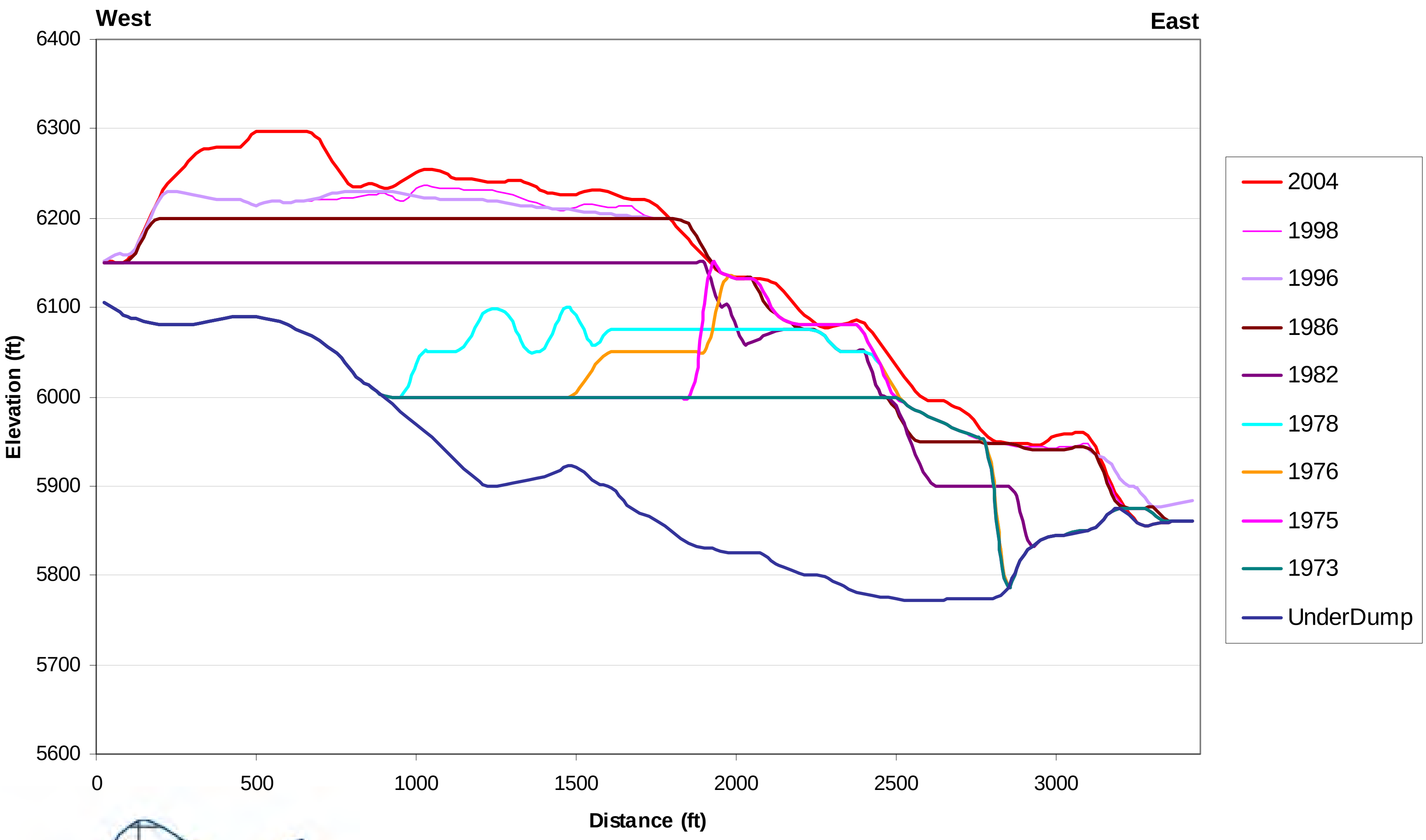

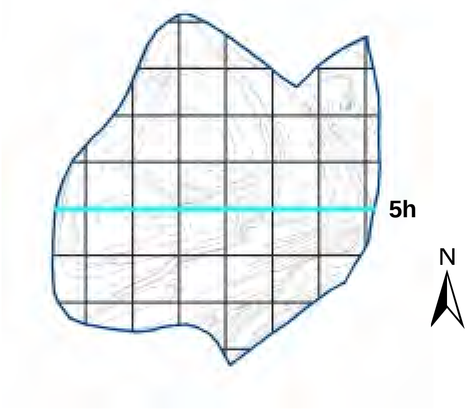

No. 3B Stockpile

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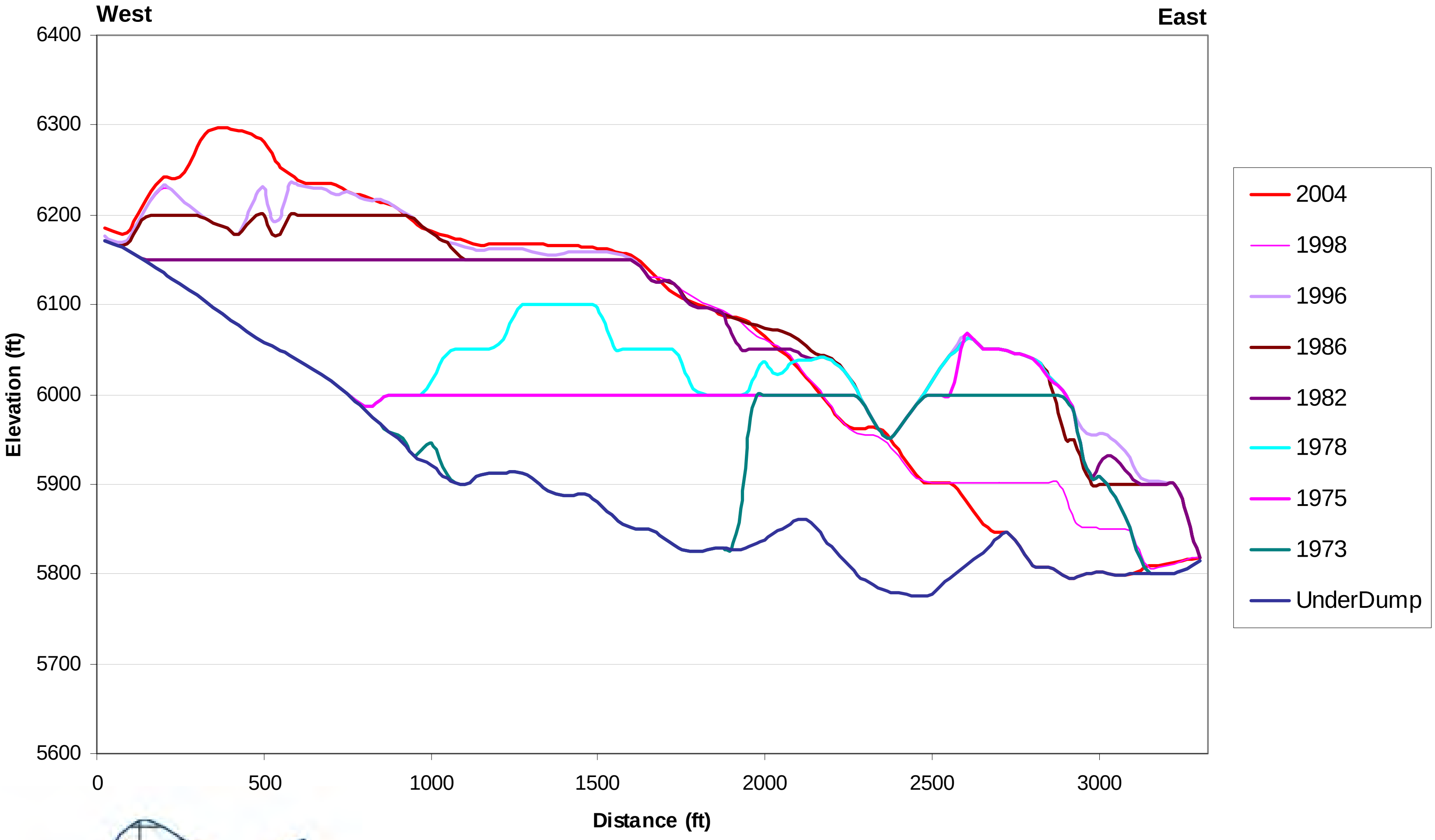

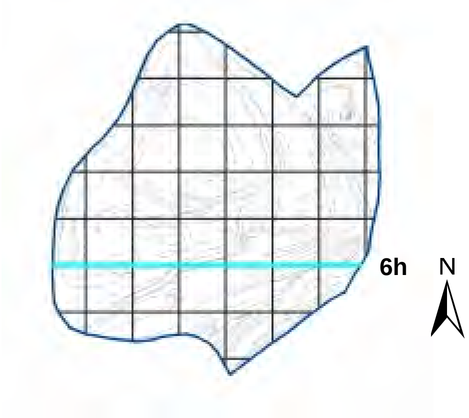

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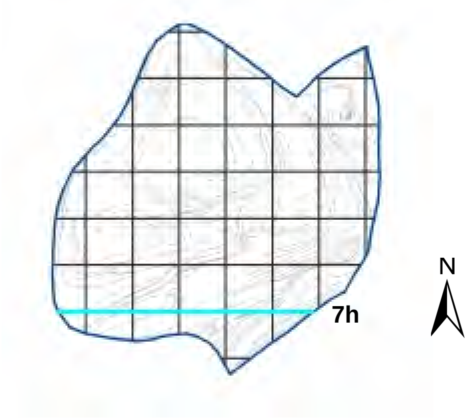

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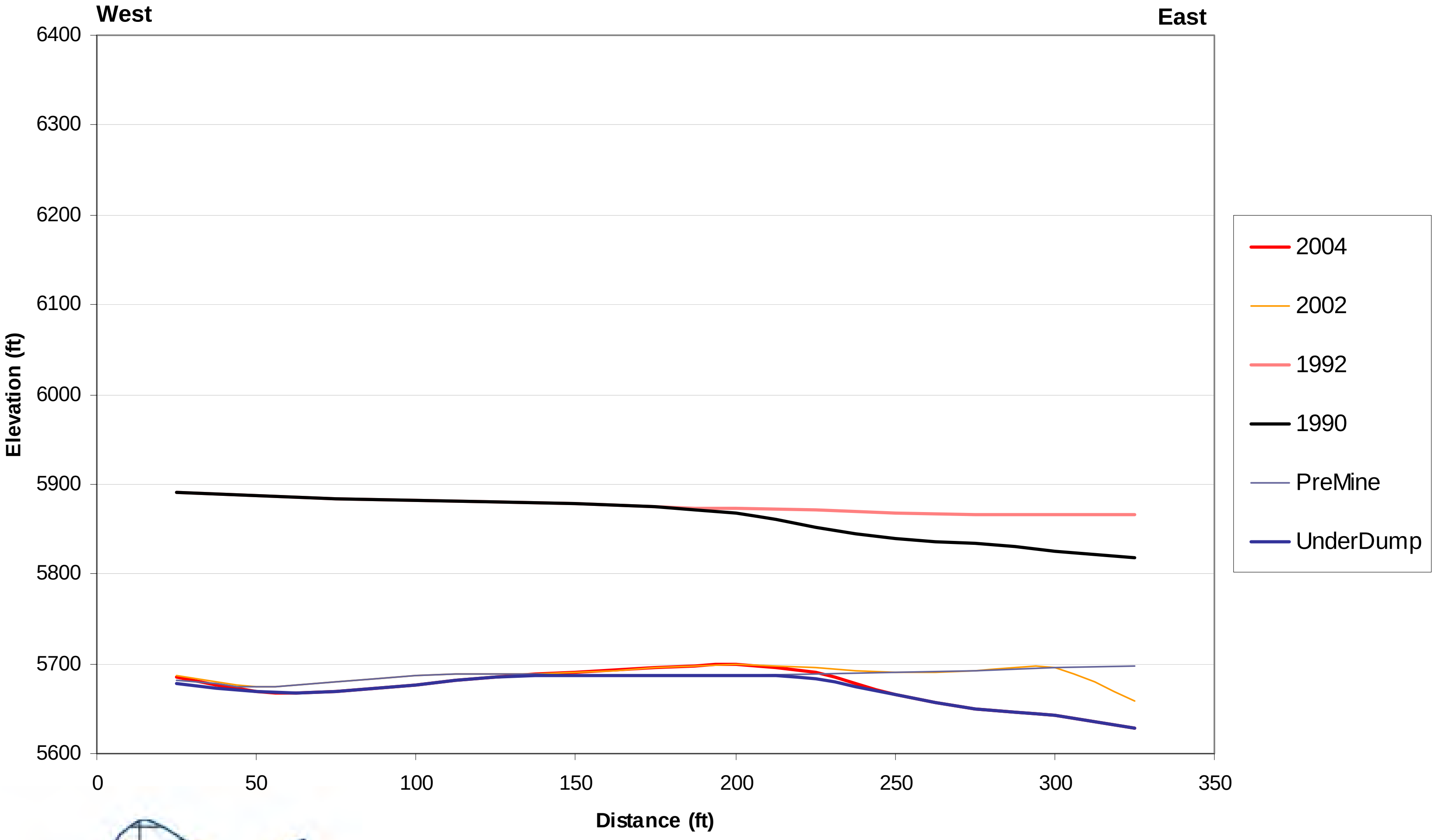

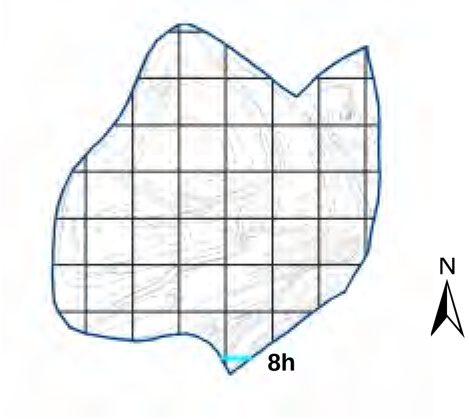

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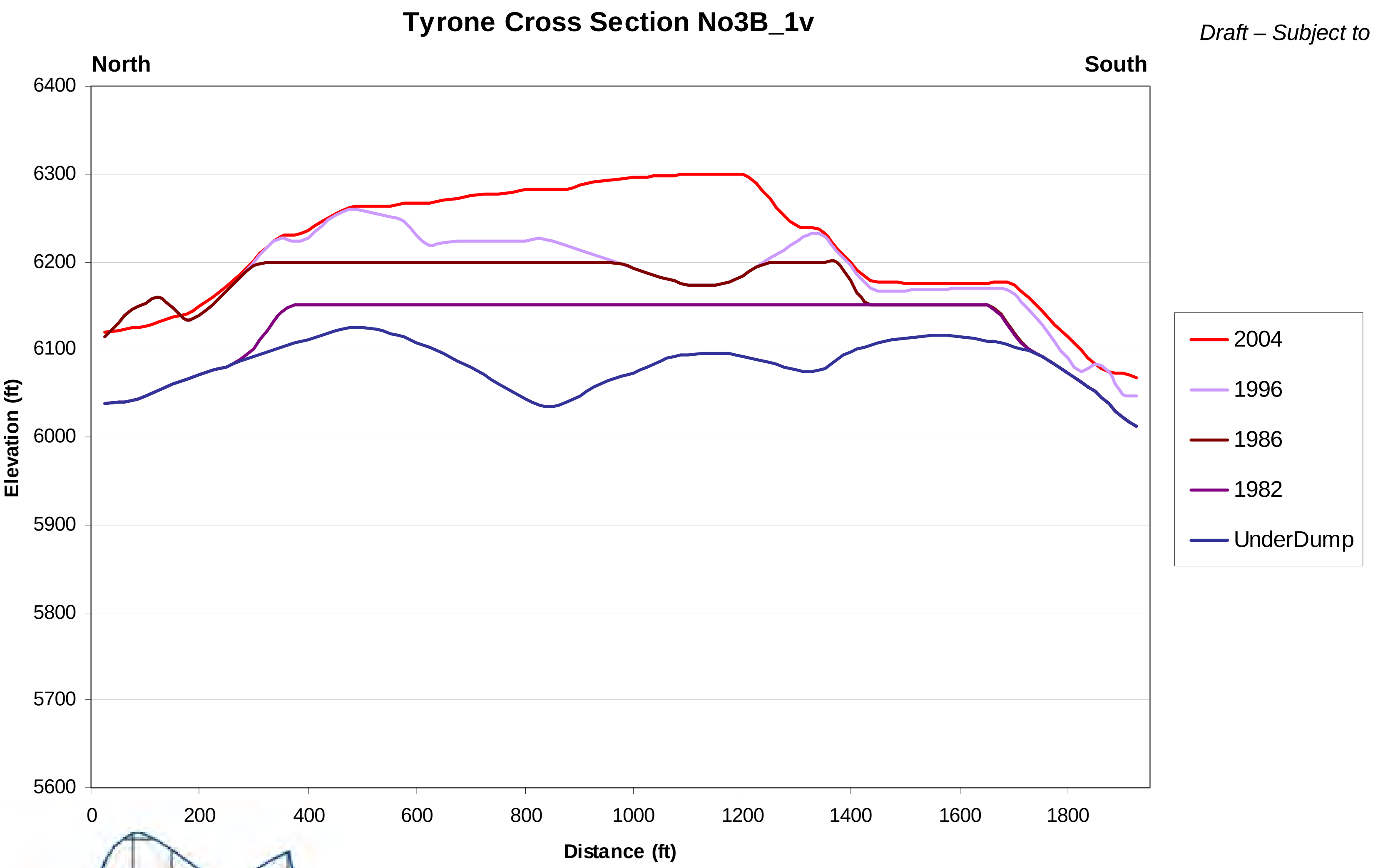

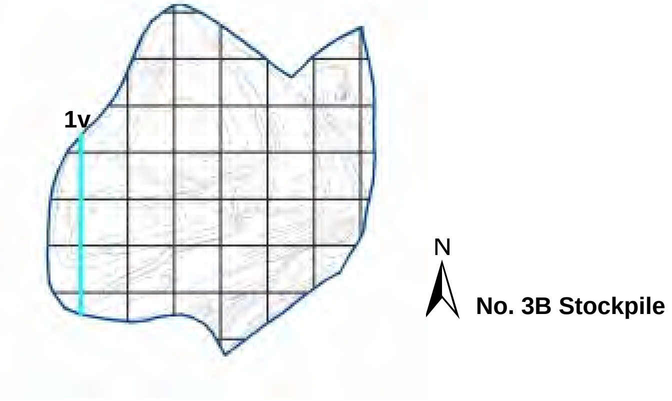

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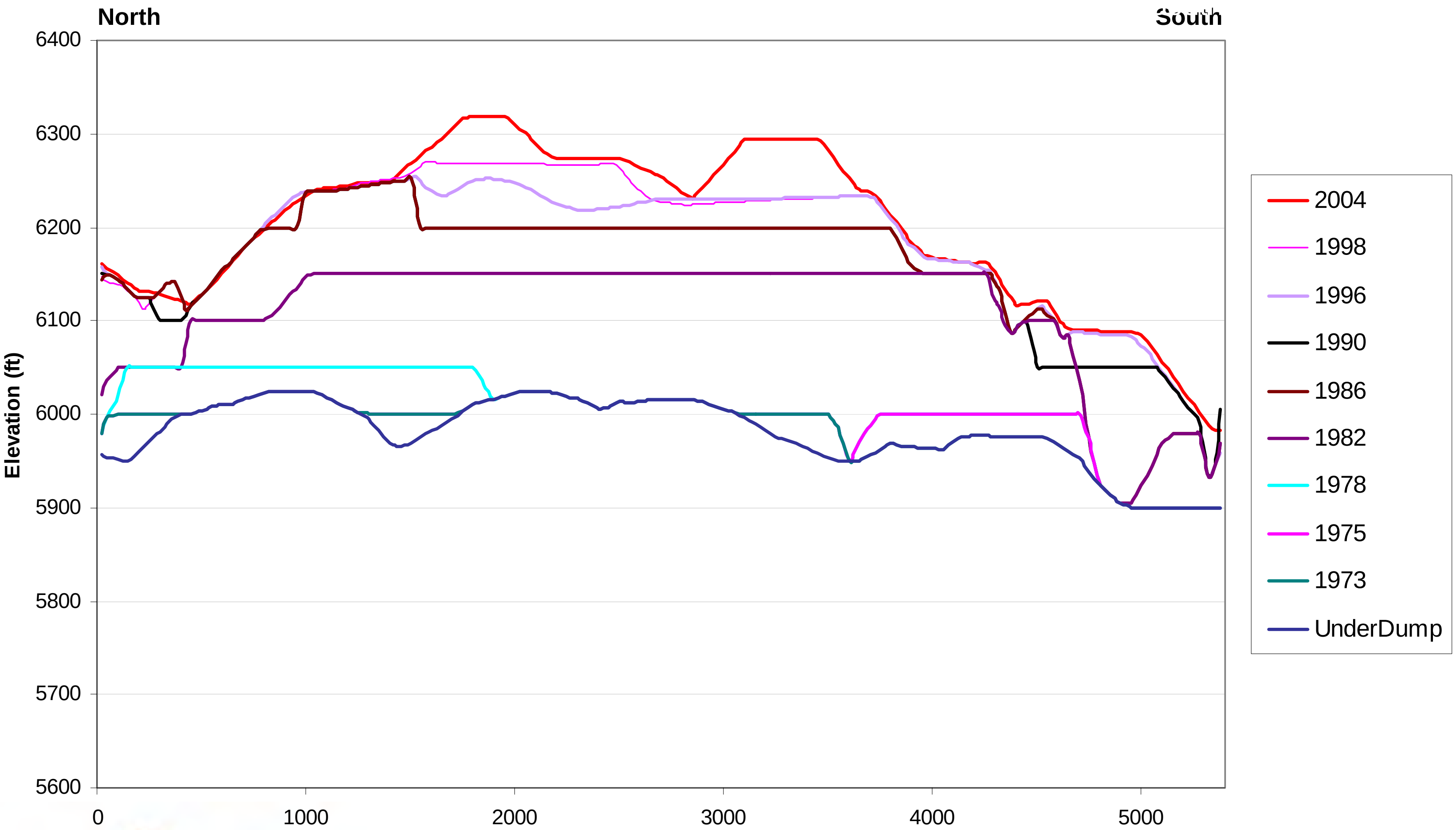

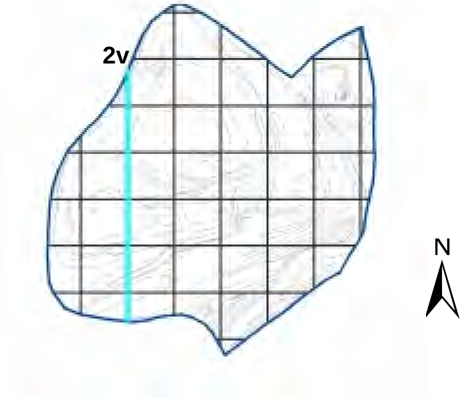

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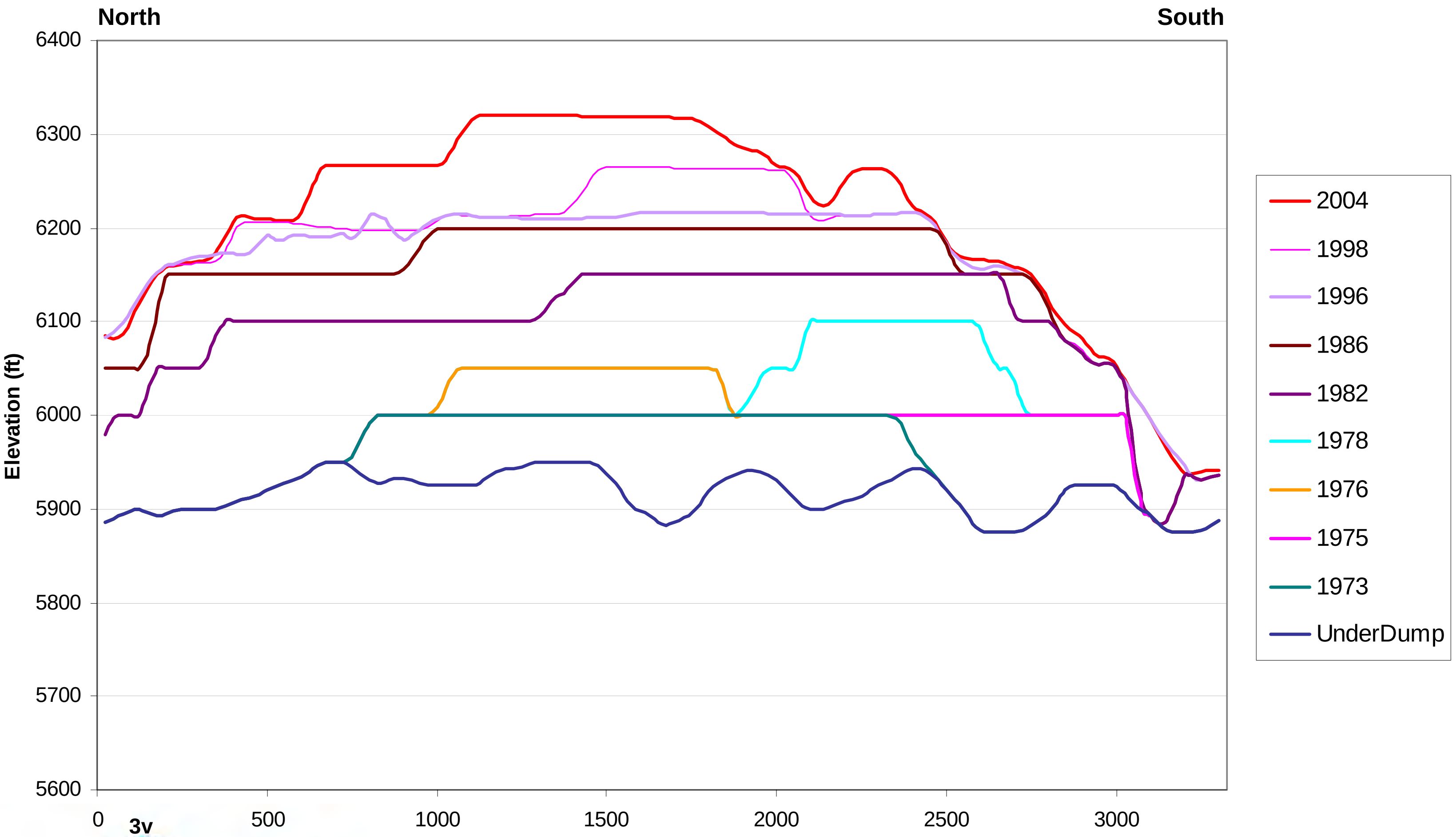

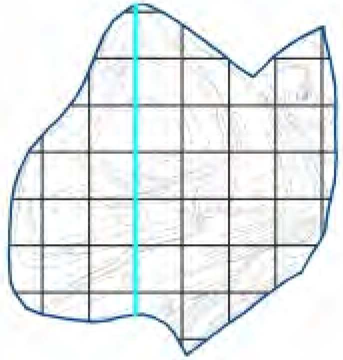

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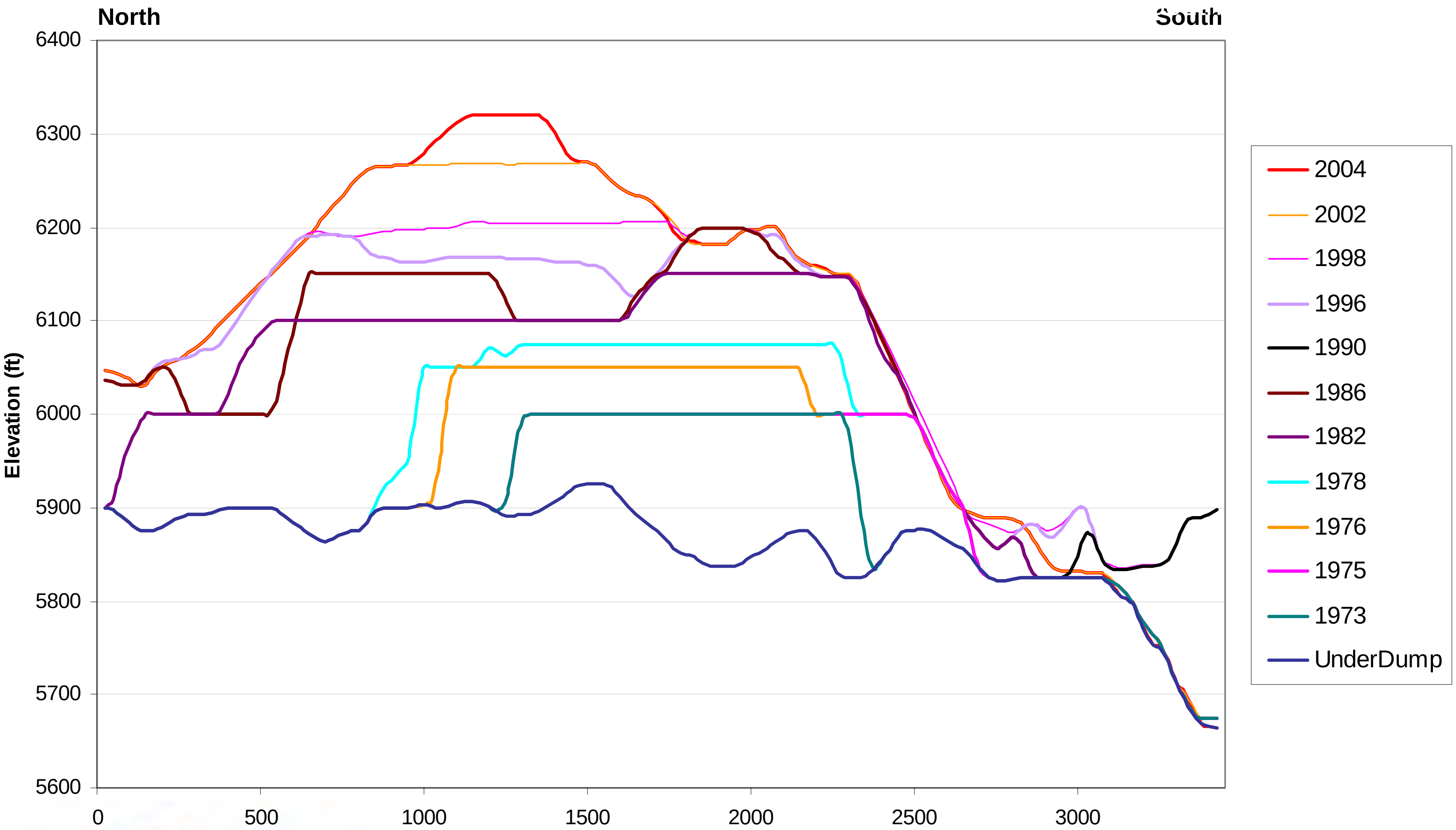

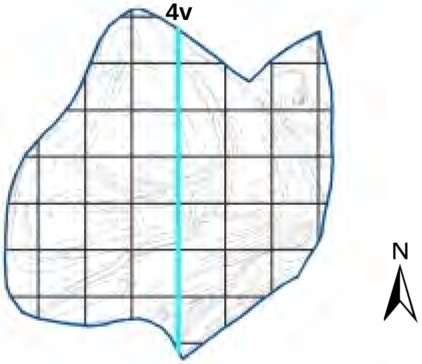

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Tyrone Cross Section No3B_5v

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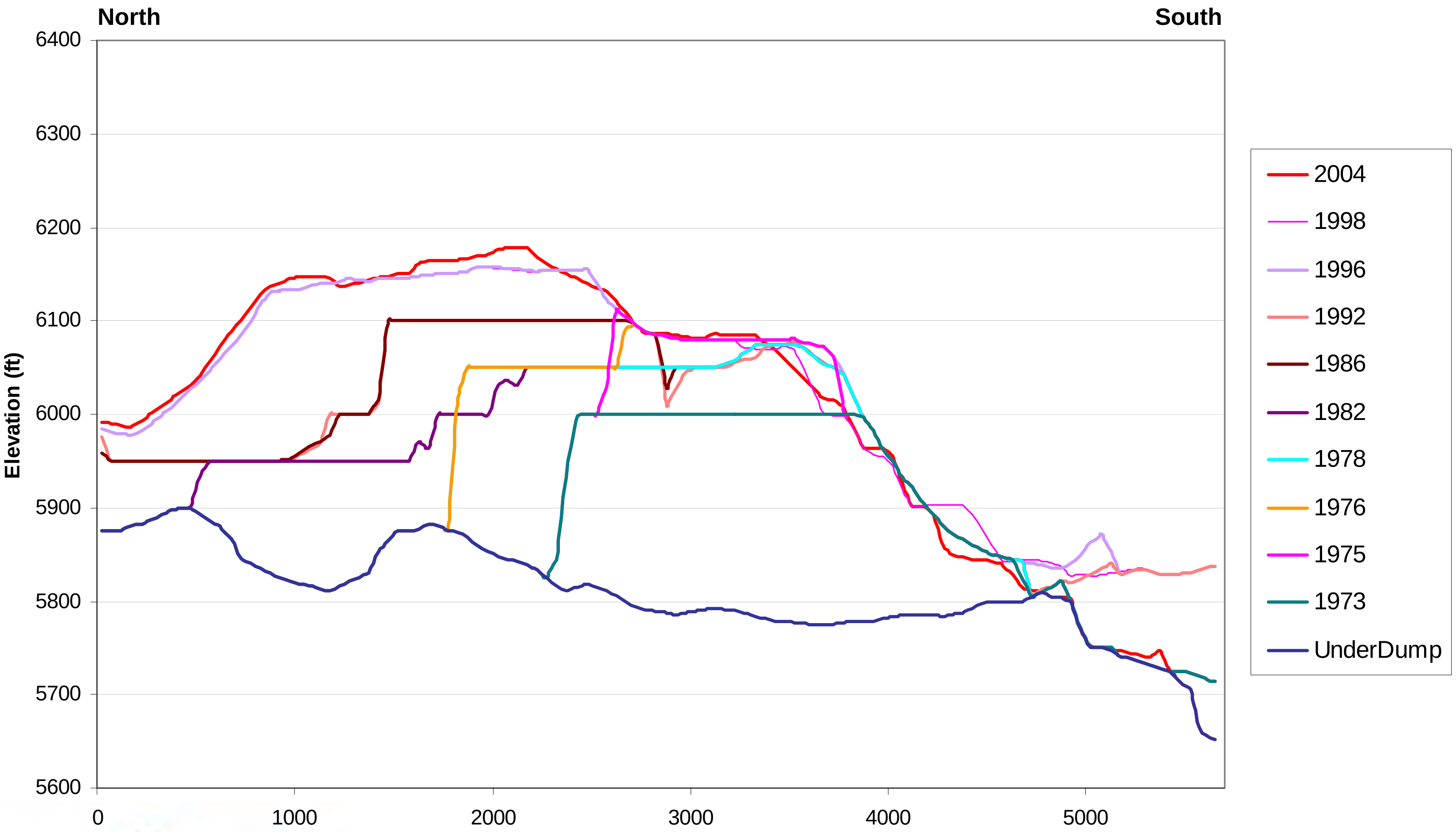

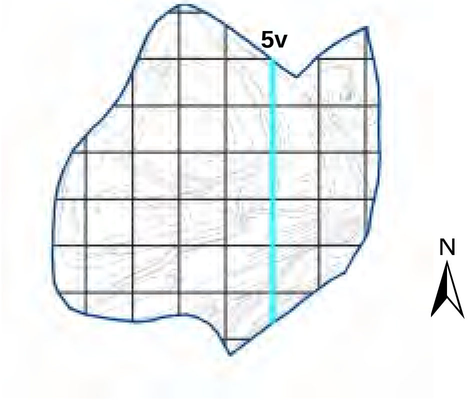

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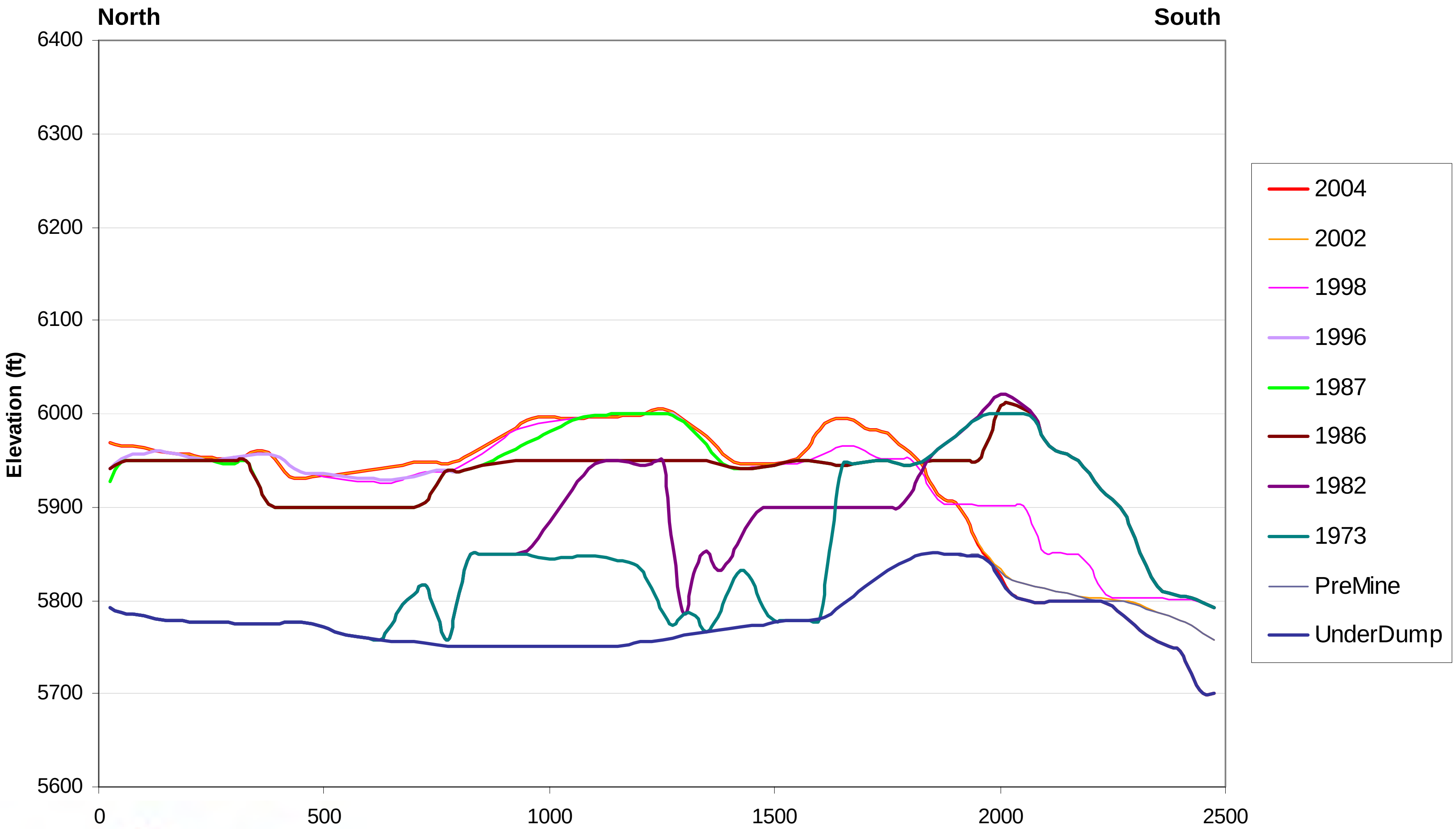

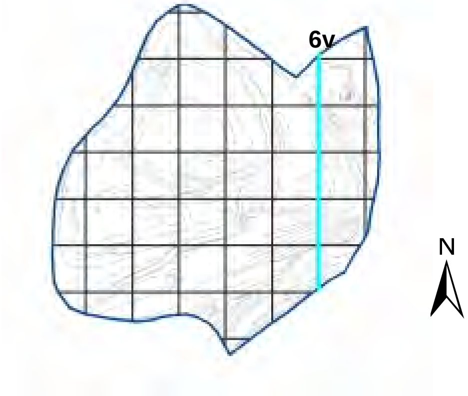

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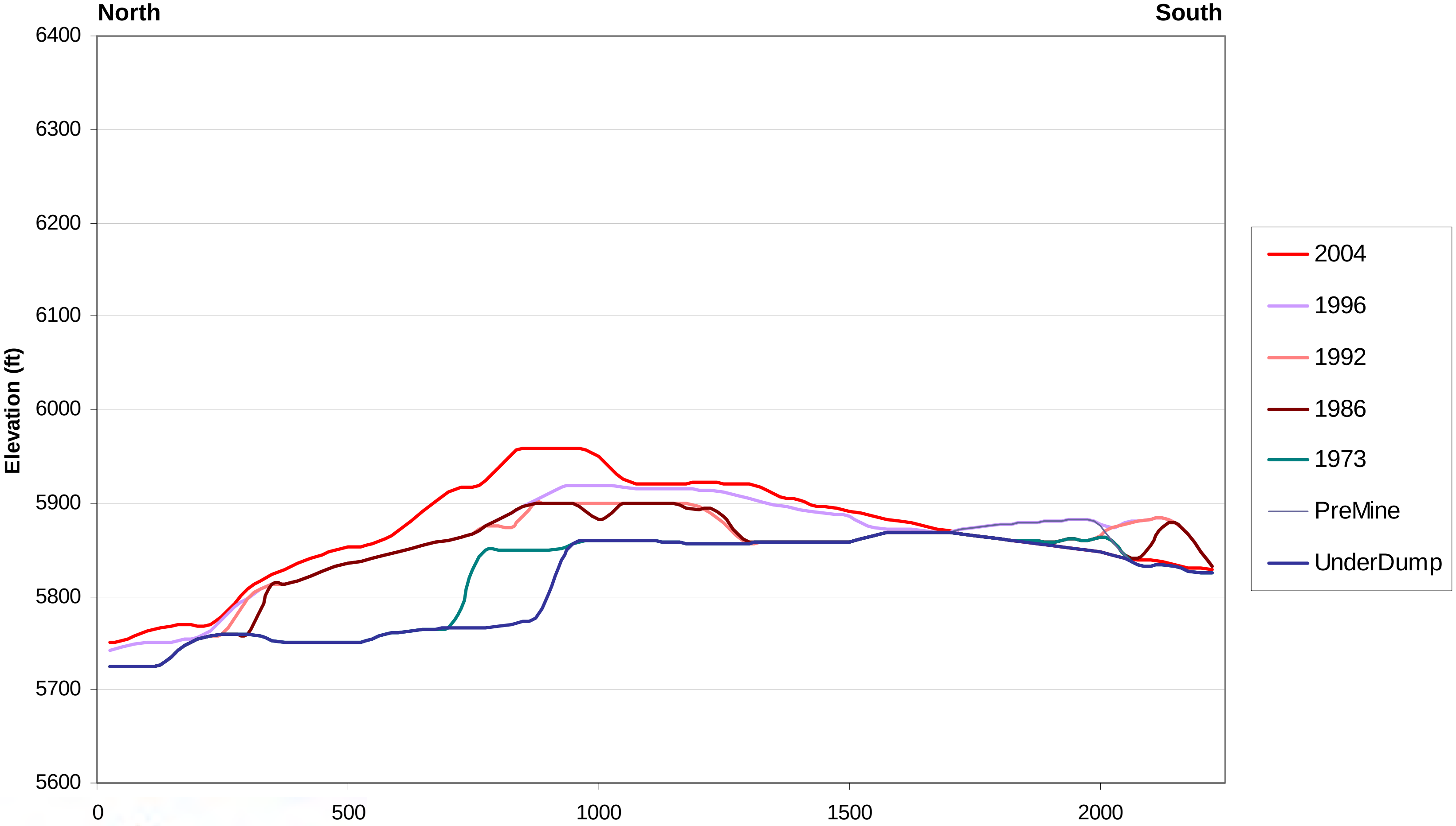

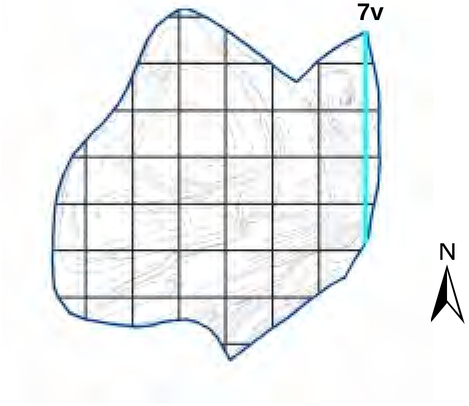

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TYRONE MINE
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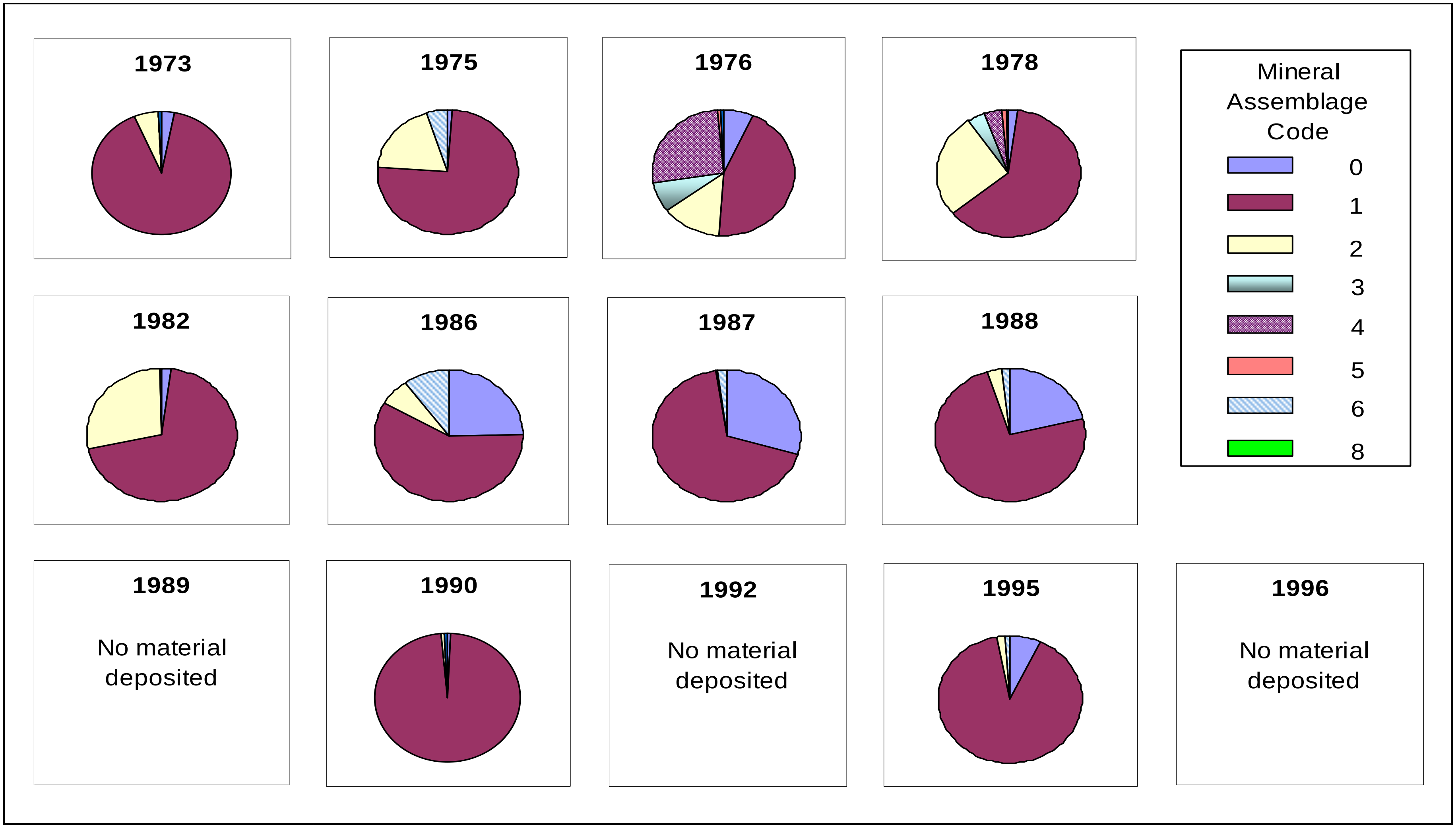

TYRONE MINE DP-1341, CONDITION 80 SUPPLEMENTAL MATERIALS CHARACTERIZATION	
Stockpile Cross-Sections	
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Mineral Assemblage Key

Code	Name	Description
0 🟦	Not mineralized	Gila Conglomerate, younger alluvium, and soils
1 🟪	Leached capping	Iron oxides are dominant mineralogies, no sulfides present, very low-grade copper zone
2 🟨	Oxide copper	Copper oxide, carbonate and silicate minerals soluble in sulfuric acid, no sulfides present, leach-grade copper zone
3 ▭	Mixed oxide and chalcocite	Copper oxide, carbonate and silicate minerals and chalcocite-pyrite, transition zone from oxide to sulfide mineralogies, leach-grade copper zone
4 ▩	Chalcocite and pyrite	Chalcocite is dominant copper mineral, pyrite present, leach-grade copper zone (The main ore processed for copper in the concentrator circuit and deposited on tailings ponds)
5 🟥	Mixed chalcocite and chalcopyrite	Chalcocite and chalcopyrite dominant copper minerals, pyrite present, some covellite associated, low-grade leach copper zone
6 ▨	Chalcopyrite and pyrite	Chalcopyrite dominant copper mineral, pyrite abundant, very low leach recoveries, not economically profitable to mine
7	Mixed oxide and chalcopyrite	Copper oxide, carbonate and silicate minerals with chalcopyrite, pyrite present, volumetrically minor mineral assemblage
8 🟩	Native copper and cuprite	Copper oxide minerals, native copper and turquoise not soluble in sulfuric acid, no sulfides present, volumetrically minor mineral assemblage
9	Stockpile	Uncharacterized stockpile material obtained from mining

TYRONE MINE
DP-1341, CONDITION 80
SUPPLEMENTAL MATERIALS CHARACTERIZATION

Stockpile Cross-Sections

Date: 10/19/2004 | Filename: TyroneStockXSection_3_3B.htm

Greystone Environmental Consultants
ENVIRONMENTAL STANDARD OPERATING PROCEDURE

PACKAGING AND SHIPPING SAMPLES

SOP NO. 003

Revision 00

Prepared by

Greystone Environmental Consultants
5231 South Quebec Street
Greenwood Village, Colorado 80111

April 1, 2003

TABLE OF CONTENTS

1.0 BACKGROUND

In any sampling program, the integrity of a sample must be ensured from its point of collection to its final disposition. Procedures for classifying, packaging, and shipping samples are described below. Steps in the procedures should be followed to ensure sample integrity and to protect the welfare of persons involved in shipping and receiving samples. When hazardous substances and dangerous goods are sent by common carrier, their packaging, labeling, and shipping are regulated by the U.S. Department of Transportation (DOT) Hazardous Materials Regulations (HMR, *Code of Federal Regulations*, Title 49 [49 CFR] Parts 106 through 180) and the International Air Transportation Association (IATA) Dangerous Goods Regulations (DGR).

1.1 Purpose

This standard operating procedure (SOP) establishes the requirements and procedures for packaging and shipping samples. It has been prepared in accordance with the U.S. Environmental Protection Agency (EPA) “Sampler’s Guide to the Contract Laboratory Program (CLP),” the DGR, and the HMR. Sample packaging and shipping procedures described in this SOP should be followed for all sample packaging and shipping. Deviations from the procedures in this SOP must be documented in a field logbook. This SOP assumes that samples are already collected in the appropriate sample jars and that the sample jars are labeled and tagged appropriately.

1.2 Scope

This SOP applies to sample classification, packaging, and shipping.

1.3 Definitions

Custody seal: A custody seal is a tape-like seal. Placement of the custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been packaged for shipping.

Dangerous goods: Dangerous goods are articles or substances that can pose a significant risk to health, safety, or property when transported by air; they are classified as defined in Section 3 of the DGR (IATA 1999).

Environmental samples: Environmental samples include drinking water, most groundwater and ambient surface water, soil, sediment, treated municipal and industrial wastewater effluent, and biological specimens. Environmental samples typically contain low concentrations of contaminants and when handled require only limited precautionary procedures.

Hazardous Materials Regulations: The HMR are DOT regulations for the shipment of hazardous materials by air, water, and land; they are located in 49 CFR 106 through 180.

Hazardous samples: Hazardous samples include dangerous goods and hazardous substances. Hazardous samples shipped by air should be packaged and labeled in accordance with procedures specified by the DGR; ground shipments should be packaged and labeled in accordance with the HMR.

Hazardous substance: A hazardous substance is any material, including its mixtures and solutions, that is listed in Appendix A of 49 CFR 172.101 and its quantity, in one package, equals or exceeds the reportable quantity (RQ) listed in the appendix.

IATA Dangerous Goods Regulations: The DGR are regulations that govern the international transport of dangerous goods by air. The DGR are based on the International Civil Aviation Organization (ICAO) Technical Instructions. The DGR contain all of the requirements of the ICAO Technical Instructions and are more restrictive in some instances.

Nonhazardous samples: Nonhazardous samples are those samples that do not meet the definition of a hazardous sample and do not need to be packaged and shipped in accordance with the DGR or HMR.

Overpack: An enclosure used by a single shipper to contain one or more packages and to form one handling unit (IATA 1999). For example, a cardboard box may be used to contain three fiberboard boxes to make handling easier and to save on shipping costs.

1.4 References

U.S. Department of Transportation, Transport Canada, and the Secretariat of Communications and Transportation of Mexico (DOT and others). 1996. 1996 North American Emergency Response Guidebook.

International Air Transport Association (IATA). 1997. Guidelines for Instructors of Dangerous Courses.

IATA. 1999. Dangerous Goods Regulations. 40th Edition.

U.S. Environmental Protection Agency. 1996. Sampler's Guide to the Contract Laboratory Program. Office of Solid Waste and Emergency Response. Washington, DC. EPA/540/R-96/032.

American Society for Testing and Materials (ASTM) D-4220. 1995 (Reapproved 2000). Standard Practices for Preserving and Transporting Soil Samples.

1.5 Requirements and Resources

The procedures for packaging and shipping nonhazardous samples require the following:

- Coolers
- Ice
- Vermiculite, bubble wrap, or similar cushioning material
- Chain-of-custody forms and seals
- Airbills
- Resealable plastic bags for sample jars and ice
- Tape

The procedures for packaging and shipping hazardous samples require the following:

- Ice
- Vermiculite or other non-combustible, absorbent packing material
- Chain-of-custody forms and seals
- Appropriate dangerous goods airbills and emergency response information to attach to the airbill

- Resealable plastic bags for sample jars and ice
- Tape (strapping and clear)
- Appropriate shipping containers as specified in the DGR
- Labels that apply to the shipment such as hazard labels, address labels, “Cargo Aircraft Only” labels, and package orientation labels (up arrows)

2.0 PROCEDURES

The following procedures apply to packaging and shipping nonhazardous and hazardous samples. Additional guidance may be provided in the site-specific sampling and analysis and health and safety plans.

2.1 Sample Classification

Prior to sample shipment, it must be determined whether the sample is subject to the DGR. Samples subject to these regulations shall be referred to as hazardous samples. If the hazardous sample is to be shipped by air, then the DGR should be followed. Any airline, including FedEx, belonging to IATA must follow the DGR. As a result, FedEx may not accept a shipment that is packaged and labeled in accordance with the HMR (although in most cases, the packaging and labeling would be the same for either set of regulations). The HMR states that a hazardous material may be transported by aircraft in accordance with the ICAO Technical Instruction (49 CFR 171.11) upon which the DGR is based. Therefore, the use of the DGR for samples to be shipped by air complies with the HMR, but not vice versa.

Most environmental samples are not hazardous samples and do not need to be packaged in accordance with any regulations. Hazardous samples are those samples that can be classified as specified in Section 3 of the DGR, can be found in the List of Dangerous Goods in the DGR in bold type, are considered a hazardous substance (see definition), or are mentioned in "Section 2 - Limitations" of the DGR for countries of transport or airlines (such as FedEx). The hazard classifications specified in the DGR (and the HMR) are as follows:

Class 1 - Explosives

Division 1.1 - Articles and substances having a mass explosion hazard

Division 1.2 - Articles and substances having a projection hazard but not a mass explosion hazard

Division 1.3 - Articles and substances having a fire hazard, a minor blast hazard and/or a minor projection hazard but not a mass explosion hazard

Division 1.4 - Articles and substances presenting no significant hazard

Division 1.5 - Very sensitive substances mass explosion hazard

Division 1.6 - Extremely insensitive articles which do not have a mass explosion hazard

Class 2 - Gases

Division 2.1 - Flammable gas

Division 2.2 - Non-flammable, non-toxic gas

Division 2.3 - Toxic gas

Class 3 - Flammable Liquids

Class 4 - Flammable Solids; Substances Liable to Spontaneous Combustion; Substances, which, in Contact with Water, Emit Flammable Gases

Division 4.1 - Flammable solids

Division 4.2 - Substances liable to spontaneous combustion

Division 4.3 - Substances, which, in contact with water, emit flammable gases

Class 5 - Oxidizing Substances and Organic Peroxide

Division 5.1 - Oxidizers

Division 5.2 - Organic peroxides

Class 6 - Toxic and Infectious Substances

Division 6.1 - Toxic substances

Division 6.2 - Infectious substances

Class 7 - Radioactive Material

Class 8 – Corrosives

Class 9 - Miscellaneous Dangerous Goods

The criteria for each of the first eight classes are very specific and are outlined in Section 3 of the DGR and 49 CFR 173 of the HMR. Some classes and divisions are further divided into packing groups based on their level of danger. Packing group I indicates a great danger, packing group II indicates a medium danger, and packing group III indicates a minor danger. Class 2, gases, includes any compressed gas being shipped and any noncompressed gas that is either flammable or toxic. A compressed gas is defined as having a pressure over 40 pounds per square inch (psi) absolute (25 psi gauge). Most air samples and empty cylinders that did not contain a flammable or toxic gas are exempt from the regulations. An empty hydrogen cylinder, as in a flame ionization detector (FID), is considered a dangerous good unless it is properly purged with nitrogen in accordance with the HMR. A landfill gas sample is usually considered a flammable gas because it may contain a high percentage of methane. Class 3, flammable liquids, are based on the boiling point and flash point of a substance. Most class 3 samples include solvents, oil, gas, or paint-related material collected from drums, tanks, or pits. Division 6.1, toxic substances, is based on oral toxicity (LD50 [lethal dose that kills 50 percent of the test animals]), dermal toxicity (LD50 values), and inhalation toxicity (LC50 [lethal concentration that kills 50 percent of the test animals] values). Division 6.1 substances include pesticides and cyanide. Class 7, radioactive material, is defined as any article or substance with a specific activity greater than 70 kiloBecquerels (kBq/kg) (0.002 [microCuries per gram [µCi/g]). If the specific activity exceeds this level, the sample should be shipped in accordance with Section 10 of the DGR. Class 8, corrosives, are based on the rate at which a substance destroys skin tissue or corrodes steel; they are not based on pH. Class 8 materials include the concentrated acids used to preserve water samples. Preserved water samples are not considered class 8 substances and should be packaged as nonhazardous samples. Class 9, miscellaneous dangerous goods, are substances that present a danger but are not covered by any other hazard class. Examples of class 9 substances include asbestos, polychlorinated biphenyls (PCB), and dry ice.

Unlike the DGR, the HMR includes combustible liquids in hazard class 3. The definition of a combustible liquid is specified in 49 CFR 173.120 of the HMR. The HMR has an additional class, ORM-D, that is not specified in the DGR. “ORM-D material” refers to a material such as a consumer commodity that although otherwise subject to the HMR, presents a limited hazard during transport due to its form, quantity, and packaging. It must be a material for which exceptions are provided in the table of 49 CFR 172.101. The DGR lists consumer commodities as a class 9 material. In most instances, the hazard of a material sampled is unknown because no laboratory testing has been conducted. A determination as to the suspected hazard of the sample must be made using knowledge of the site, field observations, field tests, and other available information.

According to 40 CFR 261.4(d) and (e), samples transported to a laboratory for testing or treatability studies, including samples of hazardous wastes, are not hazardous wastes. FedEx will not accept a shipment of hazardous waste.

2.2 Packaging Nonhazardous Samples

Nonhazardous samples, after being appropriately containerized, labeled, and tagged, should be packaged in the following manner. (Note that these are general instructions; samplers should be aware of any client-specific requirements concerning the placement of custody seals or other packaging provisions.)

1. Place the sample container in a resealable plastic bag. The bag must be 3 mil or thicker to prevent leakage.
2. Place the bagged sample in a cooler and pack it to prevent breakage.
3. Prevent breakage of bottles during shipment by either wrapping the sample container in bubble wrap, or lining the cooler with a noncombustible material such as vermiculite. Vermiculite is especially recommended because it will absorb any free liquids inside the cooler. It is recommended that the cooler be lined with a large plastic garbage bag before samples, ice, and absorbent packing material are placed in the cooler.
4. Add a sufficient quantity of ice to the cooler to cool samples to 4 °C. Ice should be double bagged in resealable plastic bags to prevent the melted ice from leaking out. As an option, a temperature blank (a sample bottle filled with distilled water) can be included with the cooler.
5. Seal the completed chain-of-custody forms in a plastic bag and tape the plastic bag to the inside of the cooler lid.
6. Tape any instructions for returning the cooler to the inside of the lid.
7. Close the lid of the cooler and tape it shut by wrapping strapping tape around both ends and hinges of the cooler at least once. Tape shut any drain plugs on the cooler.
8. Place two signed custody seals on the cooler, ensuring that each one covers the cooler lid and side of the cooler. Place clear plastic tape over the custody seals.
9. Place address labels on the outside of the cooler.
10. Ship samples overnight by a commercial carrier such as FedEx.

2.3 Packaging Hazardous Samples

The procedures for packaging hazardous samples are summarized below. Note that according to the DGR, all spellings must be exactly as they appear in the List of Dangerous Goods, and only approved abbreviations are acceptable. The corresponding HMR regulations are provided in parentheses following any DGR referrals. The HMR must be followed only if shipping hazardous samples by ground transport.

1. Determine the proper shipping name for the material to be shipped. All proper shipping names are listed in column B of the List of Dangerous Goods table in Section 4 of the DGR (or column 2 of the Hazardous Materials Table in 49 CFR 172.101). In most instances, a generic name based on the hazard class of the material is appropriate. For example, a sample of an oily liquid collected from a drum with a high photoionization detector (PID) reading should be packaged as a flammable liquid. The proper shipping name chosen for this sample would be "flammable liquid, n.o.s." The abbreviation "n.o.s." stands for "not otherwise specified" and is used for generic shipping names. Typically, a specific name, such as acetone, should be inserted in parentheses after most n.o.s. descriptions. However, a technical name is not required when shipping a sample for testing purposes and the components are not known. If shipping a hazardous substance (see definition), then the letters "RQ" must appear in front of the proper shipping name.

2. Determine the United Nations (UN) identification number, class or division, subsidiary risk if any, required hazard labels, packing group, and either passenger aircraft or cargo aircraft packing instructions based on the quantity of material being shipped in one package. This information is provided in the List of Dangerous Goods (or Hazardous Materials Table in 49 CFR 172.101) under the appropriate proper shipping name. A "Y" in front of a packing instruction indicates a limited quantity packing instruction. If shipping dry ice or a limited quantity of a material, then UN specification shipping containers do not need to be used.

3. Determine the proper packaging required for shipping the samples. Except for limited quantity shipments and dry ice, these are UN specification packages that have been tested to meet the packing group of the material being shipped. Specific testing requirements of the packages are listed in Section 6 of the DGR (or 49 CFR 178 of the HMR). All UN packages are stamped with the appropriate UN specification marking. Prior planning is required to have the appropriate packages on hand during a sampling event where hazardous samples are anticipated. Most samples can be shipped in either a 4G fiberboard box, a 1A2 steel drum, or a 1H2 plastic drum. Drums can be purchased in 5- and 20- gallon sizes and are ideal for shipping multiple hazardous samples. When FedEx is used to ship samples containing PCBs, the samples must be shipped in an inner metal packaging (paint can) inside a 1A2 outer steel drum. This method of packaging PCB samples is in accordance with FedEx variation FX-06, listed in Section 2 of the DGR.

4. Place each sample jar in a separate resealable plastic bag. Some UN specification packagings contain the sample jar and plastic bag to be used when shipping the sample.

5. Place each sealed bag inside the approved UN specification container (or other appropriate container if a limited quantity or dry ice) and pack with enough noncombustible, absorbent, cushioning material (such as vermiculite) to prevent breakage and to absorb liquid.

6. Place chain-of-custody forms in a resealable plastic bag and either attach it to the inside lid of the container or place it on top inside the container. Place instructions for returning the container to the shipper on the inside lid of the container as appropriate. Close and seal the shipping container in the manner appropriate for the type of container being used.

7. Label and mark each package appropriately. All irrelevant markings and labels need to be removed or obliterated. All outer packagings must be marked with proper shipping name, UN identification number, and name and address of the shipper and the recipient. For carbon dioxide, solid (dry ice), the net weight of the dry ice within the package needs to be marked on the outer package. For limited quantity shipments, the words "limited quantity" or "LTD.

QTY." must be marked on the outer package. Affix the appropriate hazard label to the outer package. If the material being shipped contains a subsidiary hazard, then a subsidiary hazard label must also be affixed to the outer package. The subsidiary hazard label is identical to the primary hazard label except that the class or division number is not present. It is acceptable to obliterate the class or division marking on a primary hazard label and use it as the subsidiary hazard label. If using cargo aircraft only packing instructions, then the "Cargo Aircraft Only" label must be used. Package orientation labels (up arrows) must be placed on opposite sides of the outer package.

8. If using an overpack (see definition), mark and label the overpack and each outer packaging within the overpack as described in step 7. In addition, the statement "INNER PACKAGES COMPLY WITH PRESCRIBED SPECIFICATIONS" must be marked on the overpack.

9. Attach custody seals, and fill out the appropriate shipping papers as described in Section 2.4.

2.4 Shipping Papers For Hazardous Samples

A "Shippers Declaration for Dangerous Goods" and "Air Waybill" must be completed for each shipment of hazardous samples. FedEx supplies a Dangerous Goods Airbill to its customers; the airbill combines both the declaration and the waybill. A shipper's declaration must contain the following:

- Name and address of shipper and recipient
- Air waybill number (not applicable to the HMR)
- Page ___ of ___
- Deletion of either "Passenger and Cargo Aircraft" or "Cargo Aircraft Only," whichever does not apply
- Airport or city of departure
- Airport or city of destination
- Deletion of either "Non-Radioactive" or "Radioactive," which ever does not apply
- The nature and quantity of dangerous goods. This includes the following information in the following order (obtained from the List of Dangerous Goods in the DGR): proper shipping name, class or division number, UN identification number, packing group number, subsidiary risk, quantity in liters or kilograms (kg), type of packaging used, packing instructions, authorizations, and additional handling information. Authorizations include the words "limited quantity" or "LTD. QTY." if shipping a limited quantity, any special provision numbers listed in the List of Dangerous Goods in the DGR, and the variation "USG-14" when a technical name is required after the proper shipping name but not entered because it is unknown.
- Signature for the certification statement
- Name and title of signatory
- Place and date of signing certification
- A 24-hour emergency response telephone number for use in the event of an incident involving the dangerous good
- Emergency response information attached to the shipper's declaration. This information can be in the form of a material safety data sheet or the applicable North American Emergency

> Response Guidebook (NAERG; DOT 1996) pages. Note that dry ice does not require an attached shipper's declaration. However, the air waybill must include the following on it: "Dry ice, 9, UN1845, ____ x ____ kg." The blanks must include the number of packages and the quantity in kg in each package. If using FedEx to ship dry ice, the air waybill includes a box specifically for dry ice. Simply check the appropriate box and enter in the number of packages and quantity in each package.

The HMR requirements for shipping papers are located in 49 CFR 172 Subpart C.

3.0 POTENTIAL PROBLEMS

The following potential problems may occur during sample shipment:

- **Leaking package.** If a package leaks, the carrier may open the package, return the package, and if a dangerous good, inform the Federal Aviation Administration (FAA), which can result in fines.
- **Improper labeling and marking of package.** If mistakes are made in labeling and marking the package, the carrier will most likely notice the mistakes and return the package to the shipper, thus delaying sample shipment.
- **Improper, misspelled, or missing information on the shipper's declaration.** The carrier will most likely notice this as well and return the package to the shipper.

Contact FedEx with questions about dangerous goods shipments by calling 1-800-463-3339 and asking for a dangerous goods expert.

APPENDIX C
Draft Sampling and Analysis Plan of Leached Ore Stockpiles and Waste Rock Piles at the Tyrone Mine

This Sampling and Analysis Plan (SAP) is an extension of the Supplemental Materials Characterization Study of the Leach Ore Stockpile and Waste Rock Stockpiles Work Plan for the Tyrone Mine (Greystone 2003c). The work plan was submitted on October 3, 2003 in order to fulfill the requirements of Tyrone Mine Supplemental Discharge permit for closure (DP-1341 2003). This SAP is presented in seven sections, as outlined below.

In addition to the requirements in Condition 80, the activities described in this SAP will acquire other related data needed for the Supplemental Stability Study (Golder 2003) required under Condition 78, and other conditions of DP-1341 (NMED 2003). The data has also been collected to meet the objectives of the Tyrone mine plan.

C-1 Introduction

Phelps Dodge Tyrone Inc. (PDTI) is collecting and analyzing borehole and open cut samples from the interior of the stockpiles at the Tyrone Mine as part of a Supplemental Materials Characterization Study. This work is also conducted in coordination with the Supplemental Stability Study.

C-2 Sampling and Analysis Objectives

A total of eight assay stockpile boreholes have been completed at the Tyrone Mine for geochemical sampling and monitor well installation. The location of these boreholes is shown in Figure C-1. Drilling was conducted in both leach ore and waste rock stockpiles that are composed of blasted “mine run” rock, ranging from fine sand to 36 inches in diameter. Although unsaturated conditions were encountered in the boreholes during completion, there may be perched zones of saturation within the some leach ore stockpiles. Samples have also been collected from archived stockpile borehole samples collected from previous exploration drilling and from accessible stockpile open bulldozer cuts into portions of the No. 1C Stockpile.

The objectives of the stockpile sampling study are to:

- Characterize stockpile interior materials and refine compositional models
- Evaluate effects of leaching and weathering on the mined material properties
- Provide information for stockpile stability analysis and seepage quality modeling

The major objective of this sampling and analysis effort will be to characterize the leached and weathered rock materials from the stockpile interiors through drilling and sample collection. The stockpiles that have been sampled have been leached (leach ore stockpiles) and weathered (primarily waste-rock piles) for variable durations. This data will be the basis for an evaluation of the chemical and mineralogical changes that the mineral assemblages have experienced since the material was mined and placed on the stockpiles. For the waste-rock stockpiles, these changes have resulted primarily from the natural weathering and leaching due to: (1) the exposure of the mined materials to atmospheric oxygen and (2) the ambient infiltration of precipitation through the tops of the stockpiles. Chemical changes in the leached stockpiles materials will be dominated by the effects of leaching with acidic raffinate solutions, which is applied to the upper surfaces of the stockpiles. Therefore, it is anticipated that differences in material character will be observed on the basis of leaching history as well as the original lithology of the material placed on the stockpile. These results will be used in the Revised Seepage Investigation per DP-1341, Condition 81 and other related studies.

C-3. Sampling Methods

This section describes the methods used for selection of samples from existing Tyrone stockpile assay pulp archives (Section C-3.1), and the collection of additional stockpile borehole (Section C-3.2) and surface samples (Section C-3.4). Methods used for collection of stockpile interior temperature readings and interior gas samples for oxygen concentration measurements are also provided (Section C-3.3).

C-3.1 Analysis of Archived Stockpile Material Assay Samples

Since the development of the open pit and stockpiles at the Tyrone Mine, continued exploration for copper ore has necessitated the drilling of new exploration boreholes into and through leach ore and waste rock stockpiles. Samples from over 670 stockpile boreholes have been obtained for the purpose of conducting assays for copper resource evaluation (Seibert 2004). The assay pulps were archived after the copper assays were performed in the event that additional analyses were required. Figure C-2 illustrates the method used to select one to two boreholes from 18 stockpiles (mine operational units) at random for supplemental materials characterization. This method requires the following three steps:

1) Grouping of boreholes into stockpile domains
2) Assignment of sequential serial numbers to boreholes within each stockpile domain
3) Random number generator selection of 2 borehole serial numbers from each stockpile

The boreholes that were located on or very close to stockpile boundaries were omitted to avoid ambiguity of stockpile assignment and to distribute the borehole selections. An random number generator located at the internet web site www.random.org was used because it provides unbiased and traceable random numbers. The random numbers generated are documented through screen capture of the random number generator results and the real time random numbers statistics log for each session. The series number generator was used to avoid duplicates for each stockpile.

An inventory of the boreholes that were selected through the random selection process was conducted to determine if sufficient sample existed for supplemental materials characterization. The boreholes listed in Table C-1 were confirmed to contain sufficient samples in most 10-foot intervals such that the following analysis procedures could be conducted:

- Modified acid-base accounting (ABA)
- Paste pH
- Paste electrical conductivity (EC)
- Whole rock composition by x-ray fluorescence (XRF)
- X-ray diffraction (XRD) mineral identification (on selected samples only)

These analytical procedures are described briefly in section C-5 below.

C-3.2 Supplemental Stockpile Borehole Sampling

Sampling and sample analysis will be conducted on samples collected from the interiors of the following stockpiles complexes:

No. 1 Stockpile
No. 1B, No. 1C and No. 1D Stockpiles
No. 3 Stockpile
No. 2, No. 2A and No. 2B Stockpiles

Samples from the No. 1A and No. 1C Stockpiles were collected from stockpile open cut sampling as described in section C-3.4 below.

Stockpile interior samples were obtained from the following sources in late September through mid-October, 2004:

- Becker drilling return cuttings
- Sonic drilling cores

The approximate location of proposed new drilling sites are shown on Figure C-1. These sites were selected based on information from existing boreholes, accessibility, and on the Tyrone stockpile compositional model (DBS&A 1997a,b). The proposed drilling sites and test pit sites, as detailed in the work plan (Greystone 2003c), also need to be re-evaluated following review of existing drilling data, previous test pit information and a review of existing well information. Site operational personnel relocated some of the borehole sites based on safety and longevity considerations. These relocations allowed the drilling, sampling, and the monitoring of temperature and oxygen in wells (per DP-1341, Condition 50) without interfering with operations.

Completed borehole and stockpile open cut sample locations were surveyed using a global positioning system (GPS) using the Universal Transverse Mercator/Universal Polar Stereographic (UTM/UPS) coordinate system format and the appropriate datum. These data were entered in the Tyrone Mine Stockpile Unit geographic information system (GIS) and the final sample locations are shown approximately in Figure C-1.

The geochemical characterization boreholes were drilled into stockpiles using an AP-1000 Hammer Drilling rig owned and operated by Layne Chandler. This drill rig is equipped with a pile-driving percussion hammer powered by a diesel engine. The hammer advances a dual wall drill pipe equipped with an open face drill bit. The outer diameter (OD) of the steel drill string is expected to be nominally 10 inches, and the inner steel drill string OD is approximately 6 inches in diameter. As the pipe is advanced, high pressure compressed filtered air is injected down the annulus of the dual-wall drill pipe. The air returns the cuttings from the rear of the cutting shoe back to the surface through the center of the drill pipe. The cuttings are ejected through a cyclone unit mounted on the side of the drill rig. The dual-wall drill pipe is hydraulically pulled from the ground after drilling has been completed.

This type of drill rig is used to minimize the physical and chemical disturbance ordinarily caused by rotary or other types of drilling methods and those methods that use water and mud to return samples. The hammer drill method also yields indirect information on compaction and strength of the material and occurrence of oversize materials through in situ penetration resistance testing (USACE 1996). In addition to penetration resistance testing using the Becker drill method, other downhole logging and characterization techniques may be used during drilling to assess the internal structure and moisture content of materials in the stockpile. For example, density and moisture content of the material may be measured *in situ* using a nuclear logging device (Section C-4). Sonic drilling was used to obtain geotechnical samples for supplemental slope stability studies per Condition 80. For both the hammer and sonic drilling, PDTI retained drilling contractors who could meet the sampling quality and integrity requirements of Conditions 80 and 78.

During hammer rig drilling, continuous, stockpile samples were collected at 10-foot intervals for copper resource evaluations as well as materials characterization. The return cuttings were cobble size (nominally 5.5 inches or smaller), the maximum size is limited by the diameter of the inner casing. The stockpile boreholes were between approximately 100 and 300 feet deep. The boreholes were terminated after the drill had penetrated the entire depth of the stockpile or when it reached refusal (usually when the bit impinges upon a large boulder), whichever comes first.

Samples were recovered by pumping compressed air downward through the outer casing to the cutting head. Cuttings were returned through the inner well casing and routed through a cyclone, where samples were collected and stored by the following procedure:

1) Stockpile cuttings were collected by directing the cyclone discharge into the bucket of a Bobcat loader. All cuttings from each 10-foot interval will be passed through a Gilson riffle splitter by dumping the Bobcat loads into the splitter. Multiple tips of the Bobcat bucket were usually needed because the load capacity of the splitter was less than the volume of material from the 10 foot interval. Each “tip” was leveled in the splitter’s hopper prior to running the split to avoid channeling through the chutes.

2) Using procedure (1), the sample splits were randomly divided by the splitter and the material remained homogeneous during splitting. Cross contamination was avoided by cleaning the riffle splitter, overflow tarps and collection vessels between sample batches. The air return hose and cyclone were also cleared periodically during each interval.

3) Upon completion of each interval, the entire volume of retained cuttings is passed through a riffle splitter to reduce sample size to one-half or one-quarter of the interval volume wand were collected into 5 gallon pails from each interval. In some cases multiple buckets were collected when the interval recovery was larger than average.

4) Samples were then sent to the Tyrone warehouses for shipping to SVL Analytical Laboratories for sample processing for the analysis and testing described in Section C-5.

5) Additional sample splits of each interval were collected in trays, bags and buckets for detailed logging by mine geologists. These samples are being stored at a designated area until the logging is completed, and then discarded.

Samples weights of approximately 10 to 50 pounds of stockpile were collected at 10-foot intervals and placed into 5 gallon plastic buckets. Most interval samples represent quarter splits and approximately filled one 5 gallon bucket. The estimated recovery for most samples is approximately 10 to 20 percent. Samples were labeled according to the stockpile borehole designation and depth of sampling. Other sampling, packing, and shipping protocols to be followed will be documented in Greystone Standard Operating Procedures (SOPs) (Greystone 2003a,b), which will follow American Society for Testing and Materials (ASTM) standards (ASTM 1998, 2000). Sample splits will be preserved for additional analysis if necessary.

A qualified geologist will log each well and collect all individual samples collected from boreholes and open cuts. Logging will include descriptions of the lithology, mineralization, grade, color matched to a Munsell soil color chart, and degree of alteration of based on macroscopic observation. All samples were also assigned a mineral assemblage type(s), according to the following system used by geologists at Tyrone.

MA-0, Gila Conglomerate
MA-1, Leached capping
MA-2, Oxide copper
MA-3, Mixed oxide and chalcocite
MA-4, Chalcocite and pyrite
MA-5, Mixed chalcocite and chalcopyrite
MA-6, Chalcopyrite and pyrite

MA-7, Mixed oxide and chalcopyrite
MA-8, Native copper and cuprite

This system is defined in greater detail in the Preliminary Materials Characterization study for Tyrone (DBS&A, 1997a).

Photographs of samples were taken to show field relationships with accompanying notes describing each photo written in the field notebook. Downhole well logging was also conducted to supplement material data acquisition and the logging techniques used are described in Section C-3.4 below.

C-3.3 Stockpile Monitoring

The stockpiles internal temperature and oxygen concentration in pore gases will be monitored according to the requirements of Condition 50 of DP-1341. The monitor wells were installed in the completed hammer drill boreholes according to the following procedures and sequence:

1) Instrumentation – Schedule 80 polyvinyl chloride (PVC) casing (1.5 inch outer diameter) will be installed through the opening in the 9x6 dual-wall drill pipe after borings have reached total depth. Casing joints will be threaded flush joint meeting ASTM F-480 standards. The casing supports the instrumentation attached to the outside of the casing. Four to six instrument clusters are to be taped to the outside of each PVC casing with electrical tape as it is placed in the completed drill hole. These clusters include 1/8-inch inside diameter (ID) vinyl tubing for oxygen (O_2) monitoring and thermistor strings for temperature monitoring. The thermistor string is a “harness” with the wires inside a protective sheath that attach to multiple thermisters for monitoring temperature. Care must be taken that the vinyl tubing is not kinked or restricted in any way. Use light taping pressure to prevent constriction.

2) Installation - Before the schedule 80 PVC casing is placed in the hole, the casing lengths will be laid out on the ground for the total hole length in the order that they will be installed. Each length will be numbered with a marker. The bottom casing length is to be slotted by hand by drilling holes through the casing wall. This will allow a bailer to be lowered through the casing in the event that perched water collects and can be collected at the bottom of the well. The vinyl tubing and thermistor strings will be prepared and laid out on the ground next to the casing as it will be installed in the hole. The tubing will need to be cut into the specified interval lengths or adjusted if necessary. The thermister strings have already been prepared and soldered together at the specified intervals. The locations of the instrument clusters will be marked on the respective sections of casing. The end of the tubing termination at the instrument interval will then be wrapped with a nylon fine filter fabric that will be fitted over the tubing and secured with electrical tape to prevent slippage.

The casing, with pre-attached wire and tubing bundles will be hand-lowered into each drill hole. The instrument clusters will be positioned at the specified depth interval or adjusted if necessary if the borehole falls short of the expected depth. The thermister instrument strings can be shortened by creating a loop between intervals or by cutting the wire at the base of the thermister and sealing the bottom hole with electrical tabe and silicon sealant. Four to six lengths of tubing will be cut to length according to the specified monitoring intervals. If adjustments are needed after cutting the lengths the tubing can be shortened by cutting or lengthened by using a tubing connector.

As the PVC sections are installed, the tubing and thermistor strings will be attached by taping them to sections that correspond to the specified monitoring depths after the section is threaded to the pipe already lowered into the hole. Care must be taken not to twist the installed tubing and thermistor string. The final PVC casing should protrude approximately three feet above existing grade and allow access for water sample collection. When not in use the casing should be capped to prevent rain and particle entry.

3) Backfilling – Once the PVC casing is completely in place and the instrumentation clusters are installed, terminated, and secured at the collar of the hole, annular backfill materials will be installed through the dual-wall drill casing as it is being removed from the boring. Figure C-3 illustrates the backfill layers of silica sand and bentonite, that will be installed. Each instrumentation cluster will be isolated around the PVC casing with silica sand in the instrument zone placed between layers of 6 to 24 inches of bentonite to prevent air from flowing up the sand column. The areas between the instrument zones will be backfilled with sand. The annulus between the inside and outside walls of the hammer drill will provide the conduit for the materials as they are poured down the hole from the collar.

4) Hole Completion – After the drill casing has been removed and the hole is completely backfilled, the drill rig can move off of the site. A 2-foot diameter, 4-inch thick, concrete cap will be placed around the PVC casing at the collar of the hole, finished with a slope away from the casing to divert water.

5) Terminations – The four to six vinyl tubes and the thermistor string will be connected to a metal, weather-proof and secure terminal enclosure equipped with monitoring ports. The terminal box will be mounted on a metal post driven at least 1 foot into the stockpile surface. A diagram of a typical monitor well installation and terminal station layout is shown in Figure C-3.

Documentation of the final well completions will be provided in a separate as-built report. The temperature and oxygen monitoring results will be conducted to fulfill the requirements of DP-1341, Conditions 50 and reported quarterly and submitted as required by Condition 58.

C-3.4 Stockpile Open-Cut and Surface Sampling

The south and east slopes of No. 1C and 1A stockpiles are currently being excavated to remove stockpile material from Oak Grove wash and to reduce the outslope angle of the stockpile. Eight grab samples from the bench faces of open bulldozer cuts into the No. 1C stockpile, where the stratigraphy of the stockpiles is exposed, has also been collected by Golder Associates Inc. (Wythes 2004) for the slope stability analysis. Samples were collected in 5 gallon plastic buckets (approximately 30 to 50 pounds of material). Spectral International Inc. (SII) also collected 20 samples were collected from the No. 1C Stockpile open cuts and from the surface of the No. 1 Stockpile. These samples were collected for reflectance spectroscopy analysis (Peters 2004) according to SII's SOP 41. During stockpile open cut and surface sampling, an attempt was made to collect samples from representative geology, alteration and mineralization codes, although their identification may be complicated by the development of weathering and leaching products.

Sample locations were surveyed using a GPS unit along with an altimeter and data recorded in the field logbook. The sample location coordinate system format will be UTM/UPS using the appropriate datum. These data were entered into the Tyrone Mine GIS. Physical descriptions of the exposures, including color, cementation, degree of leaching/weathering, grain and clast size, texture, and moisture content, were recorded in the field notebook. Mineralogy and lithology of the larger clasts will also be described and recorded and samples were also assigned a mineral assemblage type(s), according to the Tyrone ore control system.

During phase II investigations, additional samples of stockpile materials will be collected from trenches at selected locations around the mine site where open cuts have exposed the stratigraphy of the stockpile. Samples will be collected in 5 gallon plastic buckets (10 to 50 pounds of material), where possible, from cuts that expose the interior stratigraphy of the stockpiles. Where these cuts do not exist, samples will be collected from depths 1 to 2 feet below the surface of the stockpiles. Other sampling procedures are the same as those described for boreholes above.

All samples were sent to analytical laboratories under chain-of-custody to analytical laboratories for mineralogical and bulk composition analyses as described in Section C-5 below.

C-4 Geochemical and Geophysical Borehole Logging

Geochemical and geophysical logging was conducted in 2 sonic boreholes and in 1 Becker borehole by Schlumberger wireline logging and testing. The types of downhole logs conducted include the following techniques:

Elemental Capture Spectroscopy Sonde (ECS)

Downhole neutron activation technique for Si, Ca, Fe, S, Ti, Gd, and Al (calc), Cu (0.14 weight percent (wt%)) and Ni (0.04 wt%) for determination of,

- Mineralogy and lithology
- Specific gravity

LithoDensity Tool (LDT)

Gamma-Gamma technique for measurement of electron density and transform to bulk density, which also can be converted porosity using grain and fluid density.

- Bulk density
- Porosity

Compensated Neutron Tool (CNT)

Epithermal neutron-neutron for moisture in vadose zone or porosity in saturated media that measures water (H_2O) and hydroxyl (OH) content for determination of

- Formation moisture or porosity
- Lithology
- Clay content and stratigraphic correlation

Natural Gamma Ray Spectrometry Tool (NGT)

Gamma ray activity from K, U, and Th for

- Mineralogy determination
- Shale and clay content
- Igneous rock recognition

Cased Hole Formation Resistivity (CHFR)

Resistivity measurement in steel cased holes for detection of moisture and salinity

- Moisture content
- Salinity/total dissolved solids (TDS)

A description of the ECS (formerly known as the Geochemical Logging Tool), LDT, CNT, and NGT applications to downhole logging of porphyry copper deposits can be found in (Nelson and Johnston 1994). The CHFR is a relatively new tool for resitivity testing of cased formations but is based on the same principals as open hole resistivity logging . Essentially the nuclear and electromagnetic scans extend through the drill casing from a few inches to approximately one foot into the formation and provides a continuous profile of the in situ stockpile stratigraphy.

Schlumberger conducted downhole logging with specialized cable tools in boreholes TBGC-6, TSGT-1, and TSGT-3, after the borehole was terminated. The drive was disconnected from the drill steel and a wireline suspended from the drill rig will be used to lower the instruments down the hole with the outer casing still in place. For logging conducted in GSGT-3, a boom truck crane or another drill rig was positioned over the hole to support the down hole cable tools. The logging tools employed in each hole were varied depending upon the type of conditions expected in the hole.

C-5 Geochemical Characterization Analyses

This section describes the methods used for:

- Sample preparation
- Paste pH and paste EC
- Modified ABA testing
- Quantitative XRD mineralogy
- Reflectance spectroscopy
- Petrographic analyses
- Bulk material composition via XRF
- Meteoric water mobility procedure and kinetic testing

Table C-2 summarizes the laboratory analysis and testing methods used for sample characterization. These methods are described in sections C-5.1 through C-5.8 below.

C-5.1 Sample Preparation

The samples were sent to SVL for preparation according to the type of analysis or test to be conducted. Sample splits will be derived for each type of material analysis and test. For each bulk sample received by SVL, the plus and minus 2 inch sieve fractions weights will be measured and recorded as part of the MWMP procedure (see Section C-5.8 below). Moisture content will also be determined as part of the

MWMP procedure prior to conducting other analyses and testing. Sample preparation may include crushing of sample splits by mechanical means into pulps for bulk chemical analysis.

C-5.2 Paste pH and Paste Electrical Conductivity (EC)

SVL will conduct paste pH and paste E.C. (Sobek, 1978) analyses on all samples. Paste pH and paste E.C. are effective indicator tests of acid generation and soluble salt content in the sample.

C-5.3 Modified ABA Testing

The static acid production potential of the samples will be determined by Modified ABA analysis (Sobek 1978). ABA determines acid-generation potential (AGP) from sulfide minerals and the acid-neutralization potential (ANP) of mine material samples. SVL will conduct the ABA tests and also determine sulfide sulfur, sulfate and total sulfur in each sample.

C-5.4 Quantitative XRD Mineralogy

Quantitative x-ray diffraction will be used to determine the major mineralogical compositions of the bulk samples, using the following methods at Pittsburgh Mineral and Environmental Technology (PMET 2004). Qualitative XRD identification of clay-sized particle fractions will also be conducted by PMET.

A two-gram aliquot obtained from each sample using a riffle splitter will be pulverized for quantitative XRD analysis. Each sample was scanned using a Siemens D500 diffractometer with a Solex solid-state x-ray detector. Pattern calibration and amorphous content was determined using a standard spike of approximately nine percent rutile. Quantification of crystalline phases and total amorphous content was determined using the Topas-R Rietveld refinement software.

The remaining sample material was slurried in de-ionized water in a beaker using an ultrasonic probe. The material was allowed to settle for two days. The clay fraction was removed from the top using a pipette and deposited on glass slides. The samples were run as-is, after glycolation, and after heating at 400ºC for 40 minutes. The combined patterns for each clay sample will be reported in diffraction patters and in tabular formats. Moore and Reynolds (1989) also provide a general description for clay XRD analysis and mineral identification procedures.

C-5.5 Reflectance Spectroscopy

Reflectance spectroscopy is a rapid way to characterize and monitor mineralogical properties and changes in mine wastes. Spectral International Inc. (SII) will conduct reflectance spectroscopy on stockpile samples according to SII's SOP (SII 2003) for mining site investigations. Reflectance spectroscopy uses the energy in the visible (VIS; 0.4-0.7µm), near infrared (NIR; 0.7-1.3µm) and short-wave infrared (SWIR; 1.3-2.5µm) wavelength regions of the electromagnetic spectrum to analyze materials. Certain atoms and molecules absorb energy as a function of their atomic structures. The manifestation of this takes the form of a reflectance spectrum, with absorption features, positions and distinctive profiles that can be used to identify mineral and organic phases. Using field spectroscopy, spectra are collected in seconds and large dumps and waste piles mapped quickly and in detail. This is a critical consideration because mineralogy of unstable phases can change dramatically with exposure to drying or different chemical conditions, such as exposure of leach pad drill cuttings to the atmosphere. Some minerals also change structure and composition during grinding and other sample preparation techniques. Spectroscopy detects the alteration and weathering minerals in dumps and waste piles, both those originally in the waste rock and those produced during residence in the piles. The various iron and copper sulfates and oxides found in these environments are very diagnostic of the pH and fluid flow through the piles. Because many of them are amorphous, the infrared technique is very successful as it can see these “species” whereas XRD cannot. However, it is more difficult to identify and quantify primary gangue and ore minerals through reflectance spectroscopy. Hence, quantitative XRD and reflectance spectroscopy are complementary tools for materials characterization.

C-5.6 Petrographic Analysis

Rock chip and grain mounts from selected samples will be used for petrographic analysis using light optical microscopy (LOM). Scanning electron microscopy may also be performed in addition to LOM on selected samples using the techniques described in Brink et al. (1992).

C-5.7 XRF Analysis

The chemical composition of the bulk stockpile samples was determined through XRF. Rollinson (1993) and Crock et al. (1999) provide detailed discussions on the application of XRF to whole rock compositional analysis. The bulk sample analyses will include the concentrations of major elements (SiO_2, TiO_2, Al_2O_3, Fe_2O_3, MnO, CaO, MgO, K_2O, Na_2O, P_2O_5), loss on ignition (LOI)) and selected trace metals (V, Cr, Ni, Cu, Zn, Ga, As, Rb, Sr, Y, Zr, Nb, Ba, Mo, Pb, Th, and U).

C-5.8 MWMP and Kinetic Testing

Stockpile samples will also be subjected to a static leach test using MWMP according to ASTM E2242-02. This test was developed by the Nevada Department of Environmental Protection (NDEP 1990) to simulate the interaction between percolating meteoric water and mined materials. The test is designed to determine the mobility of chemical constituents from soluble salts generated by leaching and weathering in mined material stockpiles and heap leaching operations. The leach extracts and any will be measured for the following parameters or constituents: electrical conductivity; pH; TDS; total alkalinity; bicarbonate (HCO^{3-}); carbonate (CO_3^{-2}); free acidity; sulfate (SO_4^{-2}); and other constituents of concern (COC) specified in Condition 56 (a through c) of DP-1341. Oxidation-reduction potential (Eh) will not be measured because the columns are oxidized and do not necessarily represent field conditions. Eh conditions may be determined in the field from stockpile seepage analyses and oxygen monitoring conducted in stockpile boreholes.

Approximately 8 to 12 samples will be selected for kinetic testing according to ASTM D 5744 - 96, including core and stockpile materials. These tests will be conducted for a minimum of 20 weeks, and at least four to six tests will be conducted for a minimum of 50 weeks as requested by the NMED (2003). The leachates from the kinetic tests will be analyzed for the same parameters as the leachate samples from the MWMP tests.

C-6 Data Quality Assurance and Control

The sampling protocols, analytical data quality criteria, and the use of quality assurance/quality control (QA/QC) samples will be conducted according to Greystone's SOP 001 and 003 (Greystone 2003a,b), per ASTM standards (ASTM 1998, 2000), per SVL's Quality Assurance Plan (SVL 2003), and the other analytical and testing laboratory's SOPs cited above. The final compiled materials characterization database will be reviewed by a QA/QC officer. In addition, the data in this study for use in Conditions 78, 81, and other Conditions in DP-1341 will also be subject to the data quality objectives described in this SAP.

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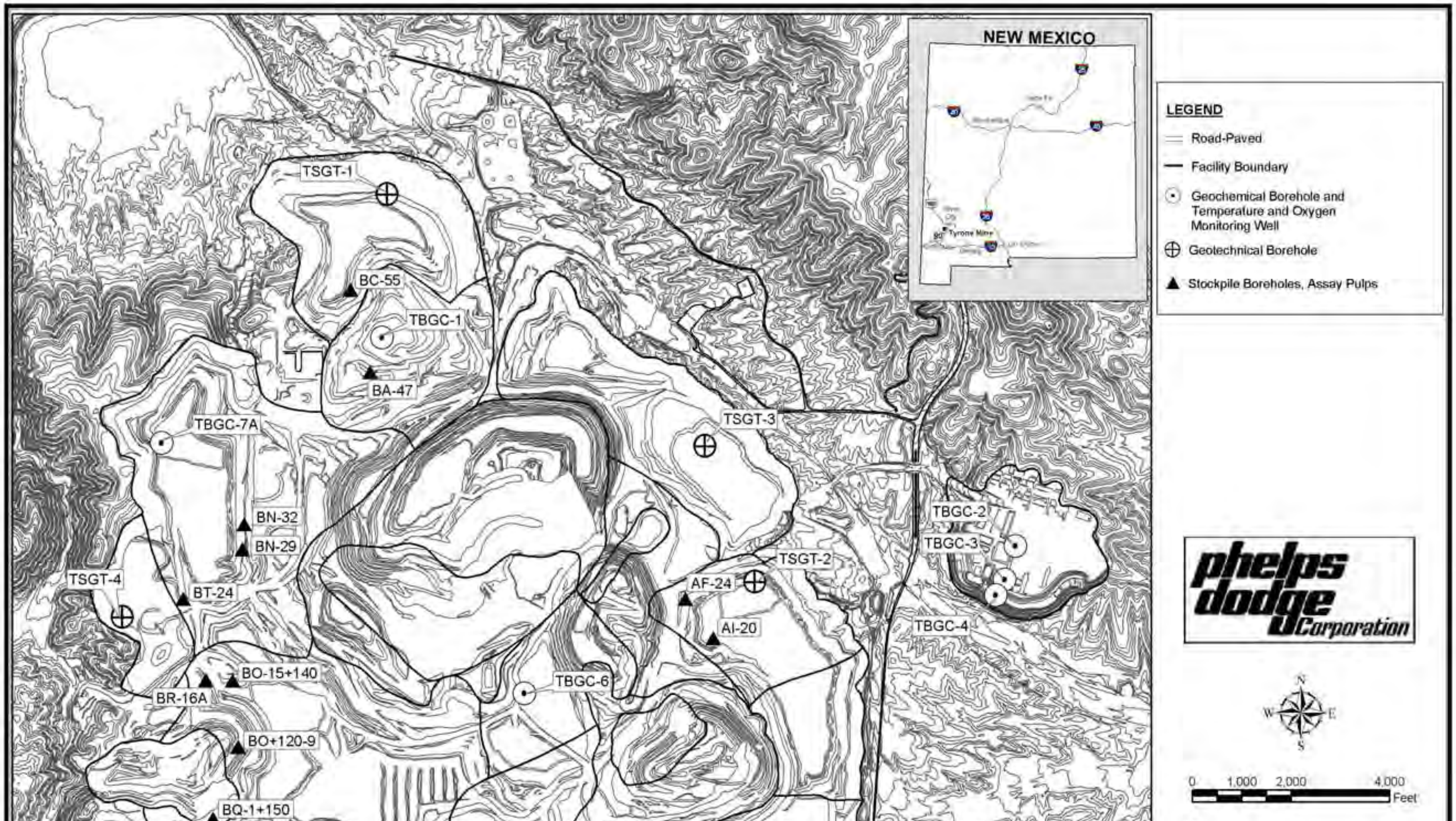
Table C-1. Archived Stockpile Borehole Samples Selected for Supplemental Materials Characterization.

Stockpile	Borehole	Total Depth Sampled	Sample Analyses Completed
1B	AI-20	0-157	ANP, paste_EC, paste_PH, S_NonExtract, S_Pyritic, S_Pyritic_AGP, S_Pyritic_NNP, S_Sulfate, S_Total
	AF-24	0-107	ANP, paste_EC, paste_PH, S_NonExtract, S_Pyritic, S_Pyritic_AGP, S_Pyritic_NNP, S_Sulfate, S_Total
2A	BN-29	0-17	ANP, paste_EC, paste_PH, S_NonExtract, S_Pyritic, S_Pyritic_NNP, S_Sulfate, S_Total
	BN-32	0-15	ANP, paste_EC, paste_PH, S_NonExtract, S_Pyritic, S_Pyritic_NNP, S_Sulfate, S_Total
2B	BT-24	0-72	ANP, paste_EC, paste_PH, S_NonExtract, S_Pyritic, S_Pyritic_AGP, S_Pyritic_NNP, S_Sulfate, S_Total
	BR-16A	0-189	ANP, paste_EC, paste_PH, S_NonExtract, S_Pyritic, S_Pyritic_AGP, S_Pyritic_NNP, S_Sulfate, S_Total
2C	BO-15+140	0-312	ANP, paste_EC, paste_PH, S_NonExtract, S_Pyritic, S_Pyritic_AGP, S_Pyritic_NNP, S_Sulfate, S_Total
	BO+120-9	0-120	ANP, paste_EC, paste_PH, S_NonExtract, S_Pyritic, S_Pyritic_NNP, S_Sulfate, S_Total
3A	BC-55	0-331	ANP, paste_EC, paste_PH, S_NonExtract, S_Pyritic, S_Pyritic_AGP, S_Pyritic_NNP, S_Sulfate, S_Total
3B	BA-47	0-256	ANP, paste_EC, paste_PH, S_NonExtract, S_Pyritic, S_Pyritic_AGP, S_Pyritic_NNP, S_Sulfate, S_Total
4B	BG-07	0-87	ANP, paste_EC, paste_PH, S_NonExtract, S_Pyritic, S_Pyritic_AGP, S_Pyritic_NNP, S_Sulfate, S_Total
	BJ-07	0-67.3	ANP, paste_EC, paste_PH, S_NonExtract, S_Pyritic, S_Pyritic_AGP, S_Pyritic_NNP, S_Sulfate, S_Total
4C	BN-011	0-159	ANP, paste_EC, paste_PH, S_NonExtract, S_Pyritic, S_Pyritic_AGP, S_Pyritic_NNP, S_Sulfate, S_Total
4D	BQ-1+150	0-27	ANP, paste_EC, paste_PH, S_NonExtract, S_Pyritic, S_Pyritic_AGP, S_Pyritic_NNP, S_Sulfate, S_Total
7A	I-07	0-6	ANP, paste_EC, paste_PH, S_NonExtract, S_Pyritic, S_Pyritic_AGP, S_Pyritic_NNP, S_Sulfate, S_Total

Table C-2 Analytical Method Descriptions

Test	Method	Description
Paste pH and paste electrical conductivity (EC)	Sobek (1978)	Effective indicator tests of acid generation and soluble salt content.
Acid Base Accounting (ABA)	Sobek (1978)	Static test evaluating acid generating potential of mine materials
X-ray Diffraction (XRD)	PMET (2004)	Quantifies relative abundance of major and minor mineralogical components.
Reflectance Spectroscopy	SII SOP (2003)	Characterizes mineralogical properties of alteration and weathering products.
Light Optical microscopy	Brink et al. (1992)	Identifies the alteration mineralogy, paragenetic sequence and texture.
Scanning electron microscopy	Brink et al. (1992)	Identifies the alteration mineralogy, paragenetic sequence, texture, and mineral composition.
X-ray Fluorescence (XRF)	Rollinson (1993), Crock et al. (1999)	Characterizes the whole rock chemical composition of the sample.
Meteoric Water Mobility Procedure (MWMP)	ASTM E 2242-02	Static leach test designed to assess the mobility of chemical constituents during leaching and weathering of mined materials.
Kinetic testing (Humidity Cell Testing - HCT)	ASTM D 5744-96	Kinetic test providing reaction rates and depletion times for sulfide minerals in stockpile material.



Source: Tyrone Mine Coverages, Bill Seibert, 2004

GREYSTONE®

TYRONE MINE

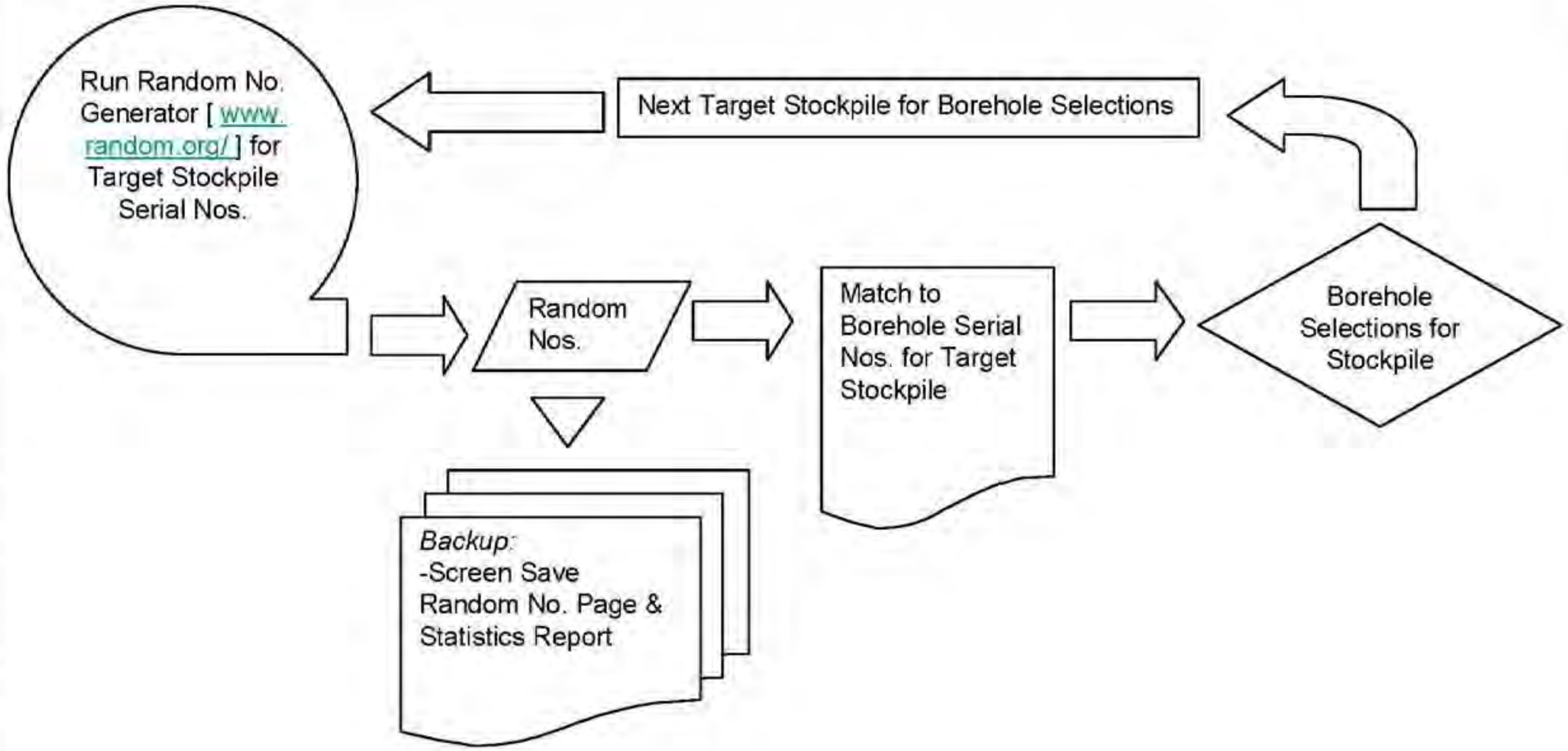
DP-1341, CONDITION 80
SUPPLEMENTAL MATERIALS
CHARACTERIZATION

FIGURE C-1
STOCKPILE
CHARACTERIZATION
LOCATIONS

ANALYSIS AREA: Tyrone Mine, Grant County, New Mexico
Date: 10/28/04
Drawn By: JMR
File: [illegible]

DRAFT

GREYSTONE®



W:\Projects\1490\Graphics\InterimReport\\StockpileBoreholeSelectionMethod.ppt

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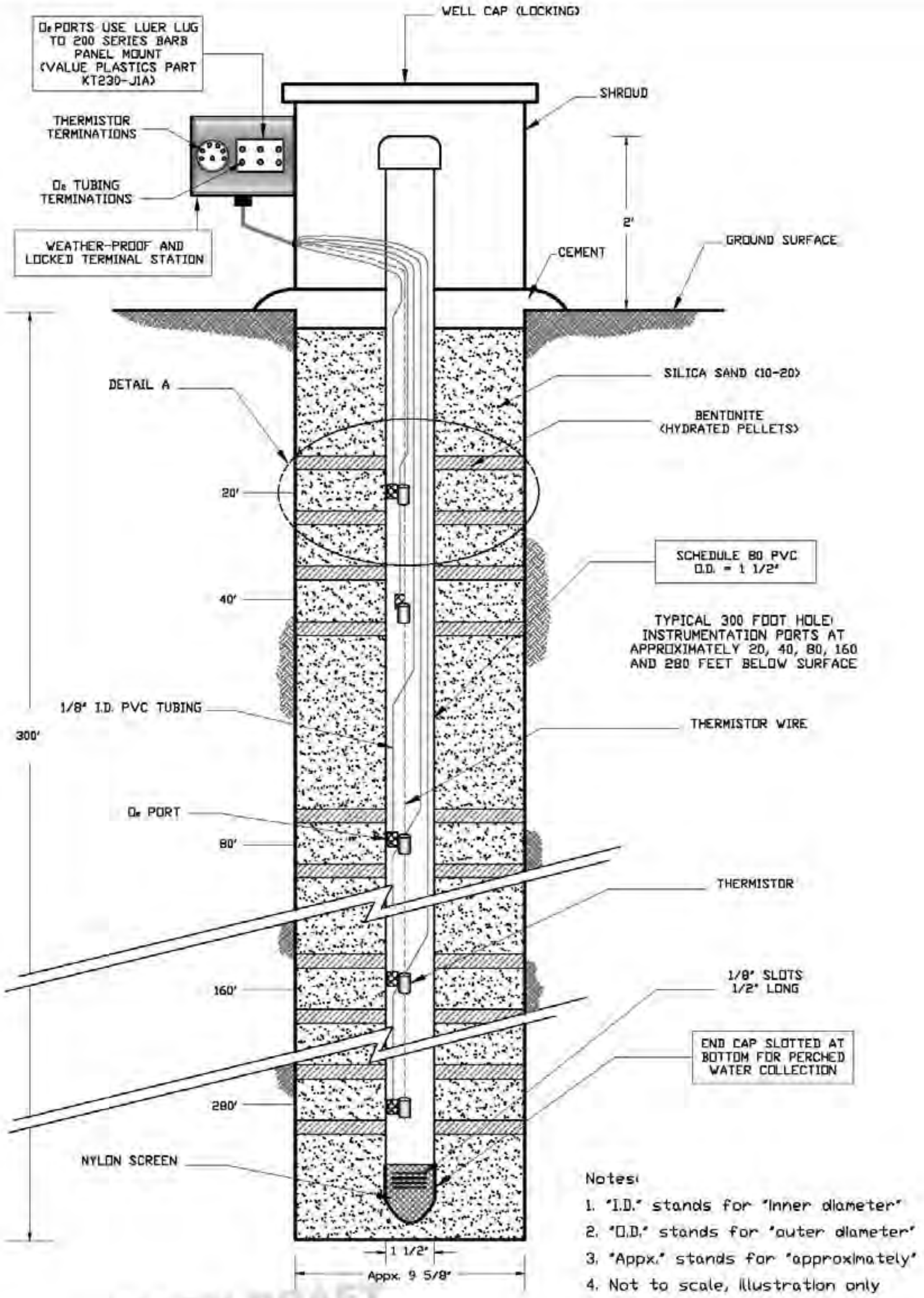
TYRONE MINE, DP1341, CONDITION 80
SUPPLEMENTAL MATERIALS CHARACTERIZATION STUDY

Stockpile Borehole Selection Method

Figure C-2



File Path: <Report Root Path>\SuppMatlChar\Tyrone InterimRpt04\Appendix C Tyrone SAP04\1490.05 TypicalMonitoringWell Installation C-3.dwg

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TYRONE MINE DP-1341, CONDITION 80
SUPPLEMENTAL MATERIALS CHARACTERIZATION
SCHEMATIC – TYPICAL MONITORING WELL INSTALLATION

Figure C-3

SPECTRAL INTERNATIONAL INC

STANDARD OPERATING PROCEDURE NO. 41

SAMPLE ANALYSIS BY REFLECTANCE SPECTROSCOPY

STANDARD OPERATING PROCEDURE NO. 41

SAMPLE ANALYSIS BY REFLECTANCE SPECTROSCOPY

REVISION LOG		
Revision Number	Description	Date
0.0	Original SOP	Nov 30, 2003

1. PURPOSE AND SCOPE

This document outlines the procedures for data collection and analysis of samples using a VIS (visible) through SWIR (Short Wave InfraRed) field reflectance spectrometer. The spectrometer will be used to collect a cross section of samples including 1) in situ field samples, 2) hand samples from rock piles, waste dumps, and pit benches, 3) powders, 4) diamond core, 5) reverse circulation (RC) chips, 6) unmined alteration scars, and 7) trenches. The spectrometer will be used to generate spectra from the various sample types and provide identification of the mineral species present. Where appropriate and possible, paragenetic and environmental information also will be provided. This document addresses equipment operation, calibration, field sampling procedures, field and core data collection procedures, and personnel responsibilities.

2. RESPONSIBILITIES AND QUALIFICATIONS

The Team Leader and selected members of the characterization team will have the overall responsibility for implementing this SOP. The Project Manager will be responsible for assigning appropriately qualified analysts to implement this SOP and for ensuring that the procedures are followed. All personnel performing these procedures are required to have the appropriate MSHA health and safety training.

In addition, all designated personnel are required to have a complete understanding of the procedures described within this SOP, and receive specific training regarding these procedures, if necessary. Only qualified personnel trained on the Analytical Spectral Devices FieldSpec Pro and TerraSpec field spectrometers will undertake the procedures outlined in this protocol.

All field staff and laboratory staff are responsible for reporting deviations from this SOP to the Team Leader.

3. DATA QUALITY OBJECTIVES

The reflectance spectrometer will be used to address objectives 2, 3, 4 and 5 in the data quality objectives outline by Virginia McLemore for the "Geological and Hydrological Characterization at the Molycorp Questa Mine, Taos County, New Mexico". It will provide initial characterization of the minerals present in the different sample media. Other interactions may be added.

- Determine how mineralogy, stratigraphy, and internal structure of the rock piles contribute to weathering and stability.
- Determine if the sequence of host rock hypogene and supergene alteration and weathering provides a basis to predict the effects weathering can have on mine rock stability.
- Determine if cementation forms in the rock piles and how does the cementation contributes to the stability of the rock piles.
- Determine how reactive are pyrite and carbonate minerals so that a representative sample goes into the weathering cells.

4. EQUIPMENT LIST

- The ASD (Analytical Spectral Devices, Inc.) FieldSpec Pro spectrometer and appropriate accessories, including the Mineral Probe and the Laboratory Probe.
- ASD TerraSpec Field Spectrometer and accessories including the Mineral Probe and the Laboratory Probe.
- GPS unit capable of real-time differential correction or post-processing differential correction
- Laptop computer
- Inverter

- Digital camera
- Log book
- Sample bags, plastic containers for fragile samples, and pens
- Basic sampling equipment (rock hammer and gardening trowel)

5. RELATED STANDARD OPERATING PROCEDURES

The procedures set forth in this SOP are intended for use with the following SOPs:

1	Data management (including verification and validation)
2	Sample management (chain of custody)
5	Sampling outcrops, rock piles, and drill core (solid)
6	Drilling, logging, and sampling of subsurface materials (solid)
9	Test pit excavation, logging, and sampling (solid)
24	Petrographic analyses
26	Electron microprobe analyses
27	X-ray diffraction analyses
29	Clay mineralogy analyses
30	Sampling for the Remaining Pyrite Model
37	Microbe sampling
38	DI leach (to be determined)
39	Samples for Pore water measurements

6. PREPARATION

A. SAMPLE SELECTION

Spectroscopy will be used for reconnaissance of all sample types, rapid mineral identification of designated phases and subsequent monitoring processes, before they are subjected to other analyses. To that end, samples will be selected by Virginia McLemore and analyzed at her discretion.

Splits of many of these samples can be sent to Spectral International in Denver. This will minimize travel costs and still provide a comprehensive data set set of spectral information.

Care must be taken in sample selection for spectroscopy to maximize the return from the analysis. The reflectance properties, particle size, degree of sample orientation, presence of surface water and interlayer water, associated organic and inorganic phases, particle orientation, degree of structural ordering, data collection and instrument parameters all influence the spectral curve and absorption features. The profile of the feature is also of great importance as this will change with changes in the listed variables. The reflectance spectroscopy technique is extremely sensitive to alteration minerals such as clays, carbonates and selected sulfates, particularly alunite and jarosite. It can track elemental substitution and changes in order or crystallinity in the minerals. In hydrothermally generated deposits, this is often an indicator of temperature changes in the alteration halo. It is also useful for looking at weathered surfaces, and weathering profiles.

When selecting samples, there are some other things to also consider. Argillized samples are of particular importance. White, soft and oxidized rocks should be examined. Spectra should be collected from veins, outward from veins into the alteration halo, from vugs and vug fillings, from fracture and bedding surfaces, from porphyritic rocks, both matrix, and phenocrysts, and with breccias, clasts and cement. Silica flooded samples should also be analyzed.

B. SAMPLE PREPARATION

Sample preparation for reflectance spectroscopy is usually quite simple.

1.. Outcrop, and hand samples.

These generally require little to no preparation. The most important consideration is a fresh surface. If the sample is to be used for remote sensing ground truth, then weathered surfaces are of interest and spectra should be collected from them also.

A new white reference should be collected before spectra are collected.

2.. Core and Reverse Circulation Samples

Spectra can be collected from rough and sawn surfaces. They can also be collected from the rounded surfaces of unsplit diamond core.

Sawn and rounded core surfaces should be inspected for smeared clay, drilling muds, and hydrocarbon residues, all of which can prejudice the analysis.

Drill chips can be analyzed in two ways. The contact probe for the ASD FieldSpec Pro and TerraSpec has been sized for the plastic chip trays and can be inserted into the top of each compartment and a spectrum rapidly collected. The probe window should be cleaned with a soft kimwipe after each spectrum is collected to remove any residue from the analyzed sample.

The **chips** can also be transferred to a glass Petri dish. The spectrum can be collected in two ways. The contact probe would be used to take a spectrum from the top of the dish, in contact with the powder/chips. The petri dish could be placed on the top of the “Mug Light” accessory, over the sapphire window, and the spectrum collected up, through the glass. This procedure would be chosen when there is a volume of powder in the bottom of the compartment which cannot be analyzed through the chips on top. Please note that the spectrum intensity will be depressed when collected through the glass.

Regardless of the method, there will be some scatter from the angular surfaces of the chips. This should be considered when choosing integration times.

A new white reference should be collected before spectra are collected.

3.. Pulps, Coarse Rejects, Powders

The procedure is as in the above section in that all of these sample media types can be transferred to a petri dish and spectra collected as described by either the probe or the ”Mug Light”.

The probe can be inserted directly into a sample bag or envelope. This is certainly an option that is more rapid then transfer to a petri dish, however, it involves cleaning the probe window and upper housing after each spectrum is collected to remove residual powders.

Also please note that spectra collected from pulps are not as reliable as from other media. In the pulping process, crystallinity can be affected and interpretive and identification information distorted.

A new white reference should be collected before spectra are collected.

4.. Liquids

Spectra can be collected from liquids. The liquid is placed in a petri dish and a back reflector, such as a silver coin (US quarter), is placed into the petri dish in such a fashion that there is a thin layer of liquid between the bottom of the dish and the coin. The dish is placed on the sapphire window of the “mug light” and the spectrum read through the glass.
A new white reference should be collected before spectra are collected.

5. Miscellaneous Sample Media Types

Thin section blanks and polished sections can be used as is. Care must be taken that any resin or glue is not present in the analysis area.

Thin sections and grain mounts can sometimes be used. This is not always successful. There are issues with resin, glue, carbon coasting and transparency. It is necessary to use a silver metallic back reflector with a thin section. Their preparation is covered in SOP #26. Microprobe grain mounts are embedded in resin and may be carbon coated. The coating must be removed. The resin has a specific organic signature.

Oriented clay slides are not recommended. Orientation enhances water features and de-emphasizes the Al-OH bond features

A new white reference should be collected before spectra are collected.

7. PROCEDURES

These procedures are only to be performed by a certified operator.

Two instruments will be used during this project. The ASD FieldSpec Pro and the ASD TerraSpec. The FSP operates with both solar and internal light illumination. The TerraSpec is internal light illumination only.

OUTLINE of PROCEDURES

1.. Sample Number Designations

There are two types of samples used in the spectral analysis protocols.

A..Those samples collected by all groups
B.. Samples collected originally by Peters and Hauff

Category “A” will have sample numbers assigned. These will be subset to eight characters relative to a protocol designated by the Team Leader. These samples will be logged with information required as described in the form in SOP #40.

The current sample Number sequence is:
XXX_YYY_0000

Category “B” will follow the defined protocol and then subset to eight characters.

2..Spectrometer is set up, optimized and calibrated

3..Analyzing Core Samples

A. Core has been split
B. Digital picture is taken
C. Print is made

D. Spectra are collected for the core

E. Data collection points are marked on picture as collected

It would be preferable to do this in the computer as work progresses

OR data points are marked on the digital file after sample collection

F. Excel file is created

Fields include: Sample ID # and ASD File #; minerals; description of sample.

See Appendix A for example of form.

G. Information is entered into the Excel file as the spectra are collected.

H..Spectra are interpreted

This is done initially as spectra are collected and then re-checked later.

4.. Analyzing Hand Samples

These would include powdered samples, coarse rejects, pulps, trench, scars, pit samples. Please note that it is preferred that samples are analyzed by IR before pulping occurs.

A. Picture taken of sample site – if applicable
B. Spectra collected, logged and interpreted as described above
C. GPS coordinate collected

A. ASD FieldSpec PRO Operating Procedure

Margaret Skokan – ASD Technical Support Chief

- ***VERY IMPORTANT*** The ASD instrument must be turned on before the laptop.
- Warm up the instrument for at least 15 – 30 minutes (with very frequent DC collection or re-optimization during the first hour; ie. every 5 – 10 minutes) – this gives each spectrometer a chance to stabilize to the temperature both internal and external to the system components and allows for “clean” data captures.
-
- After the ASD has warmed up, connect the power and parallel cables to the laptop securely.
-
- Turn on the computer and allow Windows to boot.
-
- Double-click on the FR icon located in the lower left corner of the desktop to launch the software to operate the ASD device.
  - For operations in fairly direct sunshine, it is recommended that the high contrast (BW) version be used to minimize the effects of glare.

- Open up the Spectrum Save option screen by selecting **Alt S** or **Spectrum Save** on the toolbar and enter the following details:

1. Path Name - enter the directory and folder path where you want files to be saved. An ideal way of doing this is to use the current month, day, and year to name the files in the selected directory. EX: C:\090999
2. Base Name – enter the name that will be used for each data file collected by the ASD. As data is saved, the file extension will sequence in numerical order. For example, if the first file was named C:\090999\SPECTRUM.000, the next file saved would be C:\090999\SPECTRUM.001.
3. Starting Spectrum # - this will be automatically done based upon data you may have already collected with the same Path and Base name. Up to 1000 spectra can be saved with the same Base Name (unless you choose the hexadecimal option; in this mode you can save 4,096 spectra with the same Base Name)
4. # of Files to Save – activated by the space bar

5. Interval Between Saves – can be used for multi-spectra save sessions; may be useful when the user's shadow might interfere with data collection

6. Comment – can add any notes: time of year, weather conditions, illumination source, etc…

- Once the **Spectrum Save** information is complete, select **OK** to accept the changes and close the window.

- Next, select **Alt C\C** or **Control Menu\Adjust Configuration** and enter the following details:

1. Foreoptic Type (you may also choose the foreoptic type by using the pull down arrow list on the FSFR toolbar located top center)

   The default for this project is "bare fiber".

2. Spectrum, Dark Current, and White Reference averaging values; an averaging value anywhere between 10 – 25 is recommended (For more detailed info on averaging values refer to Spectrum Averaging and Noise in the FSFR Pro User's Guide, pg. 13-15)

   For this application:

   400 will be used for the white reference
   25 for the dark current
   30-200 for the sample depending on how light or dark colored the material is

- Once the **Adjust-- Configuration** information is complete, select **OK** to accept the changes and close the window.
-

Chose the foreoptic, illumination conditions and viewing geometry best suited for the environment you are collecting data in (For more detailed info on Techniques and Instrumentation refer to the FSFR Pro User's Guide, pg. 38,46-48, & 54-67)

-
- The source and/or target must **fill** the FOV. Also keep in mind that the foreoptic you have chosen will directly effect your ASD file header information and the 'type' of data you are collecting. In other words, the correct foreoptic designation is essential.
  -

Taking relative reflectance measurements

-
- Attach the **Mineral Probe** to the bare fiber optic. Insert the fiber optic cable first into the Probe.

  Please note that the spiral collar or strain protector is unscrewed first and the FO is threaded through it. The FO is pushed to a stop and held there while the collar is screwed back into place. This holds the FO tightly in the proper geometry for taking a measurement. Pull gently on the FO cable when the collar has been tightened down to be assured that it is held securely.

  The collar in the picture is shown as plastic. Metal strain protectors are preferred as they offer more protection to the fragile fiber optic cable.

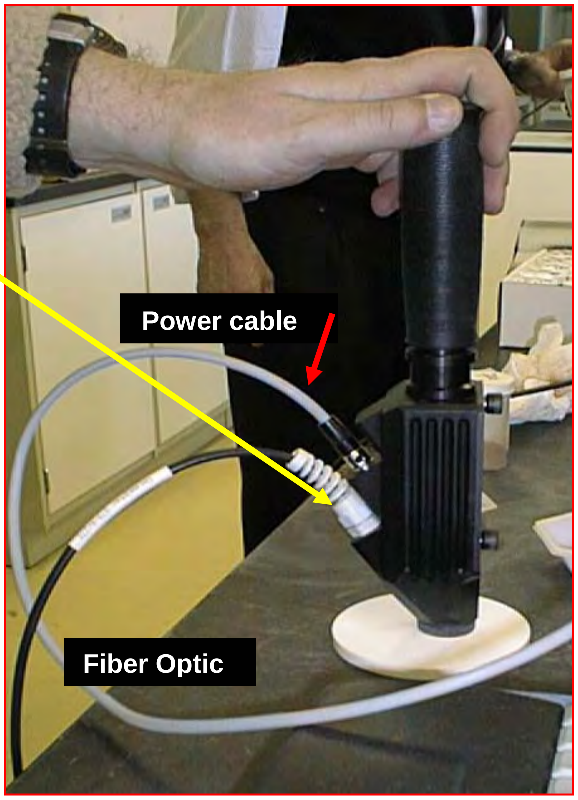

Figure 1 – Mineral Probe and White Reference.

The power cable is attached next, first to the probe and then to the power outlet panel on the FR. Depress the power button to test that the light has power.

The “Mug Light” is connected to the spectrometer in a similar fashion.

Positioning the FO is a more delicate procedure as it is inserted into a hole in a metal plate in the middle of the “mug”.

It must then be held in place as the collar is tightened.

The rest of the procedure is the same as with the Mineral Probe.

Figure 2 – Mug Light or Laboratory Probe.

OPTIMIZING AND WHITE REFERENCE CALIBRATION

Internal Light Source White Reference (WR) Calibration

- First “Adjust Configuration” as described above.

- Turn the light on to the Mineral Probe.

- Place the Mineral Probe in direct contact with the surface of the white reference as shown in Figure 1.

- Optimize the instrument by clicking **Control O** or the **OPT** button in the upper left of the screen.. It is good practice to re-optimize or recollect a WR at least every hour, unless the instrument is moved or sample conditions vary greatly.

    The number of spectra averaged for the White Reference should be twice what is used as an average for the sample.

    For instance – samples collected at an average of 30 spectra to average should have a white reference collected at at least 60 spectra.

- Press any key to continue when the screen prompts you to collect a dark current.

- Press any key to continue, again, when prompted. You will notice that the graph on the screen is displaying measurements in raw digital numbers, DNs, (vertical axis) and plotting them against wavelength in nm (horizontal axis). Three distinct raw DN peaks should be visible, representing three spectrometer regions: VNIR (350 – 1000nm), SWIR1 (1000 – 1700nm), and SWIR2 (1700– 2500nm)

Click **F4** or the **WR** button in the upper left of the screen, adjacent to the **OPT** button. Again the instrument will collect dark current just as it did while optimizing. After a few seconds a fairly straight line should be displayed on the graph at a Reflectance value of 1.00. If this line is particularly noisy, insure your illumination conditions and viewing geometry are suitable and repeat the optimization with a higher averaging number for the number of spectra collected for the white reference.

Also take note that if you re-optimize it will also be necessary to take another WR in order to get back into Reflectance mode. Notice that in Reflectance mode the vertical axis data is now listed as Reflectance instead of raw DN.

You are now ready to **collect spectra from the sample**.

- Hold the Mineral Probe against the sample target. The displayed spectrum you see will be the relative reflectance (x axis is wavelength in nm and y axis is % reflectance).

- Press the space bar to record the target spectrum data to disk. You should hear a beep after the data has been saved.

- Because it is not always apparent whether a spectra is over-saturated or not in Reflectance mode, it is good practice to scroll back to raw DN mode before an important data capture or collecting a WR (if you have opted not to re-optimize) to insure your data is within range by using the pull down arrow menu on the FR Toolbar that illustrates the data type represented on the graph. If an area is saturated and any part of the Raw DN graph is cut-off, simply re-optimize. Saturated data collected in any region is useless.

Solar Illumination:

- Point the bare fiber or attached fore-optic at the white reference in such a way as to maximize illumination – this will be oriented horizontally for most applications - and have only the reference in the probe tip or foreoptic FOV
- Optimize the instrument by clicking **Control O** or the **OPT** button in the upper left of the screen. The graph will flicker while the instrument optimizes for the present lighting conditions. Be sure not to cast a shadow on the white reference or sample you intend to capture data on while optimizing or collecting spectra. It is good practice to re-optimize or recollect a WR every 15 – 20 minutes, or more often if the illumination or viewing conditions have altered (ie. cloud cover, drastic humidity changes, sun position, etc…) In fact, re –optimizing before every bulk set of data captures is recommended.
- Press any key to continue when the screen prompts you to collect a dark current.
- Press any key to continue, again, when prompted. You will notice that the graph on the screen is displaying measurements in raw digital numbers, DNs, (vertical axis) and plotting them against wavelength in nm (horizontal axis). Three distinct raw DN peaks should be visible, representing three spectrometer regions: VNIR (350 – 1000nm), SWIR1 (1000 – 1700nm), and SWIR2 (1700– 2500nm)
- Click **F4** or the **WR** button in the upper left of the screen, adjacent to the **OPT** button. Again the instrument will collect dark current just as it did while optimizing. After a few seconds a fairly straight line should be displayed on the graph at a Reflectance value of 1.00. If this line is particularly noisy, insure your illumination conditions and viewing geometry are suitable and repeat the optimization. Also take note that if you re-optimize it will also be necessary to take another WR in order to

get back into Reflectance mode. Notice that in Reflectance mode the vertical axis data is now listed as Reflectance instead of raw DN.

- Now, hold the bare fiber or the attached fore-optic above the sample targets with the same orientation that was used to take the white reference. The displayed spectrum you see will be the relative reflectance (x axis is wavelength in nm and y axis is % reflectance).
- Press the space bar to record the target spectrum data to disk. You should hear a beep after the data has been saved.
- Because it is not always apparent whether a spectra is over-saturated or not in Reflectance mode, it is good practice to scroll back to raw DN mode before an important data capture or collecting a WR (if you have opted not to re-optimize) to insure your data is within range by using the pull down arrow menu on the FR Toolbar that illustrates the data type represented on the graph. If an area is saturated and any part of the Raw DN graph is cut-off, simply re-optimize. Saturated data collected in any region is useless.

Taking radiance measurements

- Follow the exact steps listed above for taking reflectance measurements however, rather than clicking F4 or the WR button click **F9** or the **RAD** button. It is extremely important to choose the correct foreoptic when capturing real time radiance – the radiance curve is directly linked to very specific calibration files, unique to each foreoptic. The **RAD** button will only be ‘active’ for foreoptics that have been previously radiometrically calibrated on your FSFR instrument. If the RAD button is grayed out, either you do not have radiometric reference files for the foreoptic in use or your reference files have been altered.
- After a few seconds a Radiance curve should now be displayed on the Graph and the vertical axis is now in Radiance instead of raw DN
- If there is an instrument temperature difference between when the calibrated Radiance data files were collected and when the target data is collected you may see a “step” around 1000 and/or 1700nm. Simply click the **PC** (parabolic correction) button in the upper right hand corner of the screen while viewing the Spectralon (for RAD mode only) to correct for the step. (see FSFR Pro Users Guide pg 77 Appendix C for further information)

Taking irradiance measurements

- Follow the exact steps listed above for taking radiance measurements however these measurements are made using the Remote Cosine Receptor (RCR) or other Irradiance foreoptics.
- Keep in mind that the RCR has a FOV of 180 degrees, therefore it is very important to think about the area your FOV has in its scope.

Remember that extraneous shadowing from artifacts such as tree limbs, light poles, or the User can influence the irradiance values collected.

Troubleshooting

- If the operating software seems to lock up or continues to send you back to the Windows environment check the battery state of both the computer and the instrument, along with insuring that the parallel port cable is securely attached to the computer and the instrument.
- At times you may notice that the right most part of the graph will drop out. This can occur when one of the sensors in the instrument has become either becomes too hot or temperature and illumination conditions have altered dramatically. Initially try to re-optimize the device by clicking on the **OPT** button. If the problem persists, try to cool down the instrument.
- If you feel that the data you are getting is incorrect check the following items:
    1. Am I using the correct foreoptic designation?
    2. Are my viewing geometry and illumination conditions optimal? (see FSFR Pro Users Guide pg 38)
    3. Is your FOV viewing only the reference and/or target data – nothing extraneous?
    4. Is my data over-saturated? (look at the raw DN's)
    5. Could the "abnormal" spectra be attributed to $O2$, $CO2$, $H2O$, etc… absorption bands? (see FSFR Pro Users Guide pg 58 - 60)
- Additional troubleshooting tips can be found in the FSFR Pro Users Guide pg 38, 46 – 51, or call ASD's Technical Support Department at (303)444-6522

B..ASD TerraSpec Operating Procedure

The TerraSpec is an internal light source instrument only. The instructions that apply to the FieldSpec Pro for internal light illumination will apply directly to the TerraSpec.

The operating software is the same for both spectrometers. Solar options are not accessed.

Although the TerraSpec has a different physical design, this does not affect operations or data collection procedures. It only impacts the literal physical set up of the instrument.

Spectra for both instruments have the same binary file structure, which can be translated to text or ASCII format.

A. QUALITATIVE ANALYSIS:

Spectra are collected from 350-2500nm, which includes the visible through Near Infrared (NIR) through Short Wave InfraRED (SWIR) region.

Spectra are stored as binary files.

Spectra will be collected from different parts of the rock as noted in a previous section.
Spot identifications will be made of the major and minor phases.
Notes will be made relative to zoning, crystallinity, chemical substitution, water content, degree of oxidation.

Mineral identification is done in several ways. The first is manually by the operator as the spectra are collected.
Second is through the use of the spectral reference libraries contained in the data base program SPECMIN™.
The references and unknowns are imported into the program SpecWin™ where they can be scaled and absorption feature profiles and wavelengths directly compared. See Appendix C for examples of SpecWin.
Third is by the use of the user interactive program FeatureSearch.
In FeatureSearch, unknown spectra are compared against reference spectral libraries. The best success comes from restricted libraries which contain only the minerals known to exist in the area of interest. The user visually chooses the initial best matches based on wavelength position. The computer then compares the references chosen by the user and picks its best matches. It also gives a very approximate semi-quantitative amount for each phase.
The fourth method is the program called SpecWave™, which is still under development. This program is designed to go beyond strict mineral identification and look at chemical changes of minerals through a drill core or across a map of a trench, waste pile, pit bench or outcrop.
The program extracts wavelength values of absorption features and their corresponding intensities within specified wavelength regions. It then plots the intensities as a bar graph down a drill hole or across a distribution of hand samples. Exact wavelengths are annotated.

This information can be further transferred to a GIS system, with GPS coordinates, for contouring and planar display.

B. QUANTITATIVE ANALYSIS

Semi-quantitative analysis can be done by using the feature depths. The spectra are normalized to a 100% baseline and then the depths of the major features are measured from that baseline. This information is extracted into an Excel file and plotted against mineral type and depth.

Another approach is to build weight percent calibration files from materials from the deposit or area of interest. The computer will then compare unknown spectra against these mixtures. This has limited value as only so many combinations of minerals can be created.

It is also possible to computerize this mixing process.

8. SAMPLE HANDLING

Samples will be accessed in different ways for the different types. The majority of the analyses will be done on core, and stockpiled samples.

Core samples will be analyzed from core boxes, which will be removed from storage and transferred to the core shed.

Hand Samples will be analyzed from archived storage or in-situ in the field.

Selected samples may be shipped to Colorado for analysis, in which case, the chain of custody procedures will be in effect.

Samples will be archived at the discretion of Molycorp.

9.. REFERENCES

FieldSpec Pro User’s Guide, Analytical Spectral Devices, Sterling Drive, Boulder, CO.

Hauff, Phoebe L., 2000, Applied Reflectance Spectroscopy; published by Spectral International, Inc., Arvada, Colorado, 493 pages.

SUB-APPENDIX A

Analysis Form

This spreadsheet shows one option for logging data as it is collected. A key is provided to the mineral names. The mineral species will change with different sample suites. The description provided includes, for example, color, textures, habit, degree of oxidation. Wavelengths are recorded when pertinent, especially when tracking chemical substitution or iron mineral mixtures. Several wavelengths may be recorded

This form is flexible and usually changes with different sites and sample media.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	**filename**		**Wave**	**Ill**	**Mus**	**Smec**	**Sil**	**Kao**	**FeOx**	**Jaro**	**AlOH**	**chl**	**bio**	Minerals	Description
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
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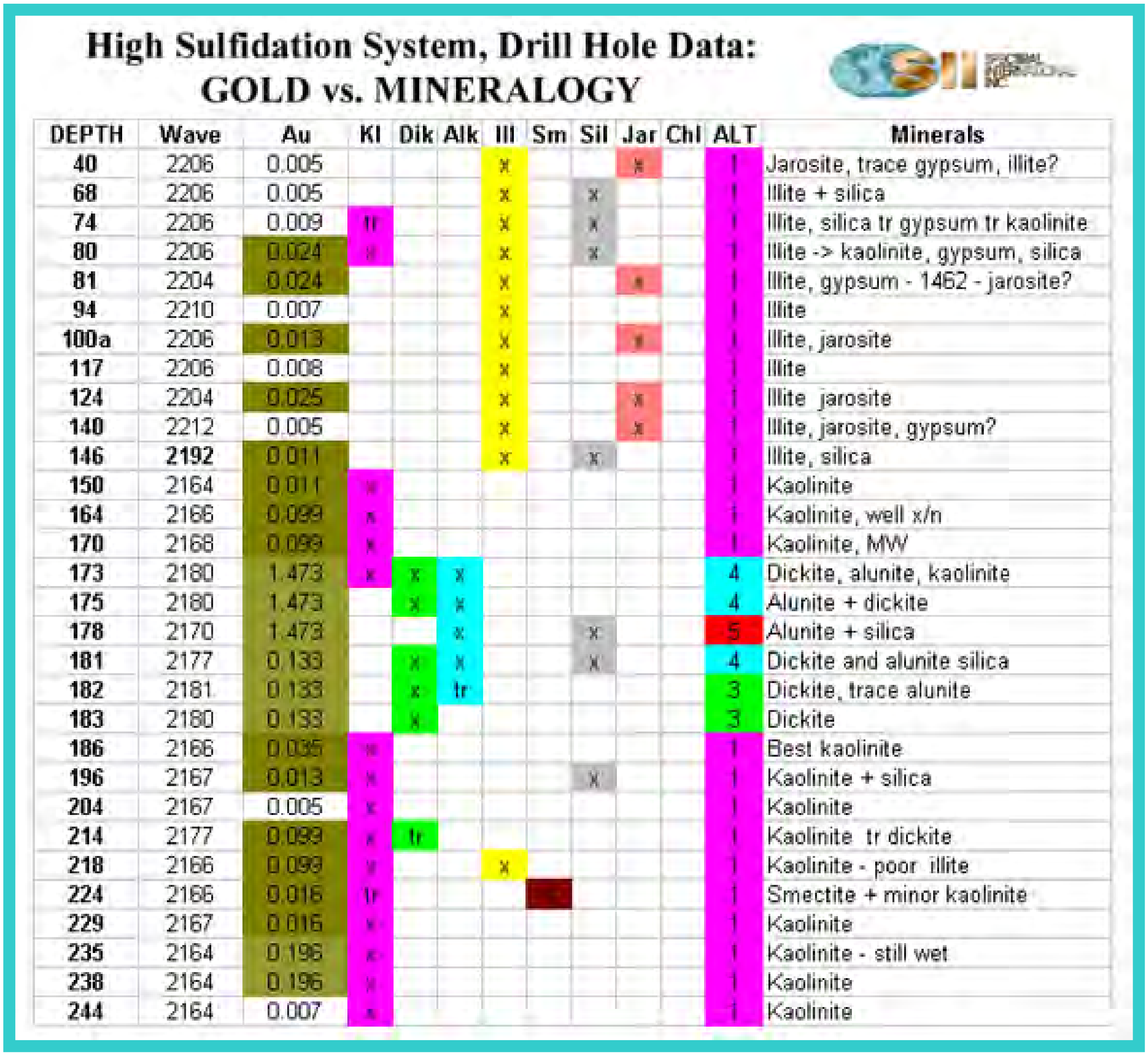
36															..

SUB-APPENDIX B

EXAMPLE of DRILL HOLE PLOT

This is an example of how data can be presented once it is analyzed and logged.



High Sulfidation System, Drill Hole Data:
GOLD vs. MINERALOGY

DEPTH	Wave	Au	KI	Dik	Alk	Ill	Sm	Sil	Jar	Chl	ALT	Minerals
40	2206	0.005				x			x		1	Jarosite, trace gypsum, illite?
68	2206	0.005				x		x			1	Illite + silica
74	2206	0.009	tr			x		x			1	Illite, silica tr gypsum tr kaolinite
80	2206	0.024	x			x		x			1	Illite -> kaolinite, gypsum, silica
81	2204	0.024				x			x		1	Illite, gypsum - 1462 - jarosite?
94	2210	0.007				x					1	Illite
100a	2206	0.013				x			x		1	Illite, jarosite
117	2206	0.008				x					1	Illite
124	2204	0.025				x			x		1	Illite jarosite
140	2212	0.005				x			x		1	Illite, jarosite, gypsum?
146	**2192**	0.011				x		x			1	Illite, silica
150	2164	0.011	x								1	Kaolinite
164	2166	0.099	x								1	Kaolinite, well x/n
170	2168	0.099	x								1	Kaolinite, MW
173	2180	1.473	x	x	x						4	Dickite, alunite, kaolinite
175	2180	1.473		x	x						4	Alunite + dickite
178	2170	1.473			x			x			5	Alunite + silica
181	2177	0.133		x	x			x			4	Dickite and alunite silica
182	2181	0.133		x	tr						3	Dickite, trace alunite
183	2180	0.133		x							3	Dickite
186	2166	0.035	x								1	Best kaolinite
196	2167	0.013	x					x			1	Kaolinite + silica
204	2167	0.005	x								1	Kaolinite
214	2177	0.099	x	tr							1	Kaolinite tr dickite
218	2166	0.099	x			x					1	Kaolinite - poor illite
224	2166	0.016	tr				x				1	Smectite + minor kaolinite
229	2167	0.016	x								1	Kaolinite
235	2164	0.196	x								1	Kaolinite - still wet
238	2164	0.196	x								1	Kaolinite
244	2164	0.007	x								1	Kaolinite

This is a modification of the form seen in Appendix A.
This shows minerals present down a drill hole and alteration type plotted against gold values.

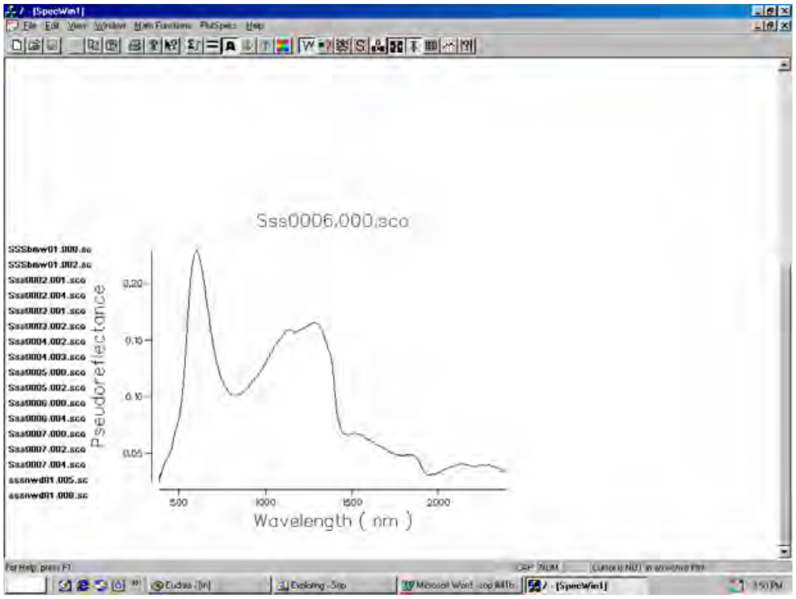
SUB-APPENDIX C

SPECWIN PROGRAM EXAMPLES

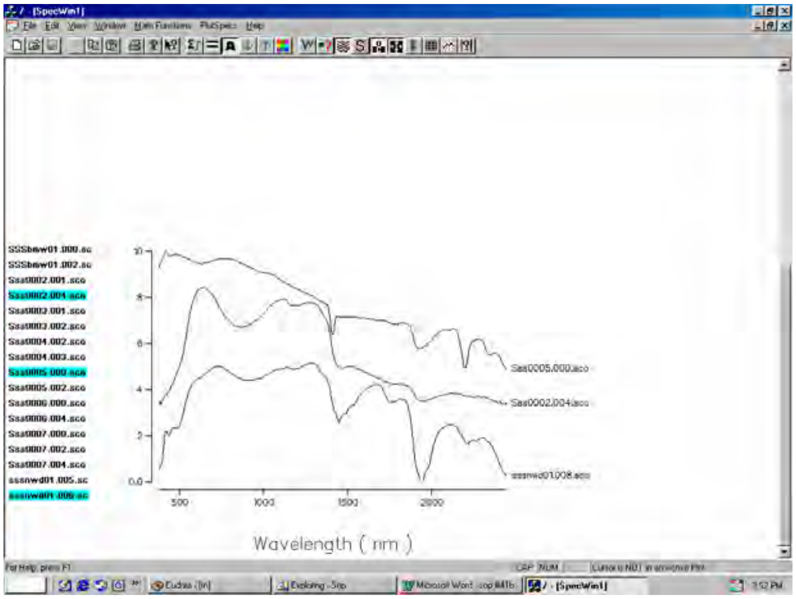
SpecWin Program

This program allows spectra to be displayed, plotted, and exported to reports.

This screen shows the option that displays one plot.

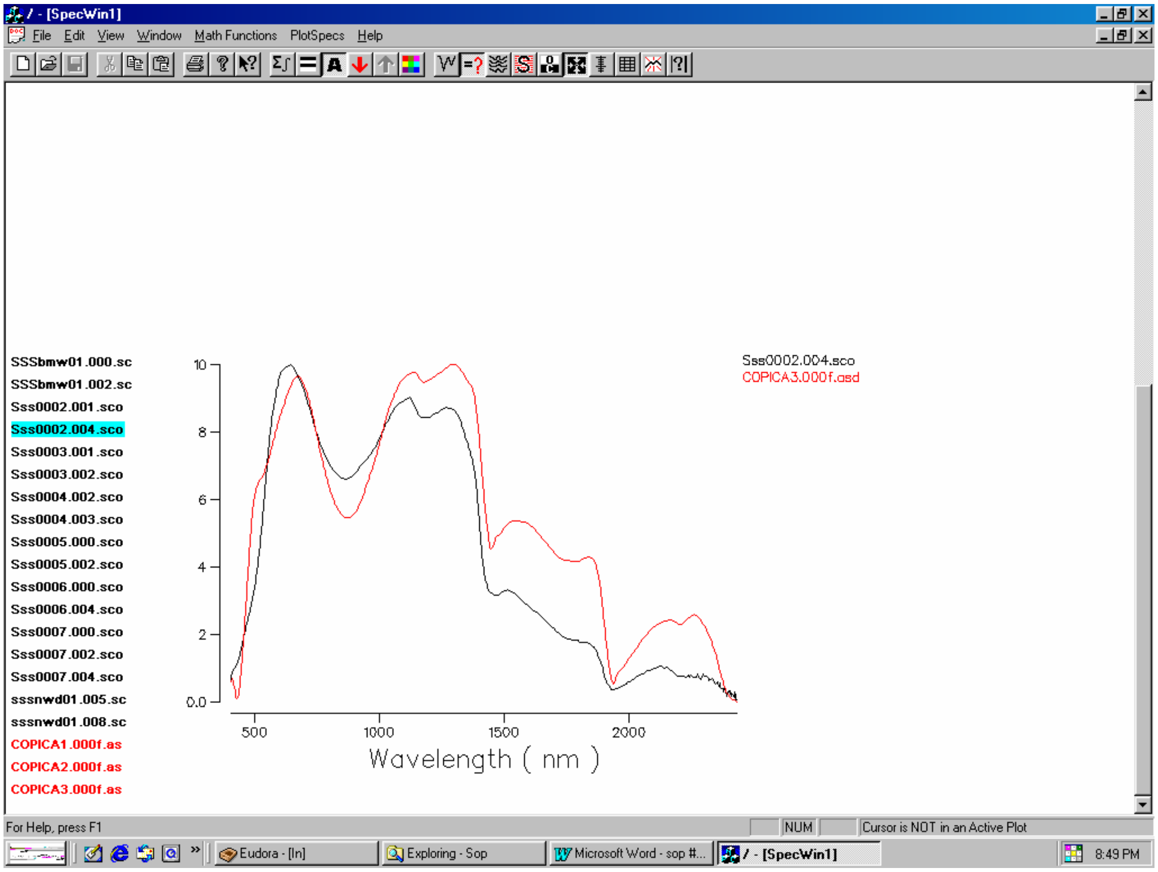


This example shows how a stacked plot can be assembled.



Either of these can easily be imported into reports with a simple “copy” command.

A major use for this program is to compare the unknown spectra against references (red), as shown below.



The program can do hull subtraction, which is one way of computing intensities and therefore semi-quantitative information. It will convert from binary to ASCII format. It will smooth spectra and calculate derivatives.

Greystone Environmental Consultants
ENVIRONMENTAL STANDARD OPERATING PROCEDURE
SOIL SAMPLING
SOP NO. 001
Revision 01

Prepared by:

Greystone Environmental Consultants
5231 South Quebec Street
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March 27, 2003

TABLE OF CONTENTS

1.0 BACKGROUND

Soil sampling is conducted for three main reasons. First, samples can be obtained for laboratory chemical analysis. Second, samples can be obtained for laboratory physical analysis. Third, samples can be obtained for visual classification and field screening. These three sampling objectives can be achieved separately or in combination with each other. Sampling locations are typically chosen to provide chemical, physical, or visual information in both the horizontal and vertical directions. A sampling and analysis plan is used to outline sampling methods and provide preliminary rationale for sampling locations. Sampling locations may be adjusted in the field based on the screening methods used and the physical features of the area.

1.1 Purpose

Soil sampling is conducted to determine the chemical, physical, and visual characteristics of surface and subsurface soils.

1.2 Scope

This standard operating procedure (SOP) describes procedures for soil sampling in different areas using various implements. It includes procedures for test pit, surface soil, and subsurface soil sampling, and describes eight devices.

1.3 Definitions

Hand auger: Instrument attached to the bottom of a length of pipe that has a cross arm or “T” handle at the top. The auger can be closed-spiral or open-spiral.

Bucket auger: A type of auger that consists of a cylindrical bucket 10 to 72 inches in diameter with teeth arranged at the bottom.

Core sampler: Thin-wall cylindrical metal tube with a diameter of 0.5 to 3 inches, a tapered nosepiece, a “T” handle to facilitate sampler deployment and retrieval, and a check valve (flutter valve) in the headpiece.

Spatulas or Spoons: Stainless steel instruments for collecting loose unconsolidated material.

Trier: Tube cut in half lengthwise with a sharpened tip that allows for collection of sticky solids or loosening of cohesive soils.

Trowel: Tool with a scooped blade 4 to 8 inches long and 2 to 3 inches wide with a handle.

Split-Spoon (or Split-Barrel) Sampler: Thick-walled steel tube that is split lengthwise. A cutting shoe is attached to the lower end; the upper end contains a check valve and is connected to drill rods.

Thin-Wall Tube Sampler: Steel tube (1 to 3 millimeters thick) with tapered bottom edge for cutting. The upper end is fastened to a check valve that is attached to drill rods.

1.4 References

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1.5 Requirements and Resources

Soil sampling requires that one or more of the following types of equipment be used:

- Sampling equipment
- Spoons and spatulas
- Trowel
- Shovel or spade
- Trier
- Core sampler
- Hand auger
- Bucket auger
- Split-spoon
- Thin-wall tube
- Other required equipment
- Sample containers, labels, and chain-of-custody forms
- Logbook
- Tape for measuring recovery
- Soil classification information
- Wax for sealing ends of thin-wall tube
- Plastic sheeting
- Decontamination equipment
- Drilling equipment
- Backhoe
- Health and safety equipment

2.0 PROCEDURES

This SOP presents procedures for conducting test pit, surface soil, and subsurface soil sampling. The site sampling plan will specify which of the following procedures will be used. Soil samples for chemical analysis should be collected in the following order: (1) volatile organics, (2) semivolatile organics, and (3) metals. Once the chemical samples have been containerized, samples for physical analyses can be containerized. Typical physical analyses conducted include (1) grain size distribution, (2) moisture content, (3) saturated permeability, (4) unsaturated permeability, and (5) Atterberg limits. Additionally, visual descriptions of samples, using the Unified Soil Classification System (USCS), should be recorded in field log books or on the approved lithologic boring log sheets. Field tests such as headspace analyses can also be conducted. Soil samples for chemical analyses can be collected either as grab samples or composite samples. A grab sample is collected from a discrete location or depth. A composite sample consists of soil combined from more than one discrete location. Typically, composite samples consist of soil obtained from several locations and homogenized in a stainless steel or Teflon® pan or tray. Samples for volatile organic analysis (VOA) should not be composited. Proper transport of samples is addressed in Greystone's SOP for Sample Shipment, SOP 003.

2.1 Test Pit Soil Sampling

Test pit soil sampling is conducted when a complete soil profile is required or as a means of locating visually detectable contamination. This type of sampling provides a detailed description of the soil profile and allows for multiple samples to be collected from specific soil horizons. Prior to conducting any test pit or trench excavation with a backhoe, the sampling team should ensure that the sampling area is clear of utility lines, subsurface pipes, and poles.

Excavation is performed under the guidance of a sampling technician. A test pit or trench is excavated by incrementally removing soil material with a backhoe bucket. Sampling is performed only after the backhoe has moved away from the trench or pit. When the trench or pit is in unstable material or is more than a few feet deep, the sampling technician should only enter the trench or pit after it has been shored up or the sidewalls have been cut back to within the angle of repose (see Occupational Safety and Health Administration regulations).

The excavated soil is placed on plastic sheeting well away from the edge of the test pit. A test pit should not be excavated to depths greater than 4 feet unless its walls are properly stabilized. Personnel entering the test pit may be exposed to toxic or explosive gases and oxygen deficient environments. Air monitoring is required before entering the test pit and the use of appropriate respiratory gear and protective clothing is mandatory. At least two persons must be present at the test pit before sampling personnel enter the excavation and begin soil sampling. Test pits are not practical for depths greater than 15 feet. If soil samples are required from depths greater than 15 feet, samples should be obtained using test borings instead of test pits. Test pits are also usually limited to a few feet below the water table. In some cases, a pumping system may be required to control the water level within the pits. Access to open test pits should be restricted by use of flagging, tape, or fencing. If a fence is used, it should be erected at least 6 feet from the perimeter of the test pit. The test pit should be backfilled as soon as possible after sampling is completed.

Soil samples can be collected from the walls or bottom of a test pit using various equipment. A hand auger, bucket auger, or core sampler can be used to obtain samples from various depths. A trier, trowel, or spoons can be used to obtain samples from the walls or pit bottom surface.

2.2 Surface Soil Sampling

The surface soil sampling equipment presented in this SOP is best suited for sampling to depths of 0 to 6 feet below ground surface (bgs). The sample depth, sample analyses, soil type, and soil moisture will also dictate the best-suited sampling equipment. Prior to sample collection, the sampling locations should be cleared of any surface debris such as twigs, rocks, and litter. The following table presents various surface soil sampling equipment and their effective depth ranges, operating means (manual or power), and sample types collected (disturbed or undisturbed).

Sampling Equipment	Effective Depth Range (feet bgs)	Operating Means	Sample Type
Hand Auger	0 to 6	Manual	Disturbed
Bucket Auger	0 to 4	Power	Disturbed
Core Sampler	0 to 4	Manual or Power	Undisturbed
Shovel	0 to 6	Manual	Disturbed
Trier	0 to 1	Manual	Disturbed
Trowel	0 to 1	Manual	Disturbed
Spoon/Spatula	0 to 0.5	Manual	Disturbed

The procedures for using these various types of sampling equipment are discussed below.

2.2.1 Hand Auger

A hand auger equipped with extensions and a “T” handle is used to obtain samples from a depth of up to 6 feet. If necessary, a shovel may be used to excavate the topsoil to reach the desired subsoil level. If topsoil is removed, its thickness should be recorded. The auger is rotated to advance the barrel into the ground. The operator may have to apply downward pressure to keep the auger advancing. The hand auger is screwed into the soil at an angle of 45 to 90 degrees from horizontal. When the entire auger blade has penetrated soil, the auger is removed from the soil by lifting it straight up without turning it, if possible. When the barrel is filled, the unit is withdrawn from the soil cavity and a sample may be collected from the barrel. Samples obtained using a hand auger are disturbed in their collection; determining the exact depth at which samples are obtained is difficult. If the desired sampling depth has not been reached, the soil is removed from the auger and deposited onto plastic sheeting. This procedure is repeated until the desired depth is reached and the soil sample is obtained. The auger is then removed from the boring and the soil sample is collected directly from the auger into an appropriate sample container.

2.2.2 Bucket Auger

A bucket auger, equipped similarly as the hand auger, is used to obtain disturbed samples from a depth of up to 4 feet. A bucket auger should be used when sampling stony or dense soil that prohibits the use of a hand-operated core or screw auger. A bucket auger with closed blades is used in soil that cannot generally be penetrated or retrieved by a core sampler.

The bucket auger is rotated while downward pressure is exerted until the bucket is full. The bucket is then removed from the boring, the collected soil is placed on plastic sheeting, and this procedure is repeated until the appropriate depth is reached and a sample is obtained. The bucket is then removed from the boring and the soil sample is transferred from the bucket to an appropriate sample container.

2.2.3 Core Sampler

A hand-operated core sampler, similarly equipped as the hand auger, is used to obtain samples from a depth of up to 4 feet in uncompacted soil. For dry, sandy soils, it includes a specially-formed bit to retain the sample in the barrel. The core sampler is capable of retrieving undisturbed soil samples and is appropriate when low concentrations of metals or organics are of concern. The core sampler should be constructed of stainless steel. A polypropylene core sampler is generally not suitable for sampling dense soils or sampling at an appreciable depth.

The core sampler is pressed into the soil at an angle of 45 to 90 degrees from horizontal and is rotated when the desired depth is reached. The core is then removed, and the sample is placed into an appropriate sample container.

2.2.4 Shovel

A shovel may be used to obtain large quantities of soil that are not readily obtained with a trowel. A shovel is used when soil samples from a depth of up to 6 feet are to be collected by hand excavation; a tiling spade (sharpshooter) is recommended for excavation and sampling. A standard steel shovel may be used for excavation; either a stainless steel or polypropylene shovel may be used for sampling. Soil excavated from above the desired sampling depth should be stockpiled on plastic sheeting. Soil samples should be collected from the shovel and placed into the sample container using a stainless-steel scoop, plastic spoon, or other appropriate tool.

2.2.5 Trier

A trier is used to sample soil from a depth of up to 1 foot. A trier should be made of stainless steel or polypropylene. A chrome-plated steel trier may be suitable when samples are to be analyzed for organics and heavy metal content is not a concern. Samples are obtained by inserting the trier into soil at an angle of up to 45 degrees from horizontal. The trier is rotated to cut a core and is then pulled from the soil being sampled. The sample is then transferred to an appropriate sample container.

2.2.6 Trowel

A trowel is used to obtain surface soil samples that do not require excavation beyond a depth of 1 foot. A trowel may also be used to collect soil subsamples from profiles exposed in test pits. Use of a trowel is practical when sample volumes of approximately 1 pint (0.5 liter) or less are to be obtained. Excess soil should be placed on plastic sheeting until sampling is completed. A trowel should be made of stainless steel or galvanized steel. It can be purchased from a hardware or garden store. Soil samples to be analyzed for organics should be collected using a stainless steel trowel. Samples may be placed directly from the trowel into sample containers.

2.3 Subsurface Soil Sampling

Subsurface soil sampling, in conjunction with borehole drilling, is required for soil sampling from depths greater than approximately 6 feet. Subsurface soil sampling is frequently coupled with exploratory boreholes or monitoring well installation. Subsurface soil sampling may be conducted using a drilling rig or power auger. Selection of sampling equipment depends upon geologic conditions and the scope of the sampling program. Two types of samplers used with machine-driven augers— the split-spoon sampler and the thin-wall tube sampler— are discussed below. All sampling tools should be cleaned before and after each use in accordance with the Equipment Decontamination SOP, SOP 002. Both the split-spoon sampler and the thin-wall tube sampler can be used to collect undisturbed samples from unconsolidated soils. The procedures for using the split-spoon and thin-wall tube samplers are presented below.

2.3.1 Split-Spoon Sampler

Split-spoon samplers are available in a variety of types and sizes. Site conditions and project needs, such as large sample volume for multiple analyses, determine the specific type of split-spoon sampler to be used. The split-spoon sampler is advanced into the undisturbed soil beneath the bottom of the casing or borehole using a weighted hammer and a drill rod. The relationship between hammer weight, hammer drop, and number of blows required to advance the split-spoon sampler in 6-inch increments indicates the density or consistency of the subsurface soil. After the split-spoon sampler has been driven to its intended depth, it should be removed carefully to avoid loss of sample material. In noncohesive or saturated soil, a catcher or basket should be used to help retain the sample.

After the split-spoon sampler is removed from the casing, it is detached from the drill rod and opened. If VOA samples are to be collected, VOA vials should be filled with soil taken directly from the split-spoon sampler. Samples for other specific chemical analyses should be taken as soon as the VOA sample has been collected. The remainder of the recovered soil can then be used for visual classification of the sample and containerized for physical analysis. The entire sample (except for the top several inches of possibly disturbed material) is retained for analysis or disposal.

2.3.2 Thin-Wall Tube Sampler

A thin-wall tube sampler, sometimes called the Shelby tube, may be pressed or driven into soil inside a hollow-stem auger flight, wash bore casing, or uncased borehole. The tube sampler is pressed into the soil without rotation to the desired depth or until refusal. If the tube cannot be advanced by pushing, it may be necessary to drive it into the soil without rotation using a hammer and drill rod. The tube sampler is then rotated to collect the sample from the soil and removed from the borehole. After removal of the tube sampler from the drilling equipment, the tube sampler should be inspected for adequate sample recovery. The sampling procedure should be repeated until an adequate soil core is obtained (if sample material can be retained by the tube sampler). The soil core obtained should be documented in the logbook. Any disturbed soil is removed from each end of the tube sampler. If chemical analysis is required, VOA samples must be collected immediately after the tube sampler is withdrawn.

Before use, and during storage and transport, the tube sampler should be capped with a nonreactive material. For physical sampling parameters, the tube sampler should be sealed by pouring three 0.25-inch layers of sealing liquid (such as wax) in each end, allowing each layer to solidify before applying the next. The remaining space at each end of the tube is filled with Ottawa sand or other, similar sand, which is allowed to settle and compact. Plastic caps are then taped over the ends of the tube. The top and bottom of the tube sampler should be labeled and the tube sampler should be stored accordingly.