# New Mexico Copper Corporation

September 3, 2010

Mr. Chris Eustice
Senior Environmental Engineer
Mining Act Reclamation Program
Mining and Mineral Division
1220 South St. Francis Drive
Santa Fe, New Mexico 87505

Dear Mr. Eustice;

On behalf of New Mexico Copper Corporation (NMCC), please accept the enclosed Sampling and Analysis Plan (SAP) for the proposed Copper Flat Mine located approximately 6 miles east of Hillsboro, New Mexico. The SAP has been prepared in accordance to the New Mexico Administrative Code (NMAC) 19.10.6.602.D and the August 2010 Guidance Document for Part 6, New Mining Operation Permitting Under the New Mexico Mining Act.

Also enclosed is a $5,000 check to address the base mine permit application fee.

I, Jon Steven Raugust, certify that I have personally examined and am familiar with the information submitted herein, and based on my inquiry of those individuals responsible for obtaining the information; I believe the submitted information is true, accurate, and complete.

Please contact me at 505.382.5770 or by email at steve.raugust@gmail.com if you have any questions or comments regarding NMCC's Copper Flat Mine Project.

Respectfully,

J. Steven Raugust, P.G.
Project Manager

Cc: Barrret Sleeman, P.Eng., CEO, New Mexico Copper Corporation

Enclosures:

1. Sampling and Analysis Plan for the Copper Flat Mine Project (6 hard copy, 1 electronic copy)
2. One check for $5,000.

# Sampling and Analysis Plan
## for
# Copper Flat Mine

**September 2010**



**Prepared for:**
**New Mexico Copper Corporation**

**Submitted to:**
**Mining and Minerals Division**
**New Mexico Energy, Minerals and Natural Resources Department**

**Prepared by:**
INTERA

with support from Parametrix and Class One Technical Services

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# Acronyms and Abbreviations

| | |
|---|---|
| ABA | acid base accounting |
| Alta Gold | Alta Gold Company |
| amsl | above mean sea level |
| APE | area of potential effects |
| AWRM | Active Water Resource Management |
| bgs | below ground surface |
| BLM | U.S. Bureau of Land Management |
| cc | cubic centimeter |
| CFQM | Copper Flat Quartz Monzonite |
| CFR | Code of Federal Regulations |
| cfs | cubic feet per second |
| cm | centimeter |
| CRMD | New Mexico State University Cultural Resources Management Division |
| CTS | Class One Technical Services |
| $^{O}$F | degrees Fahrenheit |
| DTW | depth to water |
| DVM | digital volt meter |
| EA | Environmental Assessment |
| EIS | Environmental Impact Statement |
| EMNRD | New Mexico Energy, Minerals and Natural Resources Department |
| EPA | U.S. Environmental Protection Agency |
| ESD | Ecological Site Description |
| ft | feet |
| GIS | Geographic Information System |
| Gold Express | Gold Express Corporation |
| gpm | gallons per minute |
| GPS | Global Positioning System |
| HCPI | New Mexico Historic Cultural Properties Inventory |
| HSR | Human Systems Research, Inc. |
| HSU | hydrostratigraphic unit |
| IM | isolated manifestation |
| INTERA | INTERA, Incorporated |
| JFD | joint frequency distribution |
| Km | kilometer |
| kV | Kilovolt |
| l/min | liters per minute |
| LA | Laboratory of Anthropology |
| LOG | lognormal |
| LRGB | Lower Rio Grande Underground Water Basin |
| m | meter |
| Ma | million years ago |
| mb | millibars |
| mg/L | milligrams per liter |
| ml | milliliter |

| | |
|---|---|
| mm | millimeter |
| MMD | New Mexico Mining and Minerals Division |
| MSF | Middle Santa Fe Group hydrostratigraphic unit |
| Mst | million standard tons |
| MVA | Megavolt-ampere |
| MWMP | Meteoric Water Mobility Procedure |
| NAD | North American Datum |
| NAG | Net Acid Generation |
| NELAP | National Environmental Laboratory Accreditation Program |
| NHPA | National Historic Preservation Act |
| NIST | National Institute of Standards and Technology |
| NMAAQS | New Mexico Ambient Air Quality Standards |
| NMAC | New Mexico Administrative Code |
| NMCC | New Mexico Copper Corporation |
| NMCRIS | New Mexico Cultural Resources Information System |
| NMED | New Mexico Environment Department |
| NMED GWQB | New Mexico Environment Department Groundwater Quality Bureau |
| NMED SWQB | New Mexico Environment Department Surface Water Quality Bureau |
| NMSRCP | New Mexico State Register of Cultural Properties |
| NORM | normal |
| NP | nonparametric |
| NPS | National Park Service |
| NRCS | Natural Resources Conservation Service |
| NRHP | National Register of Historic Places |
| OSE | New Mexico Office of the State Engineer |
| oz | ounce |
| PFEIS | Preliminary Final Environmental Impact Statement |
| $PM_{[x]}$ | particulate matter less than [x] micrometers |
| PSD | prevention of significant deterioration |
| QA/QC | quality assurance/quality control |
| QAPP | Quality Assurance Project Plan |
| Quintana | Quintana Minerals Corporation |
| R | range |
| RAM | random access memory |
| RH | relative humidity |
| Rio Gold | Rio Gold Mining Ltd |
| ROW | right-of-way |
| rpm | revolutions per minute |
| SAP | Sampling and Analysis Plan |
| SCS | Soil Conservation Service |
| SHPO | New Mexico State Historic Preservation Officer |
| Site | Copper Flat Mine Permit Area |
| SOP | standard operating procedure |
| SRK | Steffen Robertson and Kirsten, Inc. |
| st | standard ton |
| S-W | Shannon-Weiner Index |
| T | township |

| | |
|---|---|
| TD | total depth |
| TDS | total dissolved solids |
| Tenneco | Tenneco Minerals |
| TSP | total suspended particulates |
| TSS | total suspended solids |
| $\mu g/m^3$ | micrograms per cubic meter |
| USBR | U.S. Bureau of Reclamation |
| USF | Upper Santa Fe Group hydrostratigraphic unit |
| USGS | U.S. Geological Survey |
| UTM | Universal Transverse Mercator |
| VOA | volatile organic analysis |
| WQCC | New Mexico Water Quality Control Commission |

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# 1 Introduction to the Copper Flat Sampling and Analysis Plan

## 1.1 Background

The New Mexico Copper Corporation (NMCC) plans to re-open the Copper Flat Mine, a porphyry copper/molybdenum/gold deposit located in the Hillsboro Mining District in South Central New Mexico, in Sierra County. The Cooper Flat Mine is approximately 20 miles southwest from Truth or Consequences, New Mexico and approximately 5 miles northeast of Hillsboro, New Mexico (Figure 1-1). The proposed mining operation is located in Sections 30 and 31, Township 15 South, Range 5 West (T15S, R5W); Sections 30 and 31, T15S, R6W; Sections 23 through 27 and 34 through 36, T15S, R7W; Section 6, T16S, R6W; and Section 2, T16S, R7W (all with reference to the New Mexico Principal Meridian) in Sierra County, New Mexico. The mineralized zone is centered at approximately latitude 32.970300, longitude −107.533527.

Baseline data has been collected at the Copper Flat project starting in the late 1970s by Quintana, followed by Rio Gold Mining Ltd (Rio Gold), Gold Express, and Alta Gold Company (Alta Gold). This data is relevant and provides insights for future permitting activities. The Copper Flat Mine was first permitted by Quintana Minerals (Quintana) during the 1980s. In 1992, a new plan of operations was submitted and an environmental assessment (EA) was begun by Gold Express, but the operation was never restarted. Alta Gold acquired the property in the mid-1990s and reinitiated the permitting and approvals process, collecting significant baseline data and submitting applications for all major state and federal permits. Alta Gold declared bankruptcy in early 1999, but not before a draft environmental impact statement (DEIS, 1996) and preliminary final EIS (PFEIS, 1999) had been prepared and the associated public comments received; a public hearing had also been held on the New Mexico Mining Act Permit and the New Mexico Groundwater Discharge Permit. However, no final permits had been issued and there had been no opportunity for appeals or litigation regarding the operation. Figures 1-2 and 1-3 illustrate the Site permit boundary with topography and the 2009 aerial photo, respectively.

For the purposes of this sampling and analysis plan (SAP), the permit area is defined as the Site as illustrated on Figure 1-2. The Copper Flat project is composed of approximately 3,304.75 acres in contiguous and noncontiguous lands that include patented and unpatented mining claims (lode, placer, and mill site), and fee parcels. The acreage inside the Site permit boundary is 2,190 acres. NMCC will mine copper ore by open pit extraction methods in the area. Molybdenum, gold and silver will be recovered as byproducts.

The following sections provide an overview of the requirements and content of this SAP, a summary of previous mining activity and investigations, and a description of the proposed mining operations, which provide a basis for understanding the baseline data gathering needs related to the planned mine construction and operations. A mine plan will be submitted at a later date with the mine permit application to detail the construction and operation of the mine.

## 1.2 Applicant Information and General Plan

### 1.2.1 Name of Permit Applicant

New Mexico Copper Corporation, a New Mexico corporation.

### 1.2.2 Map of Proposed Site

Figures 1-2 and 1-3 present the Site permit boundary on a topographic map and a 2009 aerial photograph, respectively.

### 1.2.3 Surface Ownership Map with Mineral Estates at the Proposed Site

Figure 1.4 presents the map of all known owners of surface and mineral estates within the proposed permit area as of September 1, 2010. This map has been prepared by a qualified mineral title specialist working in collaboration with NMCC's legal counsel, Mark K. Adams of Rodey, Dickason, Sloan, and Robb, PA. This land ownership map is preliminary and subject to update and revision as continued title research is performed and evaluated. The final land ownership map will be submitted with the Phase II Permit Application Package.

### 1.2.4 List of Surface Owners

According to the 2010 property tax schedule of the Sierra County Assessor, Hydro Resources Corporation (Hydro) and Cu Flat, LLC (Cu Flat) own all of the fee lands within the permit area except as follows:

- Edgar E. Greer ("Greer") owns the fee surface estate in the lands within the permit area in Sections 30 and 31, Township 15 South, Range 6 West, and has contracted to sell his fee surface estate to Ryan G. and Wendy M. Fancher (the "Fanchers"). The mineral estate in such lands is owned by the United States and is subject to unpatented mining claims owned by Hydro and GCM, Inc. (GCM).
- Greer owns the fee surface and mineral estates in the Cincinnati, Graf Von Luxenburg, and Prosper patented mining claims in Sections 25 and 36, Township 15 South, Range 7 West, and has contracted to sell such claims to the Fanchers.
- The non-fee lands within the permit area are owned by the United States. All such lands are subject to unpatented mining claims owned by Hydro and GCM.

All of the fee lands and unpatented mining claims within the permit area owned by Hydro, Cu Flat, and GCM are subject to the Option and Purchase Agreement described in 1.2.5 below.

### 1.2.5 Access Agreements

The Applicant has the right to enter the proposed permit area and conduct mining and reclamation operations on all lands on which such operations will be conducted or cause disturbance under an Option and Purchase Agreement dated July 23, 2009 by and between Applicant, as Optionee, and Hydro, Cu Flat, GCM, as Optionor. The Option and Purchase Agreement has been amended by a First Amendment dated January 20, 2010, a Second Amendment dated April 1, 2010, a Third Amendment and Supplemental Memorandum dated May 28, 2010, and a Fourth Amendment dated August 2, 2010. This agreement and associated amendments are presented in Attachment 2, Access Agreements.

With respect to the Edgar E. Greer lands within the permit boundary and under contract to Ryan and Wendy Fancher, NMCC has initiated formal negotiations with Ryan and Wendy Fancher for use of the fee surface and mineral estates described in Section 1.2.4. There has been a history of land arrangements with Edgar E. Greer with previous mining companies (Quintana Minerals and Alta Gold), however, these negotiations are expected proceed in parallel with the collection of the baseline data and be concluded prior to the submittal of the Permit Application Package.

### 1.2.6 Contact Information for Surface Owners

The Applicant owns and controls the entire interest in the proposed Copper Flat operation. The Applicant's address is 2425 San Pedro, NE, Suite 200, Albuquerque, New Mexico 87110, and its telephone number is 505-382-5770. THEMAC Resources Group Limited (THEMAC), a Yukon corporation, owns and controls all of the Applicant's shares. THEMAC's address is Suite 2000, 1066 West Hastings Street, Vancouver, British Columbia, Canada, V6E 3X2, and its telephone number is (+1) 604-495-6723.

### 1.2.7 Statement of U.S.-Based Mining Operations Directly Controlled by Applicant, Owner, or Operator

Neither NMCC nor THEMAC owns, operates, or directly controls any mining operation in the United States.

### 1.2.8 Contact Information for the Applicant's Designated Agent

Barrett E.G. Sleeman, President and Chief Executive Officer, THEMAC Resources Group Limited, Suite 2000, 1066 West Hastings Street, Vancouver, British Columbia, Canada, V6E 3X2, (+1) 604-495-6723, barrettsleeman@hotmail.com.

## 1.3 Sampling and Analysis Plan

The permitting of new non-coal mines is governed by 19.10.6 NMAC (New Mexico Administrative Code). This SAP is submitted to the New Mexico Energy, Minerals and Natural Resources Department (EMNRD) Mining and Minerals Division (MMD) by NMCC as the first phase in the mine permitting process. The second phase will be submittal of the baseline characterization report and the mine permit application.

The SAP provides the sampling and analysis procedures for the data to be included in the baseline characterization report described in Paragraph (13) of Subsection D of 19.10.6.602 NMAC. As described in Part 6, baseline data include the (1) hydrological, (2) geological, (3) mineralogical, (4) ecological, and (5) cultural components within the proposed Site and the area outside of the Site that will be affected by the proposed mining activity at the Copper Flat Mine.

Pursuant to Paragraph (13) of Subsection D of 19.10.6.602 NMAC, this SAP must contain seven data subcategories, which are further described in Tables 1 and 2 of the MMD draft guidance document (MMD, 2010). These subcategories and their location in this SAP are listed below.

- Climatological factors (Section 2)
- Vegetation survey (Section 4)
- Wildlife survey (Section 5)
- Topsoil survey/sampling (Section 6)
- Surface water sampling (Section 8)
- Groundwater sampling (Section 9)
- Historic and cultural properties survey (Section 10)

An eighth subcategory, radiological survey, is not required for non-uranium mines.

This SAP presents the data requirements identified for each subcategory and describes how these will be addressed, summarizes the sampling objectives, and describes the data collection methods for each subcategory or medium. Specifically, in accordance with Subparagraph (a) of Paragraph (12) of Subsection D of 19.10.6.602 NMAC, the following information is discussed for each of the seven subcategories:

- Sampling objectives
- Sampling frequency (in accordance with Table 2 of the 2010 MMD guidance for new mining operations)
- A list of data to be collected
- Methods of collection
- Parameters to be analyzed (as outlined in Table 1 of the 2010 MMD guidance)
- Maps showing proposed sampling locations

- Laboratory and field quality assurance plans
- A brief discussion supporting the proposed sampling plan and/or use of historical data

Where the methods of collection require the use of a Global Positioning System (GPS) receiver to record site features (e.g., discrete sampling locations, transect locations, surface drainage features, weather station locations, cultural resource locations, etc.), those data will be verified by reference to landscape features and landmarks shown on USGS quadrangle maps. All GPS data will then be differentially corrected for sub-meter accuracy. Shapefiles of these features will be created using a geographic information system (GIS) compatible with ArcGIS. The shapefiles and GPS data will be presented in a baseline summary report in both hard-copy format as report figures and digital format as Microsoft Excel tables and/or ESRI shapefiles.

The following additional information is included in this SAP:

- An overview of major topographic features and topographic maps at a scale of 1-inch equals 2000 feet (1:24,000) (Section 3 and throughout document)
- Conceptual mine layout for proposed operations (Section 1.5)
- Mine operation description (Section 1.5)
- General geology, ore body description, and geologic sampling (Section 7)
- Land use information (Section 11)
- Maps to illustrate all proposed sampling locations (at end of Sections 2, 4, 5, 6, 8, 9, and 10)

Extensive site characterization activities have been performed at the Copper Flat Mine as a result of previous mining activities and attempts to re-open the mine. This SAP presents the historical data that will be incorporated into the baseline characterization report along with procedures for acquiring new data that will be collected to fill data gaps and meet the requirements of 19.10.6 NMAC. All new data collection will be performed in compliance with the procedures defined in this SAP and the Quality Assurance Project Plan included as Attachment 1.

## 1.4 Summary of Historical Mining Operations

The following history of the Copper Flat Mine and the overview of previous investigations and sampling programs were summarized from BLM (1999), Raugust (2003), and SRK (2010). The results of previous sampling programs are discussed in the applicable sections of this SAP, as relevant.

### 1.4.1 Mining History

Mining activities in the Hillsboro Mining District, including gold mining from both placer and vein deposits, began in 1877. From 1877 to 1893, numerous shafts and adits were developed along veins that radiate to the southwest and northeast from Copper Flat. Placer workings were developed along most of the major creeks that drain to the east and southwest from Black and Animas Peaks. Between 1911 and 1931, underground deposits were further developed; approximately 65 percent of the $7 million of ore produced from the district before 1931 came from underground veins (BLM, 1999). Placer mining increased after 1932 until World War II; small-scale placer mining continues in the area today (Hedlund, 1985; McLemore, 2003 as cited in Raugust, 2003).

Copper exploration began in the area in the 1950s and continued through the early 1970s. Quintana Minerals Corporation (Quintana) leased the property in 1974 and defined reserves sufficient for mine development through an extensive drilling and sampling program. The Copper Flat Partnership, Ltd., with Quintana acting as mine operator, developed and operated an open pit copper mine at the Copper Flat location in 1982 that included a 15,000 ton-per-day flotation mill and a tailings impoundment. Poor economic conditions led to the termination of mining after only 3 months of operation, although the mine remained on a maintenance status until 1986, at which point the facilities were dismantled and the Site was partially reclaimed (BLM, 1999). The mine produced 7.4 million pounds of copper, approximately 2,300 ounces of gold, and nearly 56,000 ounces of silver during its 3-month operational life (Hedlund, 1985). During the 1990s, several companies submitted plans to reopen the Copper Flat operation; however, none of the plans were realized. No mining activities have occurred at Copper Flat since 1982. More detail about copper exploration activities can be found in Section 11.3.

### 1.4.2 Surface Features of the Copper Flat Mine

Activity at the Copper Flat Mine in 1982 disturbed 358 acres of BLM-managed public lands and 331 acres of private lands (Figure 1-2). Surface features of the Copper Flat Mine include the following:

- A pit lake that covers approximately 12.8 acres and is about 40 feet (ft) deep.
- Overburden rock storage piles (disposal areas) to the north, west, south, and east of the pit.
- Former mine and mill areas including an unpaved but maintained road from NM Highway 152 to the mill area and a primitive road to the pit area, a 115-kilovolt power line, and a 20-inch welded steel water line.
- A previously state approved and permitted diversion channel re-routing Grayback Arroyo around the mine site.
- A tailings impoundment area, which is dammed by a 6,600-ft-long dam with a maximum crest height of 60 ft, and which includes at least 1.2 million tons of tailings over a 60-acre area (SRK, 1995).

### 1.4.3 Historical Investigations

A number of investigations and sampling programs have been undertaken at Copper Flat in the past 30 years; several of these provide valuable sources of baseline data as these were related to various permitting processes including EAs and a Draft EIS in 1996 and a Preliminary Final EIS in 1999. For example, in the 8-year period before the 1982 operations began, Quintana collected baseline data at the Site related to climate, soils, vegetation, wildlife, surface water, groundwater, and archeology (Glover, 1977). The geology, mining history, and mineral deposits associated with Copper Flat were described by Hedlund in 1985; the results of a later field investigation that included sampling, water supply information, and ore reserves were documented by Dunn (1992). Aquifer testing was performed as early as the late 1970s and early 1980s, as well as again related to Alta Gold's PFEIS processes in the late 1990s. At least two environmental assessments and one environmental impact statement were prepared for the Site during the 1990s (Raugust, 2003). A number of reports were prepared for Alta Gold in the late 1990s related to the DEIS process; these reports included but are not limited to those summarized by SRK, Adrian Brown Consultants, and ENSR; an independent evaluation was also prepared by Daniel B. Stephens & Associates, Inc. in 1997 (Raugust, 2003). During 2009 and early 2010, a Copper Flat drilling program was undertaken by NMCC to verify the historical Alta Gold data and to expand and refine the existing resources at Copper Flat (SRK, 2010).

Many of these previous investigations have sampled for vegetation, wildlife, soil, potential acid rock drainage, climate and air quality, surface water and groundwater at or near the Site. Between 1989 and 1998, the pit lake was sampled 65 times by various investigators (BLM, 1999). Samples were typically analyzed for pH, major cations and anions, and metals (Raugust, 2003). Attempts were made to measure the flow at local springs and seeps in the 1990s and surface water sampling of creeks began before the 1982 mining operations and continued sporadically until the late 1990s. Before 1996, only one well was available at the Site for groundwater sampling; two additional wells were drilled during 1996 and used for subsequent sampling in the late 1990s (Raugust, 2003). Groundwater samples have also been taken from wells downgradient of the tailings impoundment dam.

Characterization of waste rock from outcrop and storage piles was undertaken in 1994 and again in 1997 to assess existing geochemical characteristics and potential for future acid generation (Raugust, 2003).Test borings in the tailings impoundment area have also been undertaken to investigate the nature of near-surface material and its suitability as borrow material (Raugust, 2003).

## 1.5 Description of Proposed Mining Operations

A preliminary economic assessment (PEA) was conducted by SRK Engineers and Scientists (SRK 2010) to satisfy the Canadian Securities Administrators National Instrument 43-101. The PEA provides a preliminary overview of the Copper Flat mineral resources and operational mining activities. Mining operations at the Copper Flat deposit will be characterized by a low stripping ratio pit (strip ratio of 0.38, waste to minable resource), with the mining of disseminated porphyry mineralization situated in a moderately mountainous region. The pit was previously pre-stripped of waste prior to ore production when the mine was briefly operated in 1982. The various water diversion structures previously constructed around the pit area are still in place and will be used. Figure 1-5 illustrates the pit, three waste piles, a tailings impoundment area, and a plant-facilities area between the pit to the west and the tailings impoundment to the east.

The preliminary pit design was determined to be approximately 2,500 ft (east-west), 2,500 ft (North-South), and 900 ft deep. The pit design was broken into three phases for scheduling purposes, with 80-foot-wide ramps, 30-foot bench heights, and a maximum haul road grade of 10 percent.

Open pit mining will be conducted using conventional diesel-powered equipment, a combination of blast-hole drills, hydraulic face shovels, rubber-tired wheel loaders, and off-highway haul trucks. Support equipment such as graders, track dozers, and a water truck will aid in the mining of the mineral resources and waste.

Indicated and Inferred mineral resources were considered for all optimization and production scheduling analyses and were based on an internal cut-off grade of 0.14% Cu. (The internal cut-off grade is based on process and general and administrative [G&A] operating costs.) The PEA report includes the Inferred mineral resources that are considered too speculative geologically to have economic considerations applied to them that would enable them to be categorized as mineral reserves.

A variable cut-off grade strategy, with elevated cut-off grades for the first 14 years of production, increased the mill feed head grades in those years and provided over three years of low-grade stockpile processing after the pit mining operations ended.

Existing infrastructure in preservation includes items such as the primary access road, water systems, electrical power distribution, and the concentrate load-out facility. Where possible, existing serviceable items were presumed to be re-used or upgraded; otherwise new construction will be assumed.

The primary items that were assumed to be re-usable include the mine access road, the water well field, the primary freshwater pipeline, the main electrical substation at I-25, the 115kV power transmission lines, the 25kV power line to the well field, the reclaim tunnel, and the access cutting from the mill site to the tailings area.

Access to the mine site includes approximately 3 miles of all-weather gravel road, which will require re-grading in addition to some widening and work at key points.

The milling and process system will receive fresh water from a series of previously existing wells located about 8 miles east of the site. Additionally, the previously used 20-inch diameter pipeline was left in place. It was assumed that the wells will be uncapped and refitted with new pumps for current use, and that the pipeline will be in serviceable condition and can also be re-used. It was also assumed that the well field and pipeline pump stations powered via a 25kV power line can be reconnected and re-used.

Electrical power in the county is provided by Sierra Electric Co-op. A high-voltage substation is still in existence near Caballo, 13 miles to the east of the Site. This substation supplies a 115kV transmission line to the Site that is currently not live, as well as low-voltage distribution lines to the town of Hillsboro. The 115kV transmission line can be accessed for site power.

A new substation will need to be constructed at the Site. An emergency generator allowance was also included as backup power would be required in the event of power loss to maintain critical systems and to aid in a controlled shut down. NMCC is analyzing the viability of solar power generation to offset the mine's energy demand, along with other energy and water conservation measures.

Product concentrate will be produced on site, and the resulting dried bulk copper concentrate and bagged molybdenum concentrates will need to be shipped to other facilities. An on-site concentrate load-out facility will be required, and two possible off-site load-out facility locations have been identified. The off-site load-out facility would essentially be a fenced-in area adjacent to a new rail siding that has truck off-loading and railcar loading capabilities.

The copper concentrate will be transported via railcar to a smelter facility, such as the Freeport-McMoRan Miami Operation. Molybdenum product would be transported from the mill in "super sacks." A truck scale and scale house will be needed to weigh the copper concentrate and molybdenum concentrate trucks leaving the site en route to the load-out facility (SRK, 2010).

## 1.6 References

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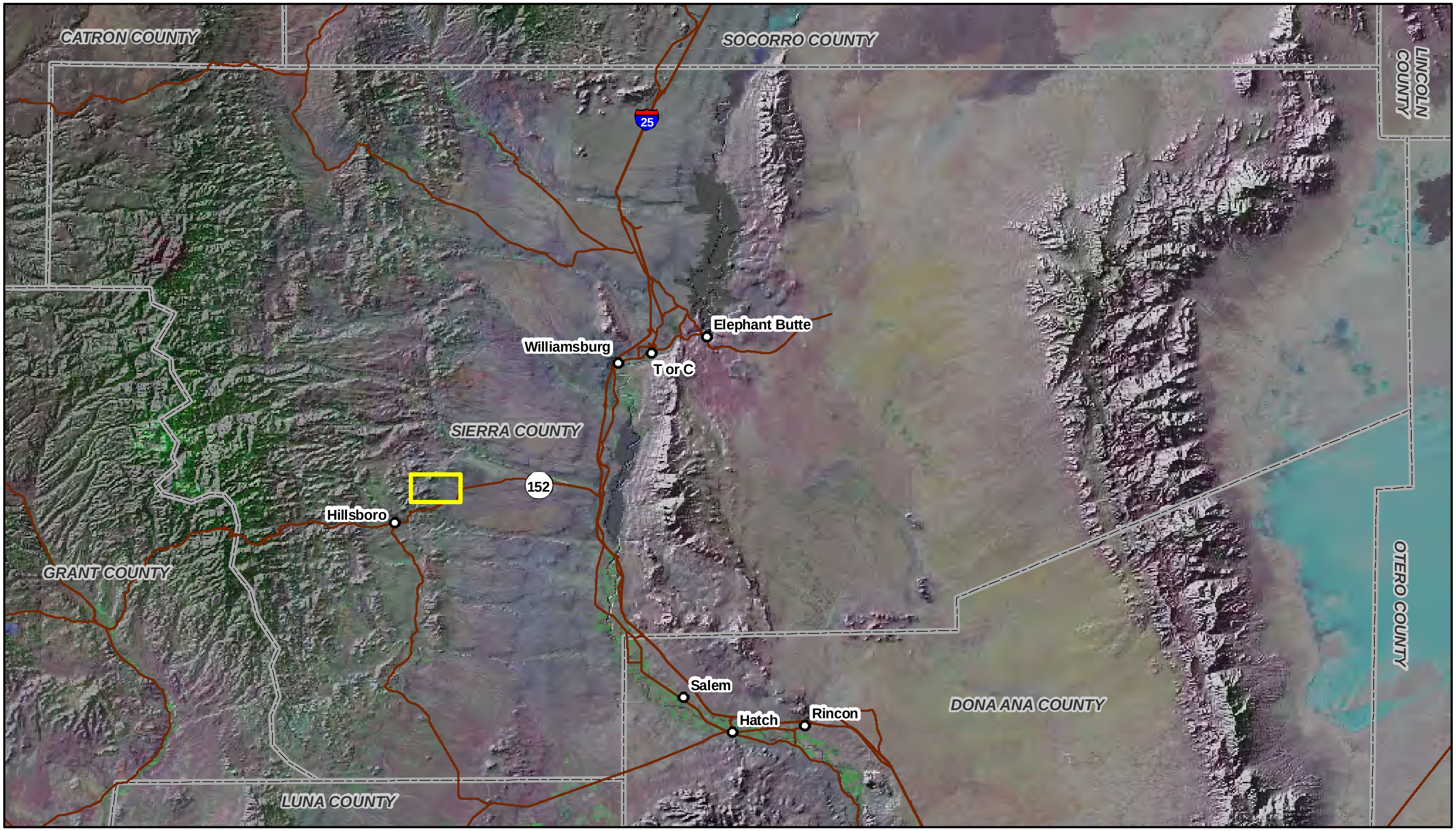
# Figures




Imagery Information:
-Landsat Imagery from
University of Maryland NLCD

**Legend**

- City/Town
- Site Location
- Road

0 6 12 24
Miles

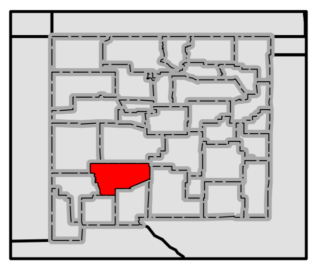
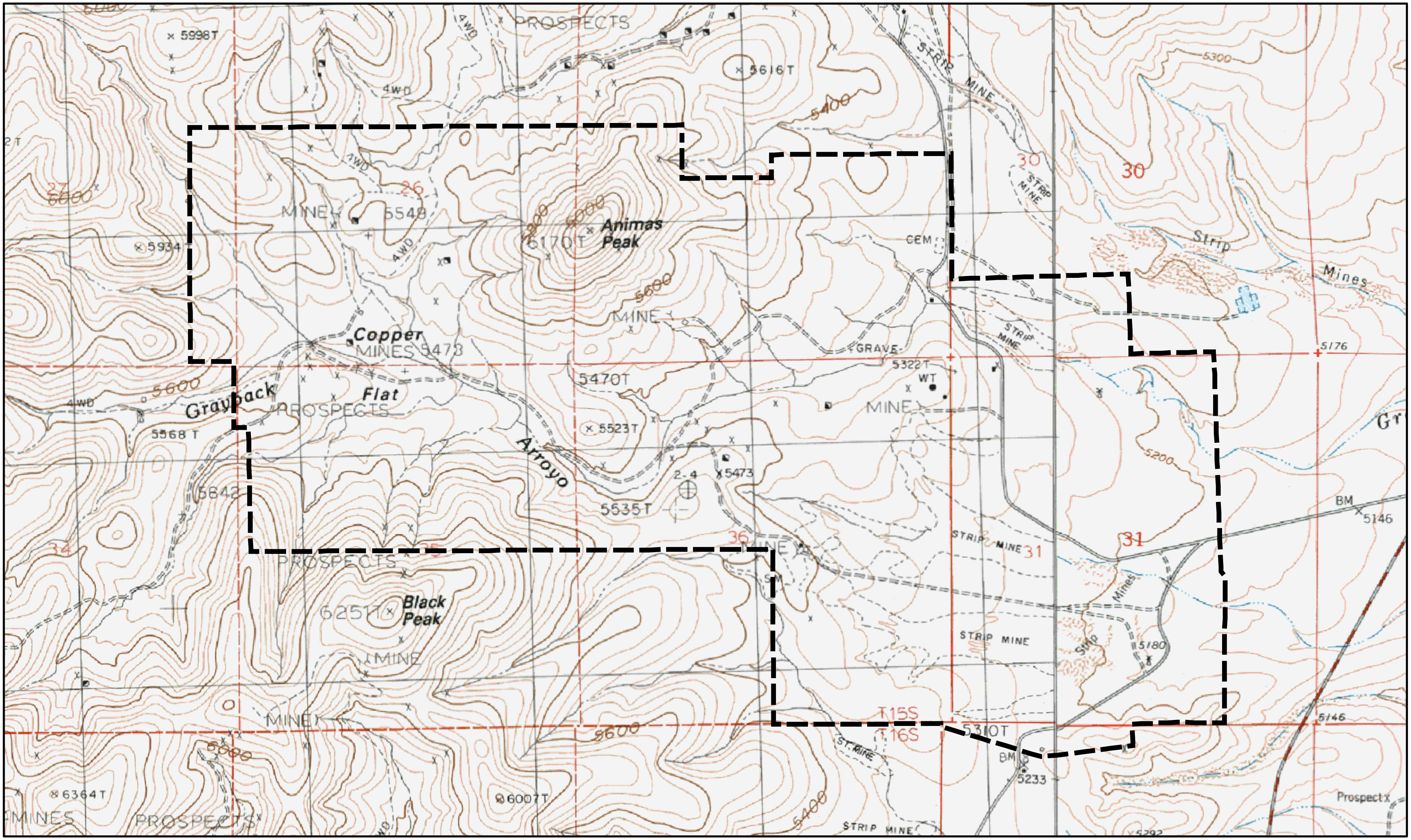


**Figure 1-1**
**Site Location**
**New Mexico Copper Corporation**

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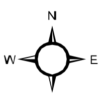
Feet

N W E S



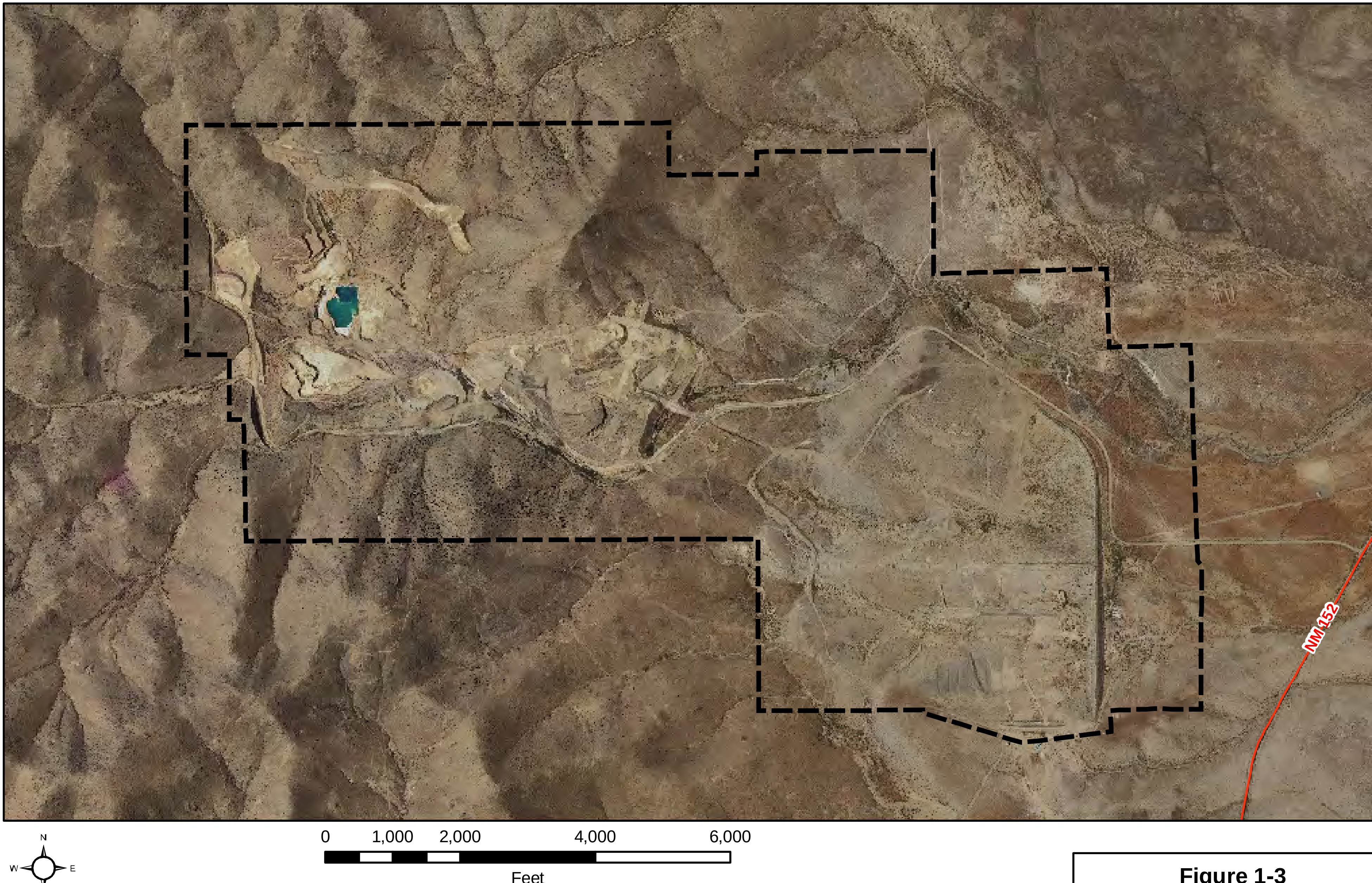
Mine Boundary:
Tom Van Bebber
Imagery Information:
-USGS 7.5-Minutes Quads; Skute Stone Arroyo & Hillsboro
Projection Information:
-New Mexico State Plane West, NAD 1927

**Legend**

Proposed Mine Permit Boundary

**Figure 1-2**
**Proposed Copper Flat Permit Area with Topography**
**New Mexico Copper Corporation**

S:\Projects\NMC-001_New Mexico Copper Corporation\GIS\Maps\SAP_7-2010\1_introduction\1-2_proposed-permit_topo.mxd 08/30/2010



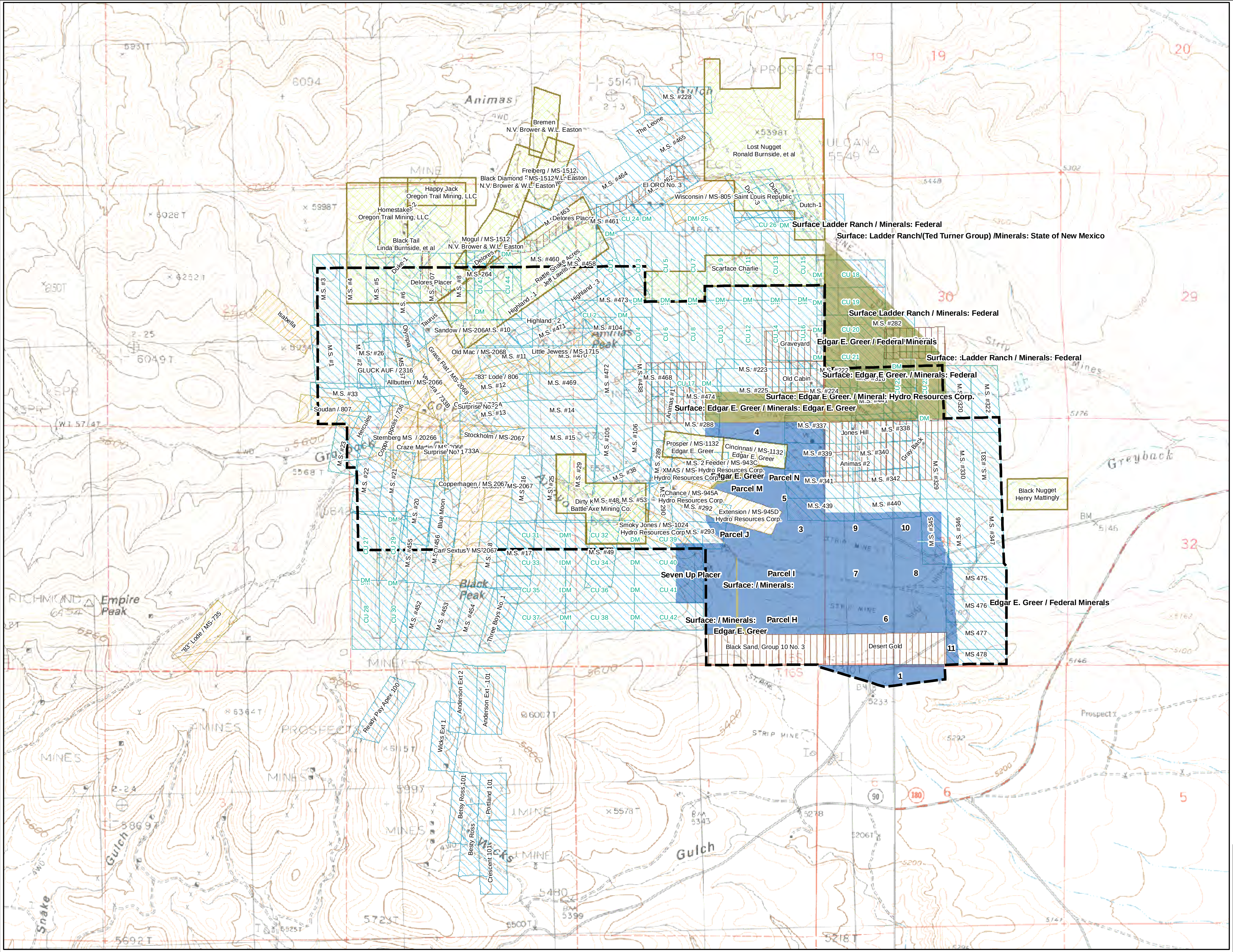

Mine Boundary:
Tom Van Bebber
Imagery Information:
-USGS 7.5-Minutes County DOQQ
mosaic Sierra County, 2009
Projection Information:
-New Mexico State Plane West, NAD 1927

INTERA

**Figure 1-3**
**Proposed Copper Flat Permit Area with Air Photography**

**New Mexico Copper Corporation**

S:\Projects\NMC-001_New Mexico Copper Corporation\GIS\Maps\SAP_7-2010\1_introduction\1-2_proposed-permit_photo.mxd 08/30/2010




N
W E
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INTERA

Mine Boundary:
John Reynolds
Claims & Feelands:
Tom Van Bebber
Imagery Information:
-USGS 7.5-Minute Quads; Skute Stone Arroyo & Hillsboro
Projection Information:
-New Mexico State Plane West, NAD 1927

0 1,000 2,000 4,000
Feet

**Legend**

- Mine Permit Boundary
- Fee, Category 3a
- Fee Lands subject to Option Agreement dated July 23, 2009
- Fee Lands NOT subject to Option Agreement dated July 23, 2009

**Figure 1-4**
**Proposed Copper Flat Permit Area with Land Ownership and Claims**

**New Mexico Copper Corporation**

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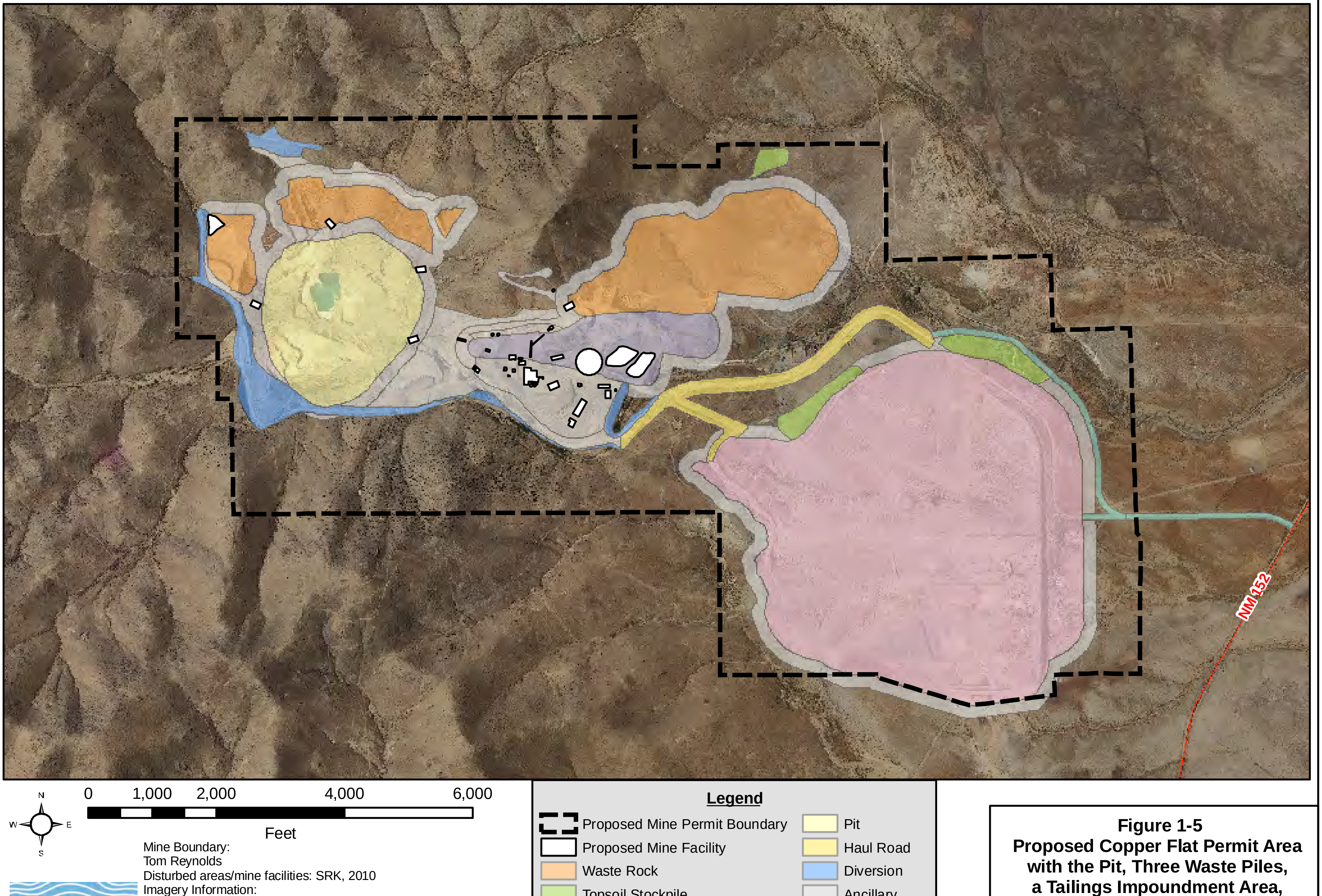


Mine Boundary:
Tom Reynolds
Disturbed areas/mine facilities: SRK, 2010
Imagery Information:
-USGS 7.5-Minutes County DOQQ
mosaic Sierra County, 2009
Projection Information:
-New Mexico State Plane West, NAD 1927

**Legend**

- Proposed Mine Permit Boundary
- Proposed Mine Facility
- Waste Rock
- Topsoil Stockpile
- Tailings
- Stockpile
- Pit
- Haul Road
- Diversion
- Ancillary
- Access Road

**Figure 1-5**
**Proposed Copper Flat Permit Area with the Pit, Three Waste Piles, a Tailings Impoundment Area, and a Plant-Facilities Area**

**New Mexico Copper Corporation**

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# 2 Climatological Factors

## 2.1 Introduction and Background

The Copper Flat Mine Permit Area (Site) lies within the belt of mid-latitude westerlies where the prevailing wind direction is from the west. Winds at the Truth or Consequences, New Mexico, airport, located about 30 miles northeast of the Site, are generally from the northwest; however, the Black Range and foothills cause local variations in the winds. At Copper Flat, the wind direction is predominantly west to east, and secondarily north to south. Local wind speeds average about 10 to 15 miles per hour, although winds in excess of 50 miles per hour may occur at times. Temperature inversions are rare at Copper Flat, but are more common farther east along the Rio Grande valley, especially during the winter months. Vertical air dilution is generally good because of the area's high surface temperatures, creating strong daytime thermal mixing. Thermal mixing and moderate winds generally tend to suppress occasional nighttime inversions. The presence of higher winds and the lack of inversions contribute to a relatively clean atmosphere at the Site since any pollutants are readily mixed and dispersed (BLM, 1999).

Temperature data for the Site show a wide diurnal and seasonal variability, which is typical of dry climates. The warmest temperatures occur in June and July and the coldest temperatures usually occur in December and January. In spring and fall, daily maximum temperatures are moderate, typically averaging 65 to 85 degrees Fahrenheit (°F). Nights are cooler, with low temperatures averaging 32 to 50°F. Winter temperatures are frequently below freezing at night, but can be above 50°F during the day. During summer, temperatures can approach 100°F during the day. Daily temperature fluctuations of 30°F are common throughout the year (BLM, 1999).

Precipitation at the Site averages about 13 inches per year (ranging from nearly 3 inches in 1956 to over 20 inches in 1986). As much as half of the annual precipitation occurs in the form of intense thunderstorms during July, August, and September, when moist air enters the region from the Gulf of Mexico. Summer thunderstorms can result in heavy rainfall and flash floods. Average monthly precipitation in January through June is typically 0.50 inch or less. Snowfall is possible from October through April, but most likely (greater than 1 inch) between December through February (BLM, 1996).

Evaporation exceeds precipitation in southwestern New Mexico. Pan evaporation data, the most commonly collected data, are correlated with lake evaporation (i.e., free water surface evaporation) to predict evaporation from reservoirs and lakes. Lake evaporation at the Site is estimated to be approximately 58 to 65 inches per year, and pan evaporation is estimated to be approximately 80 to 90 inches per year (SRK, 1995).

Prior to the preparation of this Section, two reports from Alta Gold Company baseline meteorological data were reviewed by a subcontractor on behalf of NMCC to collect baseline meteorological data and conduct $PM_{10}$ ambient air monitoring. These reports were prepared for Alta Gold Company by their air quality subcontractors, Air Sciences Inc. (Air Sciences) and present the meteorological protocols used by Air Sciences, including a letter from the New Mexico Air Quality Bureau approving the protocols. They also present the baseline air conditions for six months of on-site data (collected from August 19 to February 20, 1995), and six months of complimentary Truth or Consequences data (collected from February 21 to August 18, 1964), which was used for air dispersion modeling. On July 9, 2010, NMCC and the subcontractor visited the New Mexico Air Quality Bureau to meet with David Heath of the air modeling group, and Norma Perez and Kathy Primm, Environmental and Permit Specialists, respectively, to describe the air monitoring protocols the subcontractor would use, and to discuss the location of the on-site meteorological tower, which is the same location used by Alta Gold in 1994 and 1995. No objections were noted to either the protocols or the tower location (Air Sciences, 1995a and 1995b).

## 2.2 Sampling Objectives

### 2.2.1 Meteorological

The monitoring program will operate as a single station for a minimum of one year. The purpose of the monitoring program will be to collect baseline climatological data representative of the Site that satisfies the criteria of the New Mexico Surface Mining Act and the U.S. Environmental Protection Agency (EPA) on-site meteorological program guidance for dispersion modeling (EPA, 1987). The meteorological data will provide input to characterize the following climatological factors on a quarterly and annual basis:

- Wind direction
- Wind speed
- Temperature
- Precipitation
- Relative humidity
- Barometric pressure
- Net radiation
- Evapotranspiration

Additionally, the meteorological data will support the particulate ($PM_{10}$) air monitoring program to help determine sources of airborne particulate matter and to aid in the validation of monitored data.

The data capture goal will be 90 percent or greater for each meteorological parameter.

### 2.2.2 Air Quality – Particulate ($PM_{10}$)

Title 19, Part 6 of the New Mexico Surface Mining Act requires the mine permittee to maintain all environmental permits and to be in compliance with other state or federal laws, regulations, or standards. Other applicable ambient air quality laws, regulations, and standards include those promulgated by the New Mexico Environment Department's Air Quality Bureau and the Environmental Protection Agency.

Federal and New Mexico Ambient Air Quality Standards (NMAAQS) exist for three categories of particulate. The categories and standards are as follows:

- Total suspended particulates (TSP) (20.2.3.109 NMAC)
  - 24-hour average: 150 micrograms per cubic meter (µg/m$^3$)
  - Annual geometric mean: 60 µg/m$^3$
- Particulate matter less than 10 micrometers ($PM_{10}$) (40 CFR 50.6(a))
  - 24-hour average: 150 µg/m$^3$
- Particulate matter less than 2.5 micrometers ($PM_{2.5}$) (40 CFR 50.7(a))
  - 24-hour average: 35 µg/m$^3$
  - Annual average: 15 µg/m$^3$

Fugitive dust from material hauling and conveying, stockpiles, and tailings impoundments may contribute air emissions of particulate matter categorized as $PM_{10}$ and TSP. Currently, no monitored data exists characterizing the local ambient air quality particulate concentrations in the vicinity of the Site. Based on the need to determine current background concentrations and to address potential public concern over future air quality impacts, NMCC recommends $PM_{10}$ monitoring at two locations.

$PM_{10}$ monitoring will demonstrate compliance with the NMAAQS health-based standard and help characterize TSP episodes to address the New Mexico standards for nuisance dust and soiling. The $PM_{10}$ monitoring program will follow EPA guidelines for methodology and quality assurance, and will use samplers with equivalence method designation.

The validated data capture goal is 75 percent based on quarterly and annual report periods.

Surface mining and milling for copper are not considered significant sources for $PM_{2.5}$ emissions. Monitoring for this parameter is not recommended due to potential emissions below significant thresholds.

## 2.3 Sampling Frequency

### 2.3.1 Meteorological Station

Meteorological sensors are to be scanned once each second. The data are compiled as averages and totals at hourly and 15-minute intervals.

### 2.3.2 Air Quality Station

$PM_{10}$ samples will be taken once every 6 days. Each scheduled sample will run for a period of 24 hours from midnight to midnight of the scheduled sample date.

## 2.4 List of Data to Be Collected

### 2.4.1 Meteorological

Meteorological data will be output hourly; averages and totals will be output every 15 minutes. See Table 2-1 for the meteorological data that will be collected and the instruments that will be used.

### 2.4.2 Particulate ($PM_{10}$)

In addition to collecting 24-hour average particulate matter as $PM_{10}$, the following supporting data will be collected:

- Flow rate in liters per minute
- Fluctuation of flow rate
- Average ambient temperature
- Average ambient pressure
- Total run time in minutes
- Total volume of air sampled

## 2.5 Methods of Collection

### 2.5.1 Meteorological Monitoring

Data will be collected and stored on a Campbell Scientific CR1000 datalogger. The datalogger will interface with a digital cellular modem allowing daily data downloads to a remote PC and monitoring of real-time meteorological conditions. The datalogger will have the capacity to store approximately 2 months of data on-site.

### 2.5.2 Air Quality Monitoring

Each sample filter will be collected manually following the end of the sample period and prior to the next scheduled sample. Filters will be labeled with individual serial numbers and tracked with chain-of-custody forms between the field and laboratory. The laboratory will ship pre-exposed filters to the field in individual glassine envelopes. No later than two days following the end of sample period, a field technician will place the exposed filters into the original glassine envelope and return the filters via express mail.

The designated $PM_{10}$ sampler is a model PQ200 manufactured by BGI corporation. The sampler flow controller will maintain flow rate at 16.7 liters per minute. The processor will output hourly and daily values for average ambient temperature and pressure, flow rate, pressure drop, and error alarms. The data log will be downloaded onto a field PC at the time of each filter change.

## 2.6 Parameters to be Analyzed

### 2.6.1 Meteorological Parameters

The meteorological tower will report hourly and 15-minute averages for the following parameters:

- Horizontal wind direction
- Horizontal wind speed
- Sigma theta of the wind direction
- Temperature at 10 meters (T10)
- Temperature at 2 meters (T2)
- Delta temperature as T10 minus T2
- Relative humidity
- Barometric pressure
- Net radiation
- Pan evaporation

In addition, the meteorological tower will report hourly and 15-minute totals for precipitation and evaporation.

### 2.6.2 Air Quality Parameters

$PM_{10}$ will be calculated as a 24-hour average using standard conditions of temperature and pressure to determine flow rates for each sample. The standardized temperature and pressure will be used in combination with net weight gain on the filter to determine the final $PM_{10}$ concentration in $\mu g/m^3$.

## 2.7 Maps Showing Proposed Sampling Locations

The map provided in Figure 2-1 plots the locations of the proposed particulate ($PM_{10}$) and meteorological monitoring stations. The air monitoring stations are designated as Site 1 and Site 2. Site 1 consists of one 10-meter meteorological tower and one $PM_{10}$ monitor. Site 2 consists of a single $PM_{10}$ monitor.

The air monitoring site coordinates are as follows:

- Site 1 – 0264721 meters E; 3650403 meters N; Elevation at 5,402 feet
- Site 2 – 0262618 meters E; 3651000 meters N; Elevation at 5,596 feet
- Mill Site – 0264363 meters E; 3650403 meters N; Elevation at 5,457 feet

All coordinates are expressed as Universal Transverse Mercator (UTM) coordinates in the NAD 83 mode.

## 2.8 Laboratory and Field Quality Assurance Plans

### 2.8.1 General

#### 2.8.1.1 Data Validation and Reporting

All data will be reviewed by a senior air quality professional retained by NMCC as it is received from the field. Any problems detected during the data review will be immediately communicated to the field technicians and then to the data reduction specialists. Data reduction specialists will compile the data on a monthly basis and produce monthly engineering units, math reports, and data capture summaries of the validated data. A senior air quality professional will prepare an operations summary for each month. The individual monthly reports and summaries will be compiled into an annual database from which an annual report will be produced. $PM_{10}$ data will be reported monthly and quarterly as specified by EPA guidelines and federal regulations.

All procedures for calculation and reporting of data capture and determination of compliance will be performed in accordance with the following, as appropriate:

- Paragraph 13 of Subsection D of 19.10.6.602 NMAC
- Instruction manual for the PQ200 air sampler version 1.83 (BGI, 2007)
- 40 CFR 50, Appendices H, J, and K to Part 50
- 40 CFR 58, Appendix B to Part 58
- EPA *On-Site Meteorological Program Guidance for Regulatory Modeling Applications, Quality Assurance Handbook for Air Pollution Measurement Systems,* Volume II: Ambient Air Specific Methods (Appendix D); and *Quality Assurance Handbook for Air Pollution Measurement Systems,* Volume IV: Meteorological Measurements (EPA 1987, 2008a, 2008b).

#### 2.8.1.2 Quality Assurance/Quality Control

The quality assurance audits will be conducted with personnel and equipment completely independent from the routine field operators and their chain of supervision. Audits of the particulate samplers will be performed every six months, with a total of two proposed for the first year. Monthly flow checks will be performed by the on-site technician. The tower-based meteorological sensors will be audited every six months, with a total of two audits scheduled for the first year. Problems encountered during the audits will be corrected at the time of the audit or immediately referred to the station operator. All audit results will be summarized in a separate report to be issued following each field visit.

All audit procedures and equipment will conform to the federal regulations and guidelines listed in the previous section.

### 2.8.2 Quality Assurance Procedures for Meteorological Station

The field quality assurance procedures and schedule for the meteorological tower are provided below:

| Procedure | Schedule |
|---|---|
| Perform general station check/visit | 2 times per month |
| Review data on a real time basis | Daily |
| Audit meteorological tower instruments | Biannually |
| Check operation of meteorological sensors | Each visit |
| Check datalogger output against ambient conditions | Each visit |
| Ship data to Albuquerque (field logs) | 1 time per month |
| Review data (field) | Each visit |
| Review data (home office) | Daily |
| Maintain documentation of all field activities | Each visit |

The station operator will document the findings and actions taken during each station check on pre-printed and bound station log forms. A guidance document outlining the procedures and required corrective actions, if applicable to maintain properly functioning instruments will accompany the station logbook.

Below is a summary of the meteorological field audit procedures to be followed by all air quality personnel. Although characterized as a summary, the procedures described follow the intent of the published EPA QA/QC guidelines and satisfy the project monitoring obligations. The general guidelines to follow in preparation for a field performance audit are as follows:

1. List all parameters to be audited. Include calculated parameters (e.g., delta T, temp. lapse, sigma theta).
2. List the model type(s) for all sensors to be audited.
3. Compare the standard procedures below with the parameter/sensor model to be audited and prepare an equipment list and an information list.
    a. The equipment list should include:
        i. Actual test equipment.
        ii. Tools and spare parts.
        iii. A computer interface (lap top, keyboard, etc).
    b. The information list should include (most of the information in the first five items can be found in the field quality assurance binders and reports from previous audits):
        i. Expected sensor output values.
        ii. Calibration factors for tower sensors and audit instrumentation (e.g., net radiation).
        iii. Programs and software (LoggerNet, copies of the datalogger program and channel outputs, an audit assistant spreadsheet, and look-up tables).
        iv. Wiring diagrams for the datalogger and other connections, if available.
        v. General data points and results from the previous audit, if available.

    vi. Instruction manuals, including Campbell Scientific CR1000, Raven modem, and sensor manuals as required.

    vii. A field quality assurance binder.

4. Pack-up, review the checklist, and leave.

Each meteorological sensor is evaluated based on the comparison of performance against EPA guidelines and manufacturer specifications. If any performance values are outside the recommended ranges, the results are immediately reported to field personnel so that any field repair and/or recalibrations can be performed expeditiously. The baseline summary report will include these results for documentation purposes.

Each meteorological sensor is calibrated using procedures specifically designed to test its accuracy of response. General descriptions are given below. These procedures reflect the requirements described in the *Quality Assurance Handbook for Air Pollution Measurement Systems* (EPA, 2008b). Upon arrival at the Site, each variable is observed for reasonableness. Next, the audit manipulations to each sensor are conducted. The datalogger outputs are recorded and compared to the audit input values. If the bias between the audit and Site values exceeds the prescribed limits described below, the appropriate troubleshooting is conducted to determine the cause of the discrepancy. At the conclusion of the audit, the sensors are put back on line and are again checked for reasonableness.

See Table 2-2 for a summary of meteorological audit criteria.

#### 2.8.2.1 Sensor Heights

During the Site visit, the height of each sensor above ground is measured with a standard tape measure or using trigonometric methods and a surveyor's transit. The measured heights are then compared to those stated in the air monitoring program plan.

#### 2.8.2.2 Wind Direction

*Vane Calibration.* Two factors must be checked to assure the wind vane is accurately measuring the wind direction: the azimuth as stated on the wind vane (orientation) and the ability of the wind vane to measure winds from all directions.

The preferred method for checking the wind vane orientation marker’s stated azimuth is the solar azimuth angle technique, which is used to determine a known direction (solar azimuth). This measurement is made using a surveyor’s transit mounted either on a field tripod or directly onto the wind direction sensor mounting plate. A measurement to a local topographical marker is then taken and the difference between that value and the known solar azimuth is used to determine a calculated azimuth angle for the reference marker. The resultant azimuth for the reference marker is used in a like manner to determine the orientation of the sensor crossarm (ideally set at 180 degrees). The solar azimuth check is normally done only once to establish a known direction for measurement of the orientation of the reference marker. A minimum of three bearings will be taken for this test. If the solar azimuth angle technique cannot be used, the azimuth angles will be measured with compass bearings.

A substitute (and second preference) for using the solar angle method is to measure the reference point azimuths from a topographic map. The sensor outputs, when aligned to the chosen reference points, are compared to the azimuths determined from the topographic map. This methodology requires accurate interpretation of the angles from the topographic map and knowledge that the chosen reference points are visible from the tower site. Additionally, at least one of the reference points needs to be greater than 10 kilometers from the tower site.

Regardless of which azimuth determination technique is used, the following should be adhered to by the field staff:

1. Select reference points with as great a distance possible from the tower site. The preferred approach is to have at least one point that is a minimum of 10 kilometers distant. If points of this distance are not available, extra care must be taken during the visual alignments.
2. Always prepare the basic field data before leaving for the Site (solar angle tables, azimuth to reference points, etc.).
3. Complete all preliminary data on the audit log forms. This data includes calibration constants of all audit instrumentation (as applicable) and expected output values for each test (as applicable).
4. Always run an equipment checklist prior to leaving for the Site. The content of the equipment list depends on the methodologies to be used.

The ability of the wind sensor to measure winds from any direction is tested by visually aligning the sensor with the reference markers established above, recording the output from the datalogger, and comparing the previously determined azimuths. To ensure accuracy, the wind vane is aligned with the crossarm and the corresponding output is recorded.

*Sensor Linearity and Overall Accuracy.* Sensor linearity is checked by removing the wind vane and replacing it with a protractor and angle fixture. Wind direction readings will be taken at 30 degree intervals for a total of 12 readings. This is the preferred method.

In the event a calibrated protractor is not available for a given type of sensor, the linearity will be checked by approximating 45 or 90 degree turns. A volt or ohm meter may be also be used for the alignments. As with the calibrated protractor, readings will be taken at approximately 30 degree intervals.

*Sigma Theta Test.* The wind direction sigma theta check is a test of the datalogger sigma theta calculation. Any system errors attributable to the program algorithm and/or the signal from the sensors are detected in the outputs at the datalogger. The theta test is conducted by fixing the wind vane at a given direction for a given period of time and then moving the vane approximately 30 degrees and leaving it at this setting for the same time period. The time interval is selected to correspond to one averaging period of the datalogger. During the selected time interval, the wind speed sensor is held stationary to prevent the vector averaging routine from interfering with the sigma theta audit. Sigma theta, average wind direction, and average wind speed are recorded from the datalogger and compared to the expected values.

The following items are important to ensure the accuracy of this test:

1. Ensure that the theta test corresponds to the averaging interval on the datalogger. Most systems calculate the sigma theta over a sub-interval period of either 10 or 15 minutes. Whenever a sub-interval period is in use, the averaging period of the datalogger (i.e., final output instruction) must be modified to correspond to this interval. Remember to always reset all changes made to the program before proceeding to the next audit parameter.
2. Synchronize the timing for the test to the datalogger clock, not necessarily with the auditor's watch. Repositioning of the wind vane (for the second half of the averaging interval) must occur as closely as

possible to the midpoint of the time interval. For example, the wind vane will be moved after 5 minutes for a 10-minute test and after 7.5 minutes for a 15-minute test.

3. Always record start and end values for time, wind directions, wind speeds, and protractor settings (when applicable).
4. Perform the sigma theta test on each datalogger within a monitoring network. On towers with multiple levels of sigma theta, perform the test on the level of the most significant interest.

*Starting Threshold Torque.* The wind vane's starting threshold torque is measured using a National Institute of Standards and Technology (NIST)-calibrated torque gauge. The gauge is applied to the wind vane shaft at the center of rotation and a constant force is applied. The test is repeated six to eight times beginning at different points for a 360-degree rotation. The value recorded is the highest value observed during the test.

If a calibrated torque watch is not available, the Jonard leaf torque gauge must be employed. This method requires a ruler (capable of measuring 10 centimeters [cm]) and a protected area where the sensor can be set up and leveled free from any air disturbance.

A manual, qualified, bearing check is acceptable only in combination with the above procedures for the purpose of a QA audit.

#### 2.8.2.3 Horizontal Wind Speed

*Sensor Calibration.* The sensor is audited by removing the anemometer cups and applying a constant rate of rotation in the normal direction of spin using synchronous motors. This is done by connecting the motor shaft to the anemometer shaft using a non-rigid, non-slip connector. Using the anemometer specifications, revolutions per minute (rpm) are converted to wind speed and compared to the resulting instantaneous datalogger outputs. The following precautions will be taken during the calibration procedure:

1. Avoid applying excessive pressure to the sensor shaft during the motor test. Excessive pressure will slow the rate of rotation.
2. Be certain all connections between the motor shaft and the sensor shaft are secure. Slippage can cause erroneous readings on the sensor.
3. Always have the expected output values and audit criteria recorded on the audit log.

*Starting Threshold Torque.* The starting threshold torque measurement of the anemometer shaft follows the same procedure as that described for the horizontal wind vane. Due to the lower resistance, a more sensitive torque watch is used.

#### 2.8.2.4 Temperature

The tower-mounted temperature sensor is audited by collocation at three points with an NIST-traceable thermometer in constant temperature water baths. The field thermometer has a range of at least -1° to 51°C in 0.1°C graduations and will be certified by comparison to an NIST-certified thermometer. The tests are conducted in the following temperature ranges: 0° to 5°C, 20° to 30°C, and 40° to 50°C. The equilibrated thermometer reading is compared to the datalogger output. Finally, the aspirator is checked for proper ventilation by inspecting operation of the fans, if applicable, and checking the air pathway for obstructions.

Occasionally, a water bath test is not possible. In this instance, the temperature probes will be audited by collocation with the NIST thermometer. The field (NIST) thermometer is to be collocated, under ambient conditions, in proximity to the tower sensor. If possible, the temperature probe will be placed inside the aspirator shield. Be certain not to contact any nearby surfaces with the field probe while conducting this test and keep in mind the following considerations:

1. In addition to recording readings from the field thermometer and individual tower probes, record the delta temperature and temperature lapse values, as calculated by the datalogger, simultaneously for each of the three water baths.
2. Note that small temperature differences within the water bath tests can induce large differences in the measured lapse rates. The passing criterion is 0.1°C.

#### 2.8.2.5 Precipitation

The precipitation gauges are audited using a 100–milliliter (ml) graduated buret (within 1 percent accuracy). Two types of tests are conducted: a 10-tip test and a bucket test. The 10-tip test is conducted before disturbing the outer housing of the gauge. To conduct the 10-tip test, the buret is opened to deliver water at the approximate rate of 5 seconds per cubic centimeter (cc) of water and allowed to flow until ten tips are identified. The delivered amount of water is converted to equivalent inches of precipitation and the result compared to the datalogger output. During the 10-tip test, it is important that the bucket does not overflow on the final tip (the tenth tip). Carefully monitor the flow rate following the ninth tip and quickly close the stop cock on the final tip of the bucket. The error introduced at this point can be minimized with careful control of the water flow rate and should not have a significant effect on the 10-tip average.

In the bucket test, water is delivered until the bucket tips one time. The delivered water is compared to the theoretical amount of precipitation needed for 0.01 inch of rain in each bucket. The bucket test is repeated at least three times for each bucket. Following the bucket tip tests, the sensor is checked for level and cleanliness.

#### 2.8.2.6 Barometric Pressure

The barometric pressure sensors will be calibrated according to manufacturer specifications. The sensor output will be checked by collocation with an aneroid or digital portable barometer. The portable barometer will be calibrated to an NIST-traceable mercury barometer immediately before the team leaves for the field. The mercury barometer and documentation of the certifications will be located at the NMCC Albuquerque office.

#### 2.8.2.7 Relative Humidity

The relative humidity sensors are audited by collocation under ambient conditions using an aspirated psychrometer or digital relative humidity (RH) meter. Both thermometers used in the psychrometer are certified using the procedures cited above for temperature. The equilibrated dry bulb and wet bulb thermometer readings and the datalogger output values are recorded. The audit relative humidity value is calculated from formulas contained in the Smithsonian Meteorological Tables, corrected for the measured ambient barometric pressure. The audit relative humidity is compared to the datalogger output and the result is considered satisfactory if the difference between the two is ±3 percent RH or less.

When conducting the relative humidity audit, it is important that the following considerations be observed:

1. Position the tower sensor as close to the inlet to the psychrometer thermometers as possible.
2. Be certain to shield the tower sensor and the psychrometer from direct sunlight.
3. Allow 2 or 3 minutes for the psychrometer to stabilize at the beginning of the test.

4. Perform at least two tests, preferably three.

#### 2.8.2.8 Net Radiation

The net radiation audit is accomplished through collocation of an audit pyranometer with the tower pyranometer. The mounting of the audit sensor should closely match that of the tower sensor, accounting for elevation, sun exposure, and level. The audit sensor should be of nearly identical spectral response as that of the tower sensor.

Readings from the two sensors can either be taken as discrete points over a pre-determined time interval or as an extended time average. Discrete readings should be taken over a minimum period of 2 hours with as many as 15 to 20 values distributed over the time interval. Extended averages can be taken with an independent volt meter (capable of collecting average data) over a minimum period of one hour. The following considerations apply:

1. Ensure that discrete readings of the audit and tower sensors are closely synchronized in time.
2. Start the extended averaging period on the digital volt meter (DVM) at the beginning of the corresponding period on the tower datalogger (hourly, 15 minutes, etc.).

#### 2.8.2.9 Station Locations and Orientation

During the field portion of the audit activities, the integrity of the station reference marker is checked by determining the azimuth angle with respect to true north and comparing that value to the value used by the station operator for the meteorological tower. This is accomplished by field measurement of the solar azimuth using a leveled surveyor's transit. The solar azimuth angle is previously calculated from a computer program and available to the auditor in tables at 5-minute intervals. Once the known azimuth angle of the sun is established, it is used to determine the azimuth of station reference marker(s). These values are compared to values determined by the station operator using other orientation methods.

#### 2.8.2.10 Station Sampling Environs

Part of the system audit is to document instrument fetch and local effects on data. The Site area obstructions, field of view, and local topography are examined. Nearby obstructions are located on the azimuth scale, heights are determined (when possible), and the distance from the tower is measured. All local environs data are evaluated, compared to regulatory guidance, and submitted with the audit report for inclusion in Site documentation files.

*Meteorological Data Validation Criteria.* The following criteria will be used in preparing the quarterly summaries for the Copper Flat meteorological data for this report:

1. Temperature Summaries (10-m temperature, 2-m temperature, delta temperature, and temperature lapse rate)

   The mean, maximum, and minimum temperatures (in degrees Celsius) are reported for each day in the quarter. The maxima and the minima are based on 1-hour averages. For a 24-hour mean value to be valid, at least 18 hourly values must have been recorded during the 24-hour period. If less than 18 hours of valid data are available, the mean is calculated, but data may not be representative and should be used with care. Similarly, maxima and minima are included for these periods. Even though some data may have been available on these days, the maxima and minima may be misleading if the missing data was for the hottest or coldest part of the day.

For each month in the quarter, the mean temperature for the month is calculated from all of the hourly data, including the data from the days that did not have sufficient data to calculate a 24-hour mean. Monthly averages are calculated for months with less than 4 valid 24-hour means. The monthly maximum and minimum are also reported. Although 4 days of valid data are considered enough to report a mean, means for months with less than 18 days of valid data may not be representative and should be used with care.

A quarterly mean, maximum, and minimum are reported if there is at least one valid month of data in the quarter. However, these values may not be truly representative of the entire quarter if significant amounts of data are missing. The validity of the quarterly values depends on their intended use, and care should be taken with quarters with low data capture.

2. Wind Speed Summary

   The 24-hour mean wind speed and the maximum hourly wind speed are reported for each day of each month (in meters per second). The criterion for a valid 24-hour means is the same as that described above for mean temperatures.

   The monthly mean wind speed and the maximum wind speed are also reported. The criteria for determining the monthly values are the same as those described above for monthly temperature values. Likewise, the mean for the entire quarter and the maximum hourly value in the quarter are reported, using the criteria described above for quarterly temperature values.

3. Wind Data Summary

   The wind data summary report gives a joint frequency distribution (JFD) for wind direction and wind speed. Wind direction is divided into 16 sectors, each representing 22.5 degrees. The north sector covers 348.75 degrees to 11.25 degrees (i.e., its axis of symmetry is zero degrees). Wind speeds are divided into 8 categories. The data in each wind speed/wind direction category are given as a fraction of the total month to the nearest 1 percent. The total fraction for each wind direction sector and each wind speed category is also given.

   A quarterly JFD is printed if at least one valid month of data existed in the quarter. However, the quarterly JFD may not be truly representative of the full quarter if only one month of data is available.

4. Precipitation Summary

   The total daily precipitation in inches is reported for each day in the quarter, along with a running precipitation total beginning on the first day of the quarter. Daily precipitation is reported if at least one hour of data is available during that day.

   The total quarterly precipitation is reported along with the total number of hours during which precipitation occurred. A quarterly precipitation value is reported if there is any valid precipitation data during the quarter. Care must be taken when using quarterly precipitation values if there were significant missing data during the quarter.

5. Relative Humidity Summaries

   The daily mean, maximum, and minimum relative humidity (in percent) are reported for each day in the quarter. The maxima and minima are based on 1-hour averages. For a 24-hour mean value to be valid, at least 18 hourly values must have been recorded during the 24-hour period. If less than 18 hours of valid data are available, the mean is calculated, but data may not be representative and should be used with care. Similarly, maxima and minima are included for these periods. However, the maxima and minima may be misleading if the missing data were for the hottest or coldest part of the day.

The monthly mean relative humidity is calculated from all of the hourly data, including that from the days without sufficient data to calculate a 24-hour mean. Monthly averages are calculated for months with less than 4 valid 24-hour means in the month. The monthly maximum and minimum are also reported. Although 4 valid days are considered sufficient to report a mean, monthly means based on less than 18 days of valid data may not be representative and should be used with care.

A quarterly mean, maximum, and minimum are reported if there is at least one valid month of data in the quarter. However, these values may not be truly representative of the entire quarter if significant amounts of data are missing.

6. Data Capture Summary

   The percent of valid data, based on hourly values, is reported for each month and each parameter; the average data capture for the entire month is also reported. In addition, the percent of valid data for the quarter for each parameter and the average data capture for the quarter are provided.

7. Barometric Pressure Summary

   Barometric pressure is provided in millibars and represents the actual Site pressures; these data have not been “corrected” to sea level as is typically done with National Weather Service data. The reporting requirements for valid averages, maxima, and minima are the same as those for temperature and relative humidity summaries.

8. Net Radiation Summary

   The maximum net radiation in watts per square meter is reported for each day in the quarter. The maxima are based on 1-hour averages.

9. Evaporation Summary

   The total, minimum, and maximum evaporation values are reported in inches for each day of the quarter. Minima and maxima are based on 1-hour averages. Positive values indicate evaporation, or loss of water from the evaporation pan, whereas negative values indicate precipitation or addition of water to the evaporation pan for other reasons.

   For a 24-hour total value to be valid, at least 18 hourly values must have been recorded during the 24-hour period. If less than 18 hours of valid data are available, the total is calculated, but data may not be representative and should be used with care. Similarly, the maximum and minimum are included for these periods, but may be misleading if the missing data occurred in the hottest or coldest part of the day or during a precipitation event.

   The total monthly evaporation is calculated from all the hourly data for each month in the quarter, including the data from days with insufficient data to calculate a 24-hour total. The monthly maximum and minimum are reported as well.

   Validated data includes natural precipitation events. Scheduled and manual re-filling events are removed from the reported data set.

### 2.8.3 Quality Assurance Procedures for Air Quality Station

The field quality assurance procedures and schedule for the air quality station are provided below (EPA, 2008a):

| Procedure | Schedule |
|---|---|
| Change particulate filters | Every 6 days |
| General station check/visit | At each visit |
| Flow rate check particulate samplers ($PM_{10}$) | Monthly |
| Audit flow check of particulate samplers | Every 6 months |

During monthly sampler flow checks, the flow rate is adjusted to be within 4 percent of 16.67 liters per minute (l/min) under ambient conditions. Ambient temperature and pressure taken at the time of the flow checks/adjustments are used to calculate a correction factor. The correction factor is used to calculate actual flow rates ($Q_{ACT}$).

Actual flow rates are converted into standard flow rates ($Q_{STD}$) at standard temperature (298°K) and pressure (760 mm Hg). The filter weight gain is determined to be the difference between the unexposed filter weight and the exposed filter weight. Both $Q_{ACT}$ and $Q_{STD}$ together with net weight gain are used to determine the 24-hour particulate concentration in micrograms per cubic meter ($\mu g/m^3$).

## 2.9 Discussion in Support of Proposal

### 2.9.1 Total Suspended Particulates

Currently no NMAAQS exists for TSP. However, the state of New Mexico retains a TSP ambient air quality standard for nuisance dust and overall welfare type of impacts. Given the lack of residences and restricted public access to the mine areas, NMCC does not anticipate nuisance dust to be a significant problem, at least for the near term of the project. However, the project recognizes potential public concern for TSP impacts. NMCC proposes to use $PM_{10}$ monitoring, as described in the following section, to estimate TSP concentrations based on monitored $PM_{10}$ values.

### 2.9.2 Particulate Matter Less than 10 Micrometers

In 1987, the EPA adopted $PM_{10}$ as the NMAAQS for particulate matter, replacing TSP. Since that date, $PM_{10}$ has been one of the particulate matter health standards at the federal and state levels. $PM_{10}$ has potential local impacts due to releases from the ground level and elevated stack sources. A review of the New Mexico Energy, Minerals and Natural Resources Department (EMNRD) Mining and Minerals Division (MMD) regulations (Title 19, Part 6) revealed no specific requirement for an air quality monitoring plan to protect the environment. Additionally, a survey of several non-coal mines in New Mexico revealed no requirements for particulate monitoring.

Fugitive dust from material hauling and conveying, stockpiles, and tailings impoundments may contribute air emissions of particulate matter categorized as $PM_{10}$ and TSP. Currently, no monitoring data exists characterizing the local ambient air quality particulate concentrations in the vicinity of the Site. Based on the need to determine current background concentrations and potential public concern of future air quality impacts, NMCC recommends $PM_{10}$ monitoring at two locations.

$PM_{10}$ monitoring will demonstrate compliance with the NMAAQS health-based standard and help characterize TSP episodes to address the New Mexico standards for nuisance dust and soiling. The $PM_{10}$ monitoring program will follow EPA guidelines for methodology and quality assurance, and will use samplers with equivalence method designation.

NMCC proposes using the PQ200 low-volume (16.67 l/min) sampler manufactured by BGI. The sampler uses a 47-mm Teflon filter and is powered by a 100-amp hour gel cell lead acid battery. It uses a photovoltaic panel for charging. The sampler has EPA equivalence method designation for both $PM_{10}$ and $PM_{2.5}$.

## 2.10 References

Air Sciences Inc., 1995a, Meteorological data report, Copper Flat project, November 1, 1994 – January 31, 1995, prepared for Alta Gold Company, Truth or Consequences, New Mexico: Lakewood, Colo., Air Sciences, Inc.

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BGI, June 2007, PQ200 & PQ200A air sampler instruction manual, $PM_{2.5}$ Designation RFPS-0498-116, $PM_{10}$ Designation RFPS-1298-125, version 1.83: Waltham, MA, BGI Incorporated.

Bureau of Land Management (BLM), March 1996, Draft environmental impact statement, Copper Flat project: Las Cruces, N. Mex., U.S. Department of the Interior. Prepared by ENSR, Fort Collins, Colo.

——— BLM, 1999, Preliminary final environmental impact statement, Copper Flat project: Las Cruces, N. Mex., U.S. Department of the Interior, 491 p. Prepared by ENSR, Fort Collins, Colo.

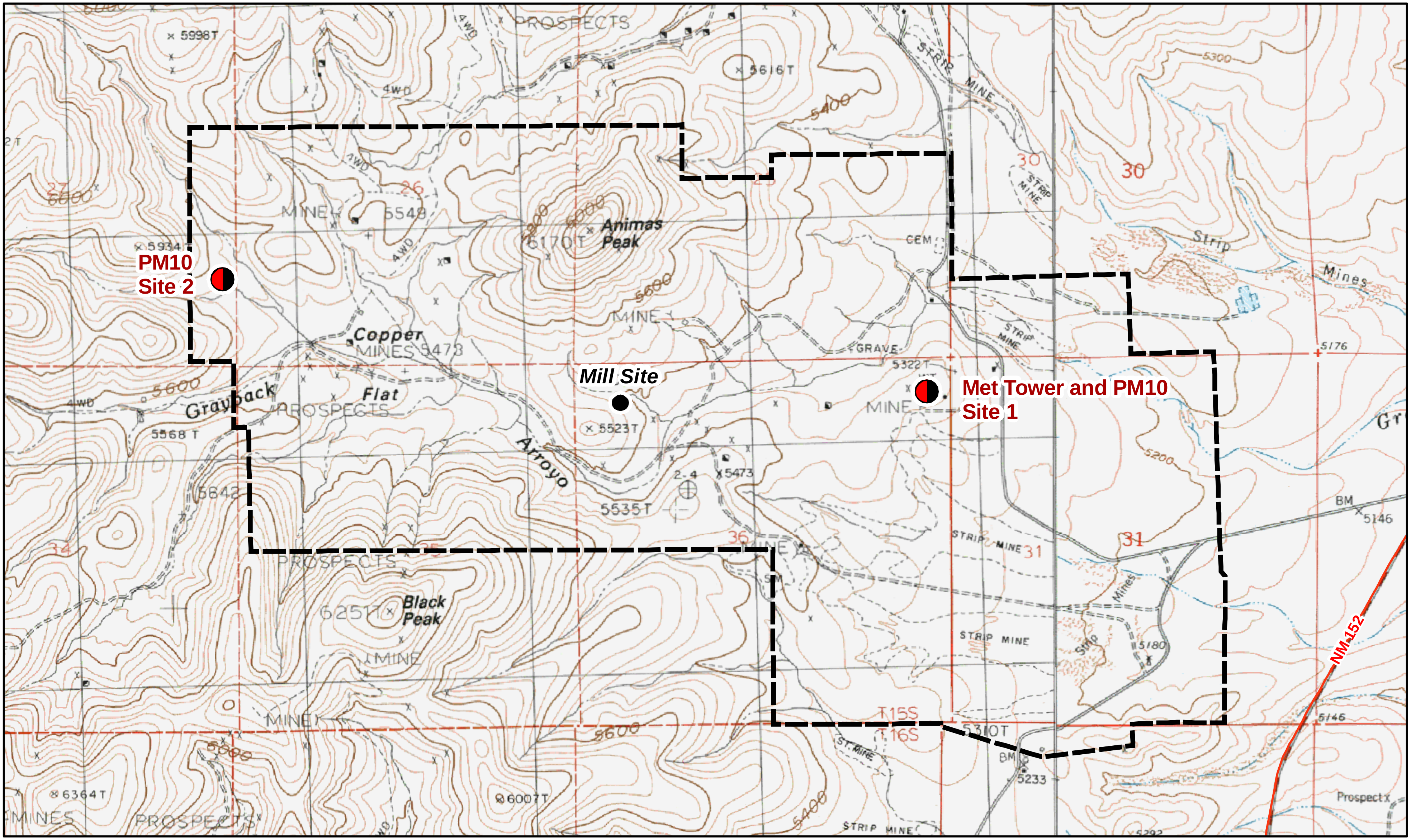
Environmental Protection Agency (EPA), 1987, On-site meteorological program guidance for regulatory modeling applications, EPA document EPA-450/4-87-013.

——— 2008a, Quality assurance handbook for air pollution measurement systems, volume II: ambient air specific methods (appendix D), EPA document EPA-454/B-08-003.

——— 2008b, Quality assurance handbook for air pollution measurement systems, volume IV: meteorological measurements, EPA document EPA/454/B-08-002.

Steffen Robertson and Kirsten (U.S.), Inc. (SRK), 1995, Copper Flat Mine, hydrogeological studies: Reno, Nev.

# Figure




Sample Locations:
Class One Technical Services
Mine Boundary:
Tom Van Bebber
Imagery Information:
-USGS 7.5-Minutes Quads; Skute
Stone Arroyo & Hillsboro
Projection Information:
-New Mexico State Plane West, NAD 1927

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Feet

**Legend**

Proposed Mine Permit Boundary

**Figure 2-1**
**Topographic Map Showing the Locations of the Proposed Particulate ($PM_{10}$) and Meteorological Monitoring Stations**
**New Mexico Copper Corporation**

# Tables

**Table 2-1**

**Meteorological Data to be Collected**

| Parameter | Tower Level (m above ground surface) | | | Equipment Manufacturer and Model |
|---|---|---|---|---|
| | 0 | 2 | 10 | |
| Horizontal Wind Direction | | | X | Climatronics F460 |
| Horizontal Wind Speed | | | X | Climatronics F460 |
| Ambient Temperature | | X | X | Climatronics 100093<br>Motor Aspirated |
| Temperature Lapse (2–10 m) | | X | X | Climatronics 100093<br>Motor Aspirated |
| Pan Evaporation | X | | | NovaLynx |
| Relative Humidity | | X | | Climatronics 100098<br>Motor Aspirated |
| Net Radiation | | X | | Kipp and Zonen |
| Precipitation | X | | | Climatronics<br>Tipping Bucket |
| Barometric Pressure | | X | | Setra |

**Table 2-2**

**Summary of Meteorological Audit Criteria**

| Parameter Tested | Acceptable EPA Deviation or Satisfactory Criteria |
|---|---|
| Wind Direction | |
| Vane Orientation | ± 5° from reference |
| Sensor Linearity | ±3° at any of the 12 points checked |
| Starting Torque | See manufacturer specifications |
| Horizontal Wind Speed | |
| Sensor Calibration | ± 0.25 m/s at speeds < 5 m/s<br>5% at speeds > 5 m/s<br>(max. error 2.5 m/s) |
| Starting Torque | See manufacturer specifications |
| Temperature | ± 0.5°C at all 3 points checked |
| Temp. Lapse | ± 0.1°C |
| Precipitation | ± 10% difference |
| Barometric Pressure | ± 10.2 millibars (mb) |
| Relative Humidity | ± 3% |
| Net Radiation | ± 5% difference |
| Evaporation | ± 10% difference |

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## List of Figures

# 3 Topography

## 3.1 Introduction and Background

A topographic map of the Copper Flat Mine Permit Area (Site) and the surrounding area at a scale of 1:24,000 (where 1 inch equals 2,000 feet) is shown in Figures 3-1, 3-2, and 3-3. Off-site sampling locations are shown in the respective sections of this SAP at the appropriate scale. In addition to topography, these figures show:

- The boundaries of the Site.
- Various manmade features not enumerated herein.
- Proposed sampling locations for soil characterization analysis.
- Surface water features.
- Groundwater wells.
- Air monitoring stations.
- Weather stations.
- Wildlife and vegetation transects.
- Paved and dirt roads.
- A conceptual mine layout showing the basics of the proposed mining operation, including the proposed locations of all surface features such as structures, stockpiles, tailings, pits, adits, shafts, etc.

An aerial photograph covering the same area as Figure 3-1 is presented in Figure 3-2, illustrating the site boundary, disturbances from previous mining and mineral development activities, including roads, pit, waste dumps, tailings, diversion channel, scraped and developed plant facilities areas, and other disturbed lands.

## 3.2 Sampling Objectives

The objective of the proposed data collection is to verify the existence, condition, and use of features within and immediately around the Site in advance of mining in order to supplement existing topographic data. This baseline data will assist in the design of the facility and the reclamation and replacement of features.

## 3.3 List of Data to be Collected

No topographic data other than the global positioning system (GPS) data collected for sampling locations, as described in each individual resources section of this SAP, will be collected. Existing USGS topographic maps and publicly available aerial photography will be used to display the sampling points collected in the field within the context of the Site or project area.

## 3.4 Methods of Collection

Field surveys will be conducted across the Site and samples will be collected at locations up to 9.2 miles from the Site to establish the existence and location of the features enumerated in Section 3.1 by means of a Global Positioning System (GPS) unit. The surveys will be conducted concurrently with other field work.

Site topography is considered to be well established by U.S. Geological Survey (USGS) topographic maps, and will be verified by comparison between topographic maps and current aerial photographs.

## 3.5 Parameters to be Analyzed

The parameters to be analyzed are the Site baseline topography and locations of existing manmade features.

## 3.6 Maps Providing Sampling Locations

See Figure 3-1, 3-3, and 3-4 for a topographic map and manmade features up to 9.2 miles from the Site. See Figure 3-2 for an aerial photographic perspective. Off-site sampling locations are shown in figures included in the respective sections of this SAP.

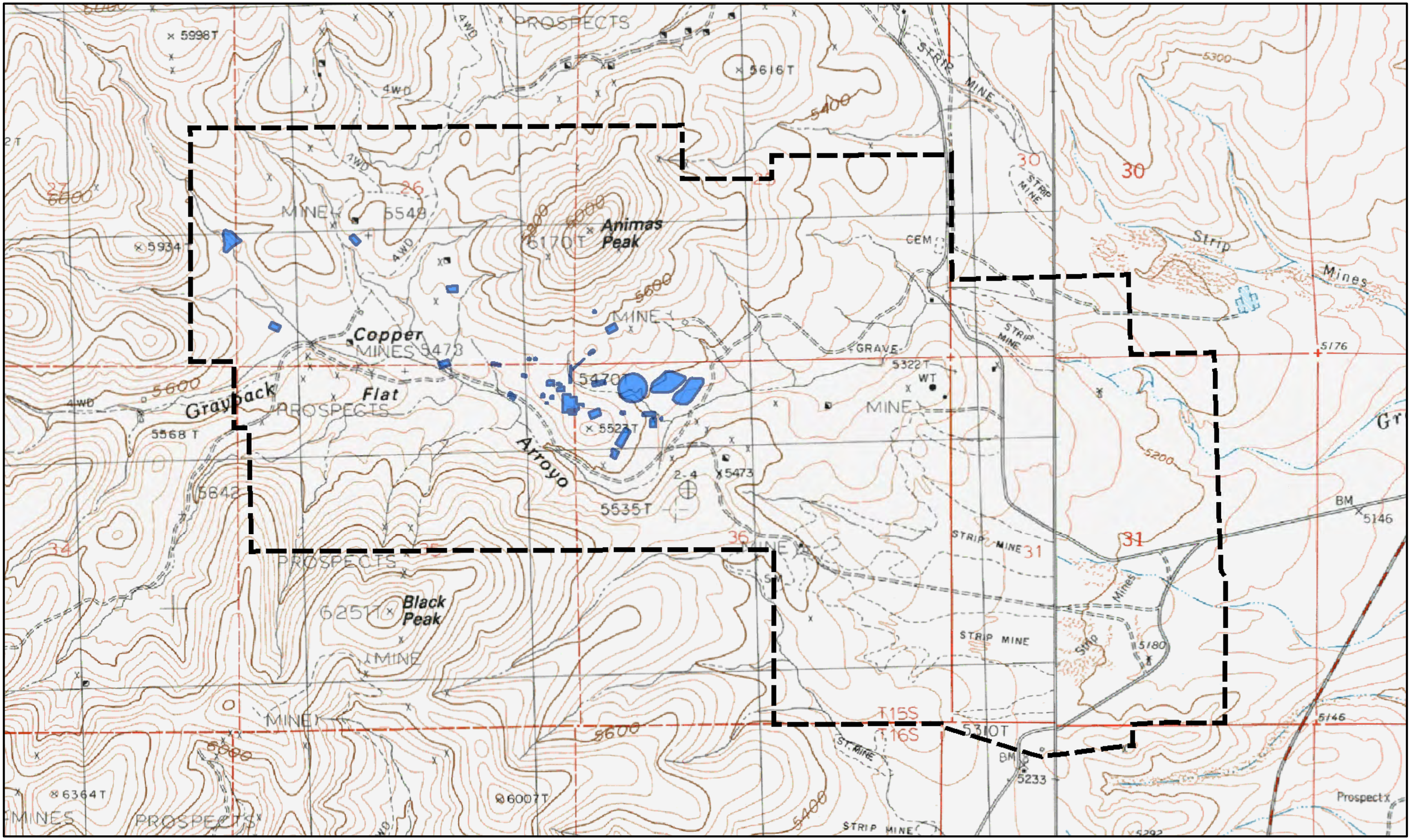
## 3.7 Sampling Frequency

Field surveys to verify manmade features will be performed concurrent with other field activities during 2010 and 2011.

## 3.8 Laboratory and Field Quality Assurance Plan

There are no analytical laboratory requirements for topographical field work. New Mexico Copper Corporation (NMCC) may utilize subcontractors to assist with gathering updated information about the baseline topographic condition of the Site. Licensed field surveyors and aerial photographers will be selected based on their qualifications and certifications. Subcontractors and in-house personnel will follow quality assurance/quality control procedures as described in the Quality Assurance Project Plan. The NMCC Task Manager or designee will select a coordinate system consistent with state requirements in order to relate all base maps and surface features to the same system. Field Leaders will verify the existence and location of manmade features as they walk the Site for other data collection activities. If necessary, the features or objects will be tied to the nearest benchmark. Digitized aerial photographs and derived contours will be used for design, baseline data presentation, and baseline conditions for reclamation and re-vegetation.

# Figures

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Mine Boundary:
Tom Reynolds
Facilities:
SRK, 2010
Imagery Information:
-USGS 7.5-Minutes Quads; Skute Stone Arroyo & Hillsboro
Projection Information:
-New Mexico State Plane West, NAD 1927

**Legend**

Proposed Mine Permit Boundary
Proposed Mine Facilities

**Figure 3-1**
**Topographic Map of the Site and Surrounding Area**

**New Mexico Copper Corporation**

INTERA

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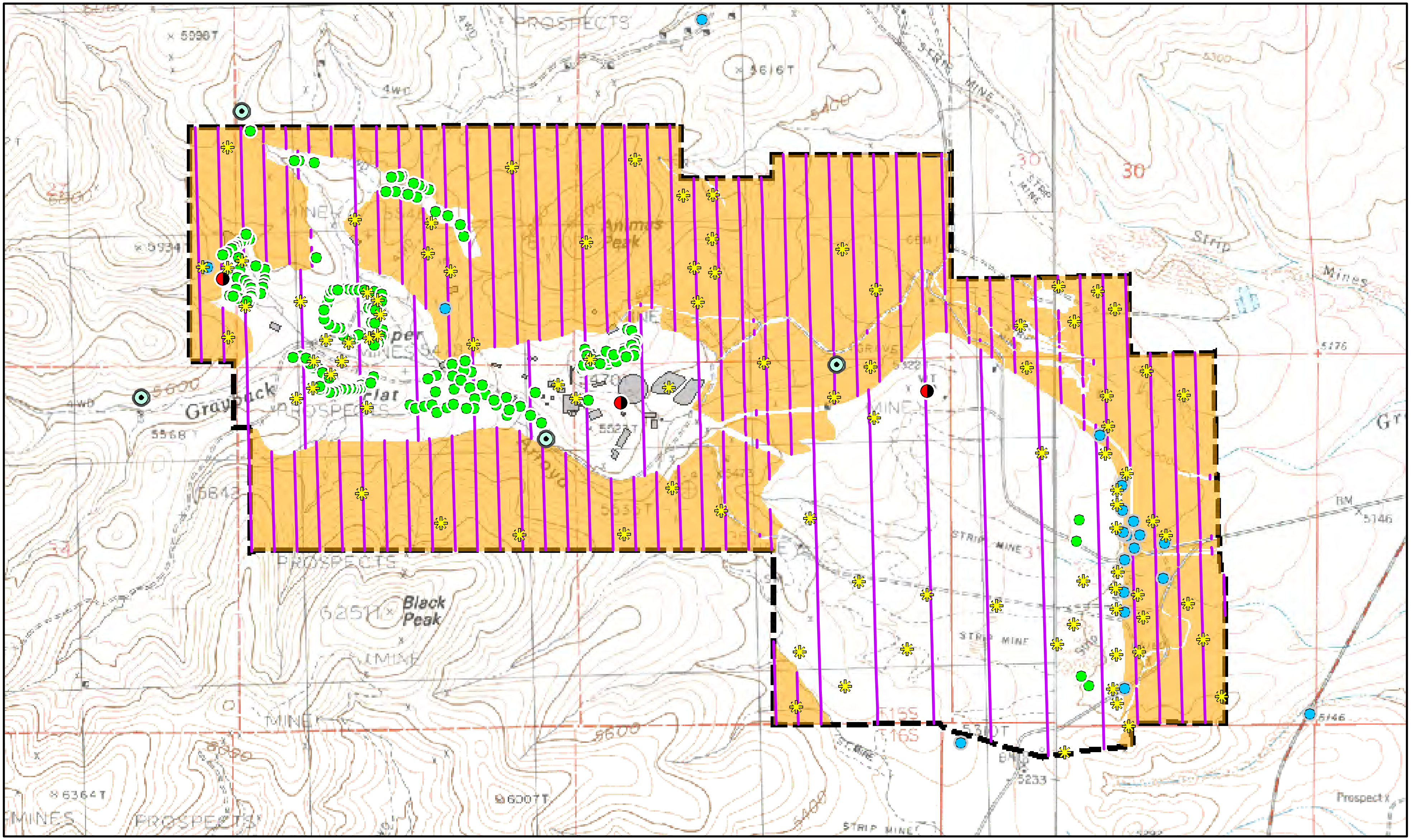
Mine Boundary:
Tom Reynolds
Facilities:
SRK, 2010
Imagery Information:
-USGS 7.5-Minutes County DOQQ
mosaic Sierra County, 2009
Projection Information:
-New Mexico State Plane West, NAD 1927

0 1,000 2,000 4,000 6,000
Feet

**Legend**
Proposed Mine Permit Boundary
Proposed Mine Facilities

**Figure 3-2**
**Aerial Photograph of the Site**
**New Mexico Copper Corporation**




Mine Boundary:
Tom Reynolds
Sample Locations:
SRK, 2010
Imagery Information:
-USGS 7.5-Minutes Quads; Skute Stone Arroyo & Hillsboro
Projection Information:
-New Mexico State Plane West, NAD 1927

INTERA

**Legend**

Proposed Mine Permit Boundary
Proposed Mine Facility
Proposed Sampling Locations
Vegetation Transect
Geologic Sample
Climate & Air Quality Sample
Monitoring Well
Surface Water Sample
Cultural Resources Survey
Wildlife/Soil Transect

**Figure 3-3**
**Topographical Map with Boundary**
**New Mexico Copper Corporation**

S:\Projects\NMC-001_New Mexico Copper Corporation\GIS\Maps\SAP_7-2010\3_topography\3-3_sample-locations.mxd 09/03/2010

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# 4 Vegetation

## 4.1 Introduction and Background

Mining activities and infrastructure constructed by the Copper Flat Partnership, ca. 1982, combined with previous mining-related activities, have contributed to the disturbance of approximately 690 acres within the Copper Flat Mine Permit Area (Site) (BLM, 1999); 358 acres is on public lands and 331 acres is estimated on private lands (according to disturbance acreages listed in BLM, 1999). New calculations by Parametrix total a total disturbed area of 965 acres for the Site, based on digitizing high resolution 2009 aerial photography (Figure 4-2). The Site was reclaimed in 1986, although it appears that only relatively small portions of the Site were actively revegetated. Baseline data has been collected at the Copper Flat project starting in the late 1970s by Quintana, followed by Rio Gold Mining Ltd (Rio Gold), Gold Express, and Alta Gold (related to the 1999 PFEIS). These data are relevant and provide insights for future permitting activity. Information from these previous baseline surveys have been researched and utilized to augment this current sampling process where appropriate.

The history of repeated disturbance at this Site has dramatically impacted vegetation communities. Current vegetation community distribution in the mined areas is more strongly correlated with previous land use than with the biotic or abiotic factors that typically render the distribution of vegetation types or vegetation potential. Given this, the “baseline” vegetation condition for portions of the Site include tailings piles, a tailings dam, barren areas, waste dumps, various roads, diversion channel, pits and pit lake, and other disturbed areas. However, relatively undisturbed areas are also still present within the permit boundary (Figure 4-2).

Biologists surveyed the Copper Flat permit area in April 2010 to assess the relative abundance of individual plant species and perform a preliminary inventory (Parametrix, 2010). During this visit, a total 93 plant species were observed. Additionally, 18 vegetation transects (six each in the control, tailings dam, and tailings piles) were completed to provide a basis for determining vegetation sampling adequacy. The statistical analysis revealed that the data collection methods proposed in this report should achieve the intended sampling objectives for evaluating the important vegetation attributes as outlined in New Mexico Energy, Minerals and Natural Resources Department (EMNRD) Mining and Minerals Division (MMD) guidance documentation (MMD, 2010).

## 4.2 Sampling Objectives

The proposed sampling and analysis approach intends to capture the current vegetation condition throughout the permit area to meet the following sampling objectives:

1. Delineate a current vegetation map stratified according to disturbance history and Ecological Site Description.
2. Describe specific vegetation attributes for plant communities delineated within the permit area through quantitative measurements of:
   - Basal vegetation cover by species and ground cover.
   - Aerial vegetation cover by species.
   - Woody plant density.
   - Herbaceous productivity.
   - Plant species richness and diversity.
3. Complete a plant species inventory.
4. Perform a threatened or endangered species survey.

## 4.3 Sampling Frequency

The growing season for warm season (C4) grass species is typically April through August in New Mexico. Since biomass production rates typically increase with precipitation, quantitative data collection transects will be performed during the late summer following monsoons to accurately capture annual biomass production. This time period is also representative of peak vegetation cover during most years and is considered a favorable period to identify many plant species. Plant cover (especially by annuals) can be greatly reduced after the first frost.

As previously mentioned, an additional plant inventory will be performed during the late summer/early fall. The spring survey was completed in April 2010.

## 4.4 List of Data to be Collected

A vegetation survey was completed at the Site during 1996 (SRK, 1997) in support of Alta Gold Company's proposal to re-open the Copper Flat Project. The survey employed a modified Parker Three-Step method to characterize vegetation composition, density, and biomass production of native perennial plants. The Parker Three-Step method uses a cluster of three transects in a stratum to characterize the desired vegetation attributes. Unfortunately, the original datasheets or data summaries by cluster are no longer available from this effort. The only information currently available pertains to the dominant native species encountered at each cluster. A recent effort to relocate metal stakes marking the 1996 transects was also unsuccessful. Consequently, the previous information cannot be incorporated into the current vegetation assessment for trend analysis or other purposes. Information collected during the April 2010 preliminary vegetation assessment (Parametrix, 2010) will be incorporated into future work, primarily to supplement the plant inventory, and was also used as a basis for estimating sample adequacy for this plan.

In order to meet the sampling objectives, several additional data needs have been identified and are summarized in Table 4-1.

## 4.5 Methods of Collection

### 4.5.1 Site Stratification

The permit area lies within the transition zone between Chihuahuan Desert Scrub and the Desert Grassland Ecotone according to Dick-Peddie (1999). Though the entire permit boundary technically lies within the Chihuahuan Desert Scrub type, the delineation line between these two types is only about 200 meters (m) west of the permit boundary. Two Natural Resources Conservation Service (NRCS) Major Land Resources Areas actually converge within the permit area. Much of the western half is considered Mogollon Transitions (Interior Chaparral – Woodlands/Grassland subclass), while the eastern half is predominantly characterized as Southern Desertic Basins, Plains, and Mountains (Chihuahuan Desert Shrubs subclass) (NRCS, 2007). The convergence of two landscape scale vegetation classes under both sources (NRCS, 2007 and Dick-Peddie, 1999) may create a relatively unique ecotone at Copper Flat.

The permit area will be stratified according to existing disturbance, proposed disturbance, and NRCS Ecological Site Description (ESD). This stratification serves as an initial vegetation map and also facilitates a stratified-random sampling design for field data collection. Figure 4-1 outlines a process for stratifying the Site and the total number of transects in each stratum. As already mentioned, previous mining activities have significantly impacted vegetation in portions of Copper Flat. Statistical analyses of the data collected during the 2010 preliminary assessment found significant differences in shrub density, grass cover, and species diversity among the tailings dam, tailings piles, and control areas. In consideration, the disturbed areas will be stratified according to whether the area is a tailings pile, pit, or tailings dam. Some areas (namely previous mining pits) are void of vegetation altogether but reflect the pre-mining vegetation condition in these areas under the current permit application. Consequently, this stratum will also be included in sampling.

Two ESDs are delineated in the permit area, Gravelly and Hills. ESD delineations will form the basis for stratifying currently undisturbed portions of the Site. Some of these areas may become waste rock areas, tailings impoundments, etc. during proposed future mining. The areas that are planned to be disturbed during future mining will be isolated as a separate stratum by ESD during sampling. Meanwhile, areas currently undisturbed where future disturbance is *not* proposed will be sampled and will serve as a control. Transects occurring in the control area will be permanently marked with a survey nail and whisker on both sides of the transect tape.

The ESDs described at Copper Flat include Gravelly (R042XB010NM) and Hills (R038XB102NM). The Gravelly ESD in this portion of New Mexico has been particularly susceptible to desertification and creosote (*Larrea tridentata*) expansion or invasion. Most of the undisturbed Gravelly portions of Copper Flat are still in a shrub savanna condition with diverse grasses, consistent with the historical climax plant community typified for this area. In fact, creosote was not observed at the Site during the preliminary site assessment. Undisturbed portions of the Hills ESD at Copper Flat also match a historical climax condition relatively well. These areas are dominated by sideoats grama (*Bouteloua curtipendula*) and other mixed grasses with well distributed shrubs. Establishing permanent control transects in these areas will assist in monitoring vegetation community change irrespective of mining disturbance in the permit area.

ESD delineations will be particularly useful since it can be difficult to delineate unique vegetation types in grasslands or scrub shrub communities that appear relatively homogenous on the surface (NRCS, 2010). ESDs are also useful for gauging vegetation potential, describing the seral state of the current community, and defining typical plant community transitions under disturbance or climatic conditions (such as drought). Data comprising an ESD is presented in four major categories (NRCS, 2010):

- Site Characteristics: Identifies the Site and describes the physiographic, climate, soil, and water features associated with the Site.
- Plant Communities: Describes the ecological dynamics and the common plant communities comprising the various vegetation states of the Site. The disturbances that can cause a shift from one state to another are also described.
- Site Interpretations: Provides interpretive information pertinent to the use and management of the Site and its related resources.
- Supporting Information: Provides sources of information and data used in developing the Site description and the relationship of the Site to other ecological sites.

### 4.5.2 Plant Species Inventory

A preliminary plant species list was compiled in April 2010. This list will serve as a spring inventory for the Site. An additional late summer/early fall inventory will be completed in the permit area during September 2010. The intent of these surveys is to capture a complete plant species list at the Site, including fall or spring annuals and species that can be difficult to definitively identify outside of their flowering and/or fruiting period.

### 4.5.3 Rare, Threatened, or Endangered Plant Species

Inventories will pay particular attention to the presence or absence of agency-,state-, or federally regulated rare, threatened, or endangered species. Field botanists will research documented nearby locations and habitat requirements of species of concern before completing the inventory. If a species of concern is encountered, a

Global Positioning System (GPS) file will be recorded. Species closely resembling a species of concern will be photographed and/or collected following the discretion of the field botanist and appropriate regulations. No species of concern were observed during the April 2010 preliminary assessment.

### 4.5.4 Noxious Weeds

If state- or federally listed noxious weeds are encountered, the specific location will be documented with a GPS receiver. Noxious weeds were not observed during the preliminary site assessment.

### 4.5.5 Sampling Methodology

This section describes the sampling methodology proposed for collecting quantitative vegetation data at Copper Flat. A map (supplied by New Mexico Copper Corporation and Steffen Robertson and Kirsten [SRK]) of the lands previously disturbed and proposed disturbance was used in determining the intensity of sampling and the distribution of transects. Sampling adequacy was based on recommendations from the preliminary site assessment (Parametrix, 2010).

#### 4.5.5.1 Transect Distribution

A stratified-random sampling approach will be used to characterize the current vegetation condition throughout the Site. The total number of transects per stratum was determined by reviewing the results of sampling adequacy calculations following the preliminary site assessment (Parametrix, 2010) and weighting the sample size according to total acreage of the stratum. Sample adequacy is a statistical measure used as a means to assist with determining the sample size that is required to statistically evaluate specific monitoring objectives. According to the preliminary assessment (Parametrix, 2010), the transect number needs to be increased to six (a minimum of ten is recommended in this report), and the transect length should be extended to 50 m. Both of these recommendations are captured in the sampling design proposed in this report. Further dividing "control" areas by Ecological Site Description may also help to reduce variability between the ESDs.

Figures 4-1 and 4-2 articulate how the Site will be stratified for random plot generation. The proposed mine permit boundary is just under 2,200 acres. Of this, the total combined acreage of existing disturbance is approximately 965 acres (Figure 4-2). A sample size of 93 transects is recommended within the permit boundary. See Figures 4-1 and 4-2 for the total number of transects per stratum and the overall transect distribution at the Site.

Transect locations were randomly selected using the random point generation function within Hawth's Analysis Tools ArcGIS plug-in. During this process, the required number of random transects was placed in each stratum. A 40-m buffer was enforced at transition lines between strata and also between individual transects to reduce cross sampling. The resulting geographic coordinates will be transferred to a GPS receiver for field navigation to the target locations. If field conditions do not match the stratum intended, the transect will be moved to a nearby location in the target stratum. After arriving at the sample point, personnel will take a digital photograph in the transect location, and then stretch a transect tape to record quantitative information specific to characterizing cover, production, density, and diversity at each individual stratum.

#### 4.5.5.2 Cover

At the beginning point of each transect, a 50-m tape will be stretched along the ground towards a random direction determined by spinning the compass dial without looking. Cover will be measured with a laser device at stations along the transect using the point-intercept method. The device consists of two green-light laser pointers fixed to a piece of angled aluminum beam and mounted on a camera tripod. Each laser produces a point of light 1 to 2 millimeters (mm) in diameter. Readings will be taken to the right and left of the tape 1 m apart along the entire 50-m tape, resulting in a total of 100 points recorded along each transect.

Both aerial vegetation cover and ground cover will be recorded at each sample point. Aerial cover will be recorded by species. In situations where multiple species are intersected by the laser, both species will be recorded. A single species will not be recorded more than once at the same point. Ground cover will also be determined at each sample point according to whether basal vegetation, litter, bare soil, downed wood, or various rock categories (i.e., cobble, gravel, rock, bedrock, etc., separated by size) are intersected at the ground surface.

#### 4.5.5.3 Biomass Production

Production will be assessed by clipping all herbaceous vegetation within 1-m² quadrats placed at 25-m intervals along the transect. Vegetation from the current growing season will be clipped and stored in labeled paper bags by species and transect. Care will be taken to remove and discard vegetation from the previous growing season (which is usually gray and sometimes partially blackened). When a large shrub covers more than 75 percent of the quadrat area, these shrubs will be clipped within a 0.25 m² quadrat nested inside the 1-m² quadrat.

Biomass collections will then be air-dried at room temperature for six to ten weeks. Samples will be weighed regularly during the drying process to monitor when weight loss stops (i.e., the samples are air dry). Following drying, sample bags will be weighed on an Ohaus Scout II electronic balance to the nearest 0.1 gram.

#### 4.5.5.4 Woody plant density

Woody plant density will be determined on belt transects 2 m wide by 50 m long (100 m²) nested along the sample transect. Field personnel will tally all woody plants rooted within the belt by species. Multi-stemmed shrubs will be considered one individual plant if they appear to emerge from a single root crown.

#### 4.5.5.5 Diversity

While the point-intercept method accurately quantifies cover (Elzinga et al., 1998 and sources within) along a transect, this method sometimes neglects incidental or less common species (sources within Elzinga et al., 1998). To alleviate this limitation, a complete list of herbaceous species encountered along the 2-m belt transect (as described in the *Woody plant density* section above) will be compiled. This information will be used to supplement species diversity information recorded from point-intercept.

There are a variety of measures that assess plant species diversity. Measures can be used to describe species richness, species evenness, and/or the structural complexity of a community. Species richness is simply the total number of species that occur within a transect, stratum, or the entire Site. Species evenness expresses how evenly or unevenly species are distributed within the plant community. Evenness can be expressed as the proportion or percentage that each species represents of the whole (sum of all species).

The Shannon-Weiner (S-W) Index is one commonly used measure of species diversity (Krebs, 1989, and Shannon, 1948). Both species richness and species evenness are factors in this index. The greater the number of species, the higher the index value becomes. In addition, the more evenly matched species are with each other with respect to quantities (whether the quantity is cover, production, or other parameter), the higher the index value. In other words, if certain species are too dominant, the index value decreases. If the species have relatively similar dominances, the index value will go up. Statistically, the index is monitoring the probability of whether the next sample will contain the same species as the previous sample or whether the next sample will be a new species (Krebs, 1989, and Shannon, 1948). The S-W equation is given below (Krebs, 1989, and Shannon, 1948):

$$H = -\sum_{i=1}^{s} (p_i) \log_2 (p_i)$$

where:

H is the diversity index

Σ means to sum the values for each species

i refers to the ith species

s refers to the total number of species

pi is the proportion of individuals of the total sample (in this case, cover) belonging to the ith species

log2 is the same as the natural log or ln

The absolute plant covers recorded by the point method are converted to relative covers by lifeform (grass, forb, shrub, annual), by perennials, and by all live vegetation (perennials and annuals). In this manner, the relative perennial cover contributions can be compared to the defined values.

## 4.6 Parameters to be Analyzed

Analysis parameters were designed to measure standard vegetation attributes and also meet the requirements of MMD guidance documents (MMD, 2010). Specific parameters are listed in Table 4-2.

## 4.7 Maps Showing Proposed Sampling Locations

As previously mentioned, a stratified-random sampling approach will be used to characterize the baseline vegetation at the Site. Figure 4-2 displays the proposed sampling locations randomly plotted in ArcGIS and the preliminary Site strata.

## 4.8 Laboratory and Field Quality Assurance Plans

### 4.8.1 Personnel

The approach recommended within this proposal describes a relatively standard, replicable process that can be applied to the Copper Flat permit area to describe and assess existing vegetation. Quantitative field data collection and plant species inventories will only be completed by trained field botanists with a minimum of a Bachelors of Science in Botany or related qualifications, and five years of regional field experience. Each of the botanists will be accompanied by a field technician for recording data and assisting with transect set-up. All staff will also be trained in use of GPS field devices. Names and resumes of field botanists completing field data collection and data analysis will be available for inclusion in annual reports and survey memoranda.

### 4.8.2 Sampling Protocol

Specific sampling protocols in this report have been reviewed by senior scientists with extensive experience completing vegetation surveys on rangeland and mine lands. This plan will be independently evaluated again before field data collection is initiated.

### 4.8.3 Data Quality Assurance and Quality Control

A single field crew chief will be assigned to ensure data collection is consistent between crews. This individual will review a sub-set of the field forms following each field day. Formalized data collection training will also be completed prior to field sampling. All field botanists will be familiar with plant systematics and techniques to identify plants using taxonomic keys. Plant species not readily identifiable in the field will be collected and preserved for identification at the University of New Mexico Herbarium.

Vegetation material produced during the previous growing season will be discarded before placing samples into a paper bag. Rocks, soil, and/or litter will not be placed into sample bags. Biomass production will only be calculated as an actual dry-weight sample. No double sampling or estimations will occur.

Field data entered into an electronic format such as MS Excel or Access will be evaluated for integrity, consistency, and completeness before data analysis. Oversights or incorrect entries will be corrected. A sub-set of the field forms will be compared to the electronic version for an accuracy assessment. If significant differences are identified, a thorough re-evaluation of each of the forms will be completed.

## 4.9 Discussion in Support of Sampling Proposal

The approach recommended in this report conforms to agency sampling guidelines and objectives (MMD, 2010) and provides a methodology for accurately measuring and characterizing current vegetation at Copper Flat. This information will be used to document baseline vegetation before mining operations continue, and will also provide long-term monitoring locations in undisturbed portions of the permit area that may be useful in the future for gauging reclamation success and climatic or other disturbance-driven changes to vegetation in the permit area.

## 4.10 References

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**Figures**

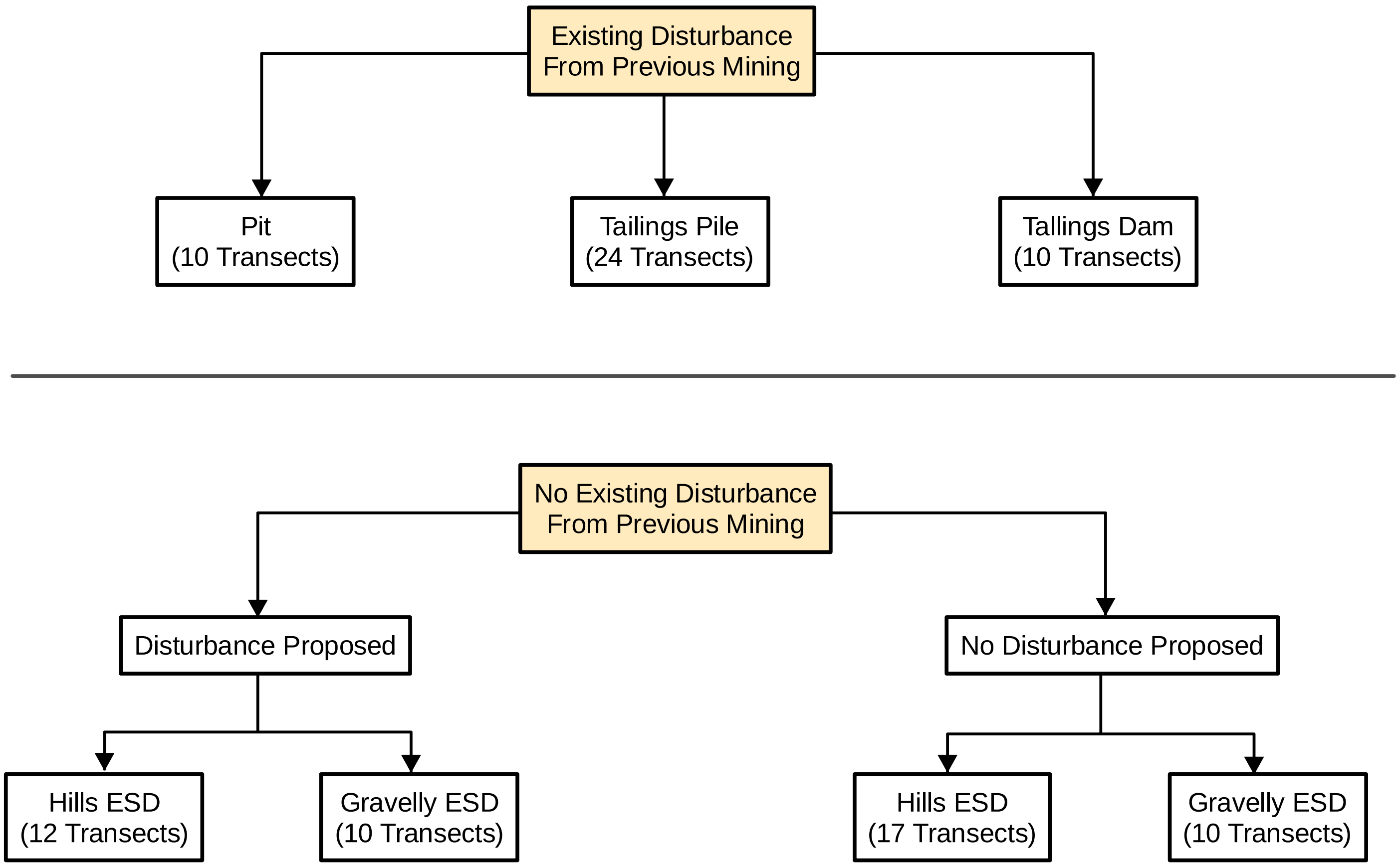
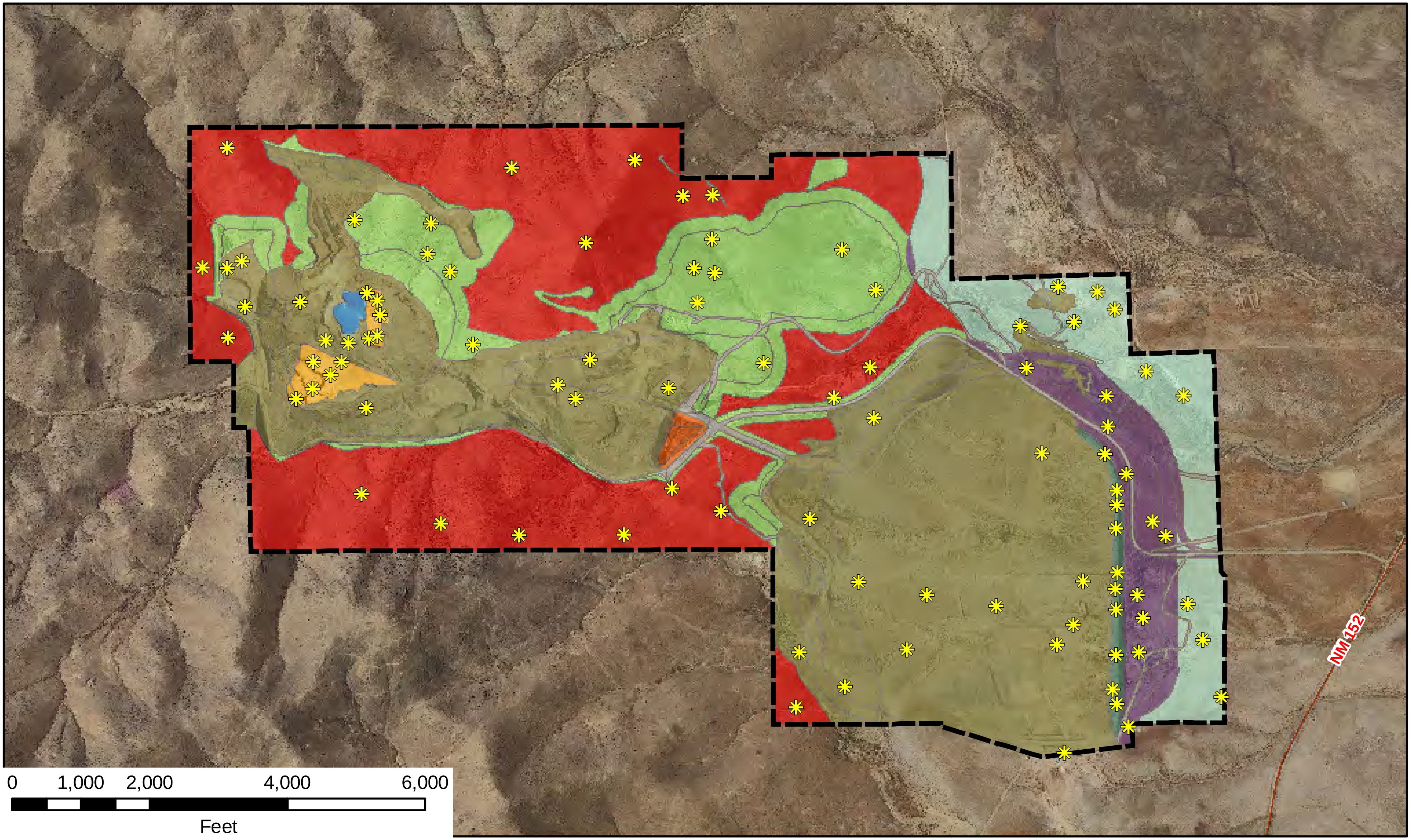



**Figure 4-1**
**Graphical Depiction of the Strata Recommended for Vegetation Sampling and Analysis**

**New Mexico Copper Corporation**

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Mine Boundary:
Tom Van Bebber
Strata/transects:
Parametrix
Imagery Information:
-USGS 7.5-Minutes County DOQQ mosaic
Sierra County, 2009
Projection Information:
-New Mexico State Plane West, NAD 1927

INTERA

**Legend**

- Proposed Mine Permit Boundary
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- Baseline No Proposed Disturbance - Hills
- Baseline Proposed Disturbance - Gravelly
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- Tailings Pile

**Figure 4-2**
**Map of the Proposed Vegetation Transect Sampling Locations and Site Strata**

**New Mexico Copper Corporation**

# Tables

**Table 4-1**

**List of the Current Data Needs Addressed in this Report**

| Data Needs | Plan to Address Data Needs |
| --- | --- |
| Vegetation map | A vegetation map will be initially stratified according to the Ecological Site Description and existing disturbance. This source will then be updated based on field observations and further review of aerial photography during quantitative vegetation assessment. |
| Vegetation survey data | Quantitative assessments of vegetation cover, diversity of plant life form, productivity, and woody plant density will be completed per Mining and Minerals Division Guidance document requirements (MMD, 2010). |
| Complete plant species inventory | Plant species observed during the April 2010 assessment will be supplemented by additional inventories completed during late summer/early fall per Mining and Minerals Division Guidance document requirements (MMD, 2010). |

## Table 4-2

## List of Vegetation Attributes, Data Sources, and Proposed Analysis Processes

| Vegetation Attribute | Source Used for Analysis | Analysis Process |
|---|---|---|
| Acreage of existing vegetation community | Vegetation map | Total acreage calculated in ESRI ArcGIS for individual vegetation types in the permit boundary. |
| Aerial vegetation cover | Quantitative vegetation transects | Parameter calculated from vegetation transects. Results summarized by species and life forms as a weighted average for the Site and also by stratum. |
| Ground cover | Quantitative vegetation transects | Parameter calculated from vegetation transects. Individual ground cover attributes include basal vegetation (by species, life form, or in total), rock, cobble, gravel, litter, downed wood, and bare soil. Results summarized as a weighted average for the Site and also by stratum. |
| Species richness and diversity | Plant species inventory and quantitative vegetation transects | Parameter calculated from vegetation transects to summarize diversity by stratum as recorded during this effort. Analysis will employ simply summing the total number of species encountered and Shannon-Weiner Index calculations. Diversity for entire Site supplemented by information collected during the plant species inventory. |
| Diversity of plant life form | Plant species inventory and quantitative vegetation transects | See description for species richness above. Results also summarized by life form. |
| Biomass production | Quantitative vegetation transects | Parameter calculated from vegetation transects. Annual production of native grasses summarized by species and in total as a weighted average for the Site and also by stratum. |
| Woody vegetation density | Quantitative vegetation transects | Parameter calculated from vegetation transects. Results summarized by species and life forms as a weighted average for the Site and also by stratum. |

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# 5 Wildlife

## 5.1 Introduction and Background

Baseline data has been collected at the Copper Flat project starting in the late 1970s by Quintana, followed by Rio Gold Mining Ltd (Rio Gold), Gold Express, and Alta Gold (related to the 1999 PFEIS). These data are relevant and provide insights for future permitting activity. The previously completed wildlife surveys and studies have been reviewed (SRK, 1997, and BLM, 1999). Relevant information from these previous baseline surveys have been researched and utilized to augment this current sampling process where appropriate. The Chihuahuan desert is a harsh environment home to many birds, reptiles, and mammals. While the actual wildlife diversity is much greater than the list below, some of the more common species are:

- black-chinned sparrow (*Spizella atrogularis*)
- brown thrasher (*Toxostoma rufum*)
- cactus wren (*Campylorhynchus brunneicapillus*)
- roadrunner (*Geococcyx californianus*)
- whiptail lizard (*Cnemidophorus* sp.)
- kangaroo rat (*Dipodomys* sp.)
- western diamondback rattlesnake (*Crotalus atrox*)
- jackrabbit (*Lepus californicus*)
- pronghorn antelope (*Antilocapra americana*)
- and coyote (*Canis latrans*)

Biologists surveyed the Copper Flat permit area on April 15, 2010, to identify migratory bird nests and sensitive habitat areas. This survey was conducted using methods required to fulfill Migratory Bird Treaty Act requirements for the proposed mining activities. During the field survey, numerous bird nests were observed. The most common nests found were cactus wren and brown thrasher nests. These birds build stick and grass nests in cholla cactus (*Opuntia imbricata*) and were common in the tailings pond area as well as around the existing pit.

## 5.2 Sampling Objectives

The sampling objectives for this project are:

1. Delineate and map current habitat, including disturbed areas.
2. Describe wildlife use of the area through measurements of:
    a. Big game fecal pellet group counts for deer, elk, and antelope.
    b. Call counts for birds and amphibians.
    c. Trend routes for mammals.
    d. Visual sighting transects for birds, mammals, and reptiles.
3. Complete a bird species inventory.

4. Complete a threatened or endangered species survey by comparing known records and habitat requirements with current field conditions to determine the likelihood of occurrence of all federal and state listed wildlife species.
5. Develop a list of species encountered during surveys or deemed likely to occur within the permit area. Species encountered will be given an estimate of relative abundance in the permit area.
6. Determine species distribution by habitat and season. Certain animals, especially birds, use specific habitats during different times of the year.
7. Enumerate other key habitat areas observed (e.g., cliffs, talus slopes, ponds, springs, known nests).

## 5.3 Sampling Frequency

Wildlife presence and activity surveys will occur twice per year. One survey will be conducted in December or January for overwintering birds (MMD 2010). Another survey will be conducted in late May or June during peak breeding season. Other groups of animals such as mammals, reptiles, and amphibians will also be recorded during the May/June surveys. Habitat features and characteristics will be noted during spring surveys.

## 5.4 List of Data to be Collected

Data to be collected will include:

1. Counts (sightings) of the various wildlife species including birds, reptiles, amphibians, and mammals.
2. Record signs of species (i.e. scat, feathers, burrows, bones, etc.).
3. Frequency—the number of transects and/or surveys a particular species is encountered.
4. Record key habitat features and characteristics suitable to various wildlife.
5. Survey for threatened or endangered species, including sightings, signs, and potential habitat encountered.

## 5.5 Methods of Collection

Data will be collected through visual/pedestrian transect surveys to identify nests, burrows, fecal pellets, and other pertinent signs of wildlife. These transects will consist of parallel lines spaced between 100 to 300 meters apart and oriented to capture the entire sampling unit. Smaller sampling units or strata, such as the tailings dam and pit will be surveyed with a closer transect spacing (approximately 100 meters). In larger sampling strata, such as the tailings pile and undisturbed areas, transect spacing will be greater (between 200 to 300 meters). As deemed necessary, these surveys will also be conducted during late evening and early morning to identify potential diurnally active animals and bat roosts, through direct observation or by listening for calls. Some of these wildlife surveys may include "time-constraint" surveys. A “time-constraint” technique uses a controlled or closely monitored amount of time to walk a transect line or survey area to record the total number of occurrences of particular species, such as a horned lizard for example. Such surveys are completed at specific times of the day when target species are more active.

## 5.6 Parameters to be Analyzed

Parameters to be analyzed include:

1. Bird nest density and distribution.

2. Density of observed avian species.
3. Relative abundance and distribution by habitat and season.
4. Density and distribution of wildlife indicators (e.g. fecal pellet counts) and occurrences (sightings) of wildlife.
5. Acreages and maps of key habitat areas for various wildlife species.
6. Threatened and endangered species survey results.

These parameters will be summarized and evaluated by individual species. Mobile or transient species, referring to those species without fixed habitat needs (such as those without nests or burrows) will similarly be tabulated and analyzed to determine abundance and frequency of occurrence.

## 5.7 Maps Showing Proposed Sampling Locations

Figure 5.1 shows a map of the sampling areas. These same areas will be surveyed for wildlife activity using the walking transects described above (Section 5.5). Transect spacing will vary as described based on the size of the sampling areas.

## 5.8 Laboratory and Field Quality Assurance Plans

Biologists will have a minimum of a BA/BS in Biology and five to ten years of field experience conducting a wide variety of animal surveys ranging from reptiles and amphibians, to birds, mammals, insects, and other invertebrates. This includes experience in recognizing and identifying signs of wildlife. All findings and results will be reviewed by senior scientists.

## 5.9 Discussion in Support of Sampling Proposal

Most of the protocol specific surveys for wildlife involve threatened and endangered species, or species with a "sensitive" status. Although our surveys will assess for the potential occurrence of threatened, endangered, or sensitive species, we are not anticipating that these will occur. Consequently, much of the sampling and analysis plan for wildlife is of a generalized nature. The intent of the sampling and analysis plan for wildlife is to obtain general or basic information on species presence and habitat use within the permitted area of the mine. All qualitative information will be included in the findings. Some of the information gathered will be of a quantitative nature and thus serve as a basis in which to monitor trends in wildlife use of these areas. The sampling approach will be revised if threatened, endangered, or sensitive species are suspected to occur

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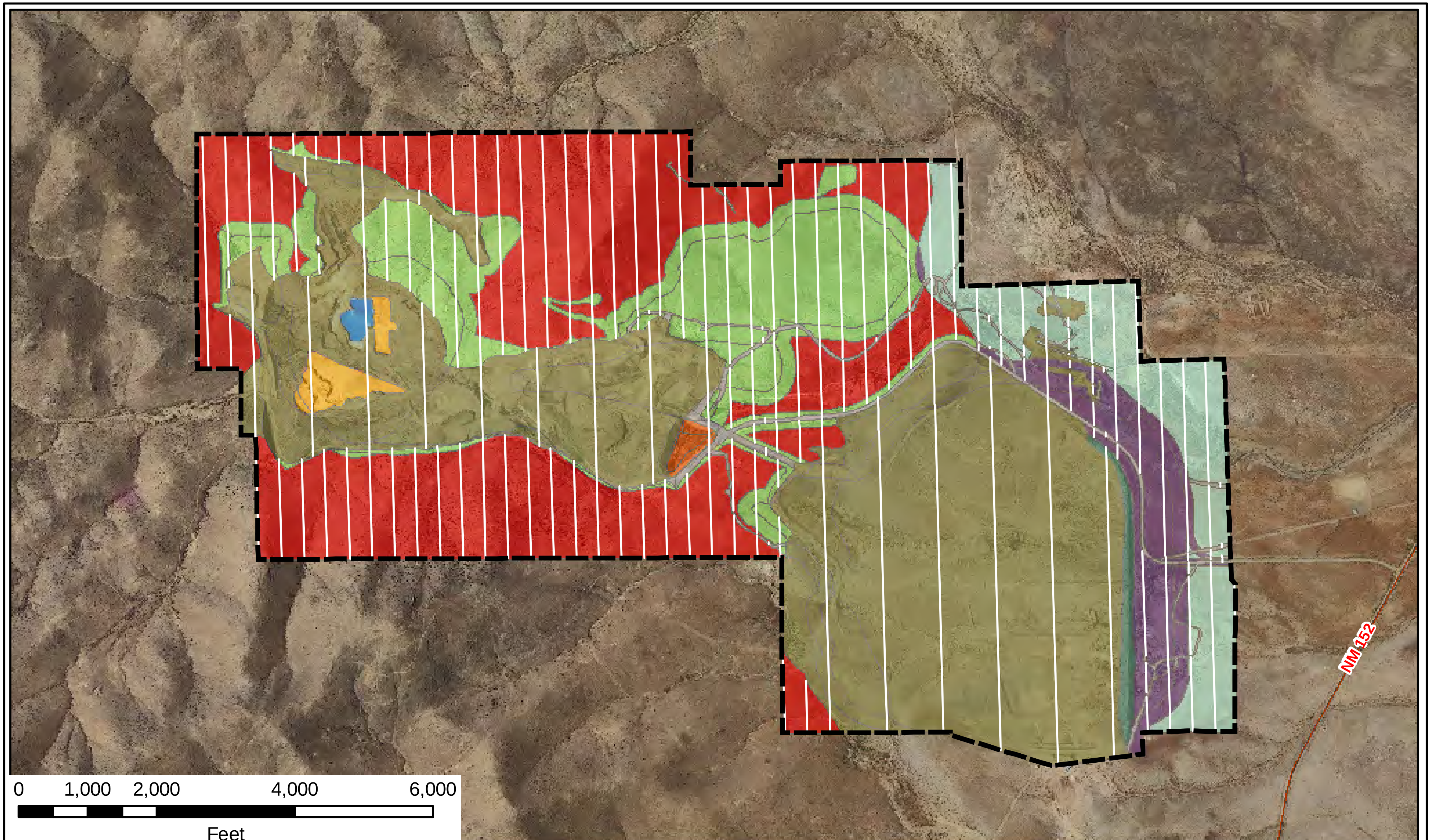
**Figure**




Mine Boundary:
Tom Van Bebber
Strata/transects:
Parametrix
Imagery Information:
-USGS 7.5-Minutes County DOQQ mosaic
Sierra County, 2009
Projection Information:
-New Mexico State Plane West, NAD 1927

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**Figure 5-1**
**Map of the Proposed Wildlife Transects and Site Strata**

**New Mexico Copper Corporation**

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# 6 Topsoil Survey and Sampling

## 6.1 Background and General Description of Topsoil

A successful reclamation program is dependent, in part, upon the quantity and quality of soil available for use during the reclamation process. New Mexico Copper Corporation (NMCC) assessed the quantity and suitability of topsoil present at the Copper Flat Mine Permit Area (Site) in two ways. First, NMCC reviewed current literature concerning soil characteristics, and second, NMCC determined site-specific soil characteristics. The findings are summarized in this section of the SAP. In addition, baseline soil surveys were completed on the project area as recently as the late 1990s, and are briefly summarized and referenced in the PFEIS (BLM, 1999).

The term "topsoil" refers to the A master soil horizon (Soil Survey Staff, 1999), which is the uppermost mineral horizon that contains organic matter and can be salvaged from the areas to be disturbed and is capable of supporting vegetation, or other soil material capable of supporting vegetation. This material is often referred to as "suitable top dressing." NMCC has reviewed previous literature describing the results of soil surveys completed at the Site (BLM, 1999) and is aware that the presence of an A master soil horizon across the Site is limited. The purpose of the soil survey and sampling proposed in this section of the SAP is to evaluate the presence of suitable top dressing. However, in the interest of conforming to the requirements of the Mine Act regulations, the term "topsoil" will be used throughout this section to refer to suitable top dressing.

General information about the soils present at the Site was obtained from a Soil Conservation Service (SCS) survey completed by Neher (1984). The SCS (now the Natural Resources Conservation Service) mapped two major soil types that occur in the Copper Flat area:

1. The Luzena-Rock Outcrop association
2. The Scholle-Ildelfonso association

Figure 6-1 shows the boundary of the two soil types found in the proposed mine area along with the proposed operational areas within the proposed mine permit boundary. All but the easternmost portion of the proposed Site is mapped as Luzena-Rock Outcrop association, which is typically present on the steeper slopes of hills and mountains. These soils are typically shallow, very gravelly and cobbly loams and clay loams. The Scholle-Ildelfonso association occurs on more gentle slopes of the piedmonts and mountain toes and is deep, well-drained, and formed in mixed alluvium. The resulting soil texture in these areas is primarily gravely loams and gravelly clay loams (SRK, 1996).

The soils are thin and of low productive capacity. The soil textures are primarily gravelly loams and gravelly clay loams and are subject to continuing wind and water erosion. Along with the natural erosion, much of the Copper Flat landscape has been severely disturbed by historical placer mining and the 1982 mining operation. Over 63 percent of the areas targeted by the proposed operation were disturbed during the 1982 operation. Soils were replaced in the north cell of the tailings impoundment and over a portion of the plant site during 1986. Much of the remaining 1982 operational area remains disturbed and unvegetated (SRK, 1996).

## 6.2 Sampling Objectives

The objectives of soil sampling plan are:

- To determine the suitability of in-place soils in areas of proposed disturbance for use as a topsoil material during reclamation. Suitability parameters will be defined. Two key parameters for a topsoil source are soil texture and coarse fragment content because these are the most difficult parameters to amend. Also critical, particularly for soils in the southwestern United States, are soil salinity and sodicity.

Salt and sodium concentrations in soils affect plant growth and soil infiltration characteristics, and are also difficult to amend. Other soil characteristics that are important in reclamation, but which can more easily be amended, are organic matter content, macronutrient concentrations, and micronutrient concentrations.

- To determine the volume of suitable material present and calculate the amount of topsoil that must be obtained from a borrow source to complete Site reclamation.

## 6.3 Sampling Frequency

In accordance with 19.10.6.602 of the New Mexico Administrative Code (NMAC), there will be one sampling event for topsoil characterization during the 12-month baseline data collection period.

## 6.4 List of Data to Be Collected

Table 6-1 shows the four data requirements identified for topsoil and the plans for addressing these requirements. NMCC proposes to satisfy the data requirements by characterizing soils in areas that will be disturbed by proposed mining operations and that may be used as topsoil borrow sources. Figure 6-1 shows the proposed mining disturbance areas.

## 6.5 Methods of Collection

First order (order 1) pedestrian soil surveys will be conducted by a qualified soils scientist within each of the disturbed areas shown on Figure 6-1 to delineate topsoil. First order soil surveys have delineations of 1 hectare (2.5 acres) or less, depending on scale; typically show phases of soil series and miscellaneous areas as components of map units; and typically display results at a scale of 1:15,840 or larger (Soil Survey Division Staff, 1993). Surveys will be conducted by walking along parallel transects defined within the boundary of each disturbed area. The total number of transects per disturbed area will be randomly selected using the random point generation function within Hawth's Analysis Tools ArcGIS plug-in. During this process, the required number of random transects will be placed in each disturbed area. The resulting geographic coordinates will be transferred to a Global Positioning System (GPS) receiver with a horizontal accuracy ≤3m for field navigation to the target locations. If field conditions do not match the stratum intended, the transect will be moved to a nearby location within the disturbed area. While walking along each transect, the soils scientist will delineate the boundaries for topsoil by making visual observations of surface soils and confirming those observations with hand-auger holes. Topography, vegetative cover, slope and aspect will all be used to guide the decisions. Boundaries recorded in the GPS receiver will later be downloaded and imported into an ESRI geographic information system (GIS) as a shapefile.

Soil samples will be collected from topsoil within the disturbed areas using a hand auger, shovel, mechanized geoprobe (if permitted), or other means necessary to retrieve samples until bedrock or a hardened surface is reached. A total of six samples will be taken: three from the tailings impoundment and one each from the North, West, and East Waste Rock disposal areas (Figure 6-1). It is anticipated that at each sample location, a soil subsample will be collected at three different depth intervals in the topsoil. The subsamples from each location will be collected and mixed to form a composite sample. Typically, the soil scientist will estimate soil texture visually at 6-inch intervals within the top 2 feet (ft). Below 2 ft, texture will be estimated at 1-ft intervals. Soil features, such as color, presence of calcium carbonates, salt accumulation, volume of coarse fragments, and depth to bedrock or rocky layer, will also be noted. For mapping purposes, the location of the subsample will be documented with a GPS receiver.

Soil samples will be air-dried before submission to the laboratory. Sample handling and chain-of-custody procedures will be followed for the preparation of soil samples for shipment to the off-site analytical laboratory.

### 6.5.1 Sampling Methods

The sampling methods described below may be used for obtaining the necessary soil samples. The surface soil sample collection procedures discussed in 6.5.1.1 may be used if the soil sampling location is not below a water surface. The procedures discussed in 6.5.1.2 may be used if the soil sampling location is below a water surface.

The following equipment will be assembled before surface-soil sampling begins:

- Coolers
- Sample containers and laboratory-supplied preservatives (if needed)
- Sample labels
- Personal protective equipment
- Custody seals
- Waterproof pens
- Appropriate sampling equipment
- Acetate sleeves (if needed)
- Personnel/equipment decontamination supplies
- Field logbook
- Sample control logs
- Chain-of-custody forms

All sampling equipment will be cleaned before use.

#### 6.5.1.1 Surface Soil Sample Collection Procedure (Dry)

The following procedure will be used for collecting surface soil samples for chemical analysis.

1. If necessary, use a shovel to remove vegetation from the sampling point.
2. Use any of the following three methods to obtain representative samples from the intervals of interest:
    a. Soil samples may be collected using a hydraulic soil sampler or a hand-driven soil sampler, both with acetate sleeves. These samples will be extruded from the acetate sleeve or else the sleeve will be cut to segregate the sample interval of interest.

       Cap the acetate sleeves as quickly as possible and send them intact to the laboratory so that the interval of interest can be tested with a minimum loss of volatile components.

    b. A pit may be excavated with a clean shovel to expose a soil profile, which is a vertical cut in the soils that exposes the genetic layers or horizons. Because the soil samples will be analyzed for metals, samples will not be collected from the surface that was in contact with the shovel. Instead, the surface will be scraped with a clean, non-metal trowel before collection. Soil samples may be collected using a clean, stainless-steel trowel or an appropriate disposable trowel to remove equal portions of the soil from the surface or near the surface to the base of the interval of interest.

    c. Soil samples may be collected using a clean, stainless-steel hand auger. Note the sampling depth. Use a non-metal trowel, spatula, or knife to assist in removing the sample for placement in the sample container.
3. Remove obvious rock material from each sample.

4. Place each sample in a clean, labeled sample container and cap securely as quickly as possible. Ensure that neither the sample nor its container comes into contact with any contaminated surfaces.
5. Provide complete information when filling out the sample label. Labels must include the following information:
   - Project name and/or number
   - Field sample number
   - Depth interval (if applicable)
   - Initials of collector
   - Date and time of collection
   - Sample type and preservative (if any)
6. Immediately place the sealed and labeled sample container in a cooler containing double-bagged ice or frozen ice packs. Store at <4°C, if required. (The use of protective packaging will be dictated by the mode of transport.)
7. Record the sampling data on the sample control log and in the field logbook, as appropriate.
8. Decontaminate the sampling equipment before collecting the next sample. If possible, have a sufficient quantity of clean, decontaminated equipment available so that each sample can be taken with separate equipment and all sampling tools can be decontaminated periodically or at the end of the sampling effort rather than between each sampling event.
9. Complete a chain-of-custody form for laboratory shipment.
10. Place custody seals across the shipping container lids so that the shipping containers cannot be opened without breaking the custody seals. Custody seals must contain the following information:
    - Collector's signature or initials
    - Date of shipping
11. Ship sample containers to the laboratory for analysis within 24 hours of sample collection, carefully observing all minimum holding time requirements for degradable constituents.

The chain-of-custody form, sample control logs, and field logbook must be completed in accordance with the procedures set forth in the Quality Assurance Project Plan (Attachment 1).

#### 6.5.1.2 Sampling Beneath a Water Surface

The following sampling methods may be used if the soil sampling location is below a water surface.

##### 6.5.1.2.1 Sampling with a Trowel

Sediment samples can be collected using a stainless steel or disposable trowel provided the water depth is very shallow (e.g., a few centimeters). A stainless steel trowel or scoop is recommended because of its inert nature. Single grab samples may be collected or, if the area in question is large, a grid can be used and multiple samples can be collected and composited. The sample collection procedure is as follows:

1. Label all bottles. Fill out all information except the sampler's name/initials and the actual date and time. Sort bottles according to the sampling locations.
2. Note the sampling location in the logbook, measuring distances and direction from stationary landmarks. If possible, photograph the location.

3. Record the date, time, and sampler's name/initials on all sample containers and on the sample control log. Cover all container labels with wide transparent waterproof tape to ensure label integrity.
4. Insert the trowel into the sediment and begin to remove material. Avoid collecting large rocks or plant roots as much as possible.
5. Decontaminate the sampling equipment before collecting the next sample by cleaning the equipment with warm water and Liquinox, then rinsing again with warm water. If possible, have a sufficient quantity of clean, decontaminated trowels available so that each of the sediment samples can be taken with a separate trowel and decontamination can be performed on all the trowels at the end of the sampling effort rather than between each sampling event.
6. Store and transport at <4°C, if required, and place custody seals on the cooler lid so that the cooler cannot be opened without breaking the seals.

#### 6.5.1.2.2 Sampling with a Hand Corer

A hand corer is essentially the same type of thin-wall sampler that is used for collecting surface soil samples. It has a handle to facilitate driving the corer into the sediment and a check valve on the top to prevent sample washout during retrieval through an overlying water layer.

Hand corers can be used for the same situations and with the same materials as trowels (see previous section). The advantage of a hand corer is the ability to collect an undisturbed sample that can profile any stratification in the sample as a result of changes in the deposition. Some hand corers can be fitted with extension handles that allow collection of sediment samples in water of moderate depth (6 ft). Most corers can be fitted with liners of brass, polycarbonate plastic, or Teflon. The appropriate liner can be chosen to match the type of contamination expected in the sample and the intended analytical procedures.

The sample collection procedure using a hand corer is as follows:

1. Label all bottles. Fill out all information except the sampler's name/initials and the actual date and time. Sort bottles into sets: one per sampling location, with additional sets as needed for blanks and duplicates.
2. Note the location of the sample in the logbook, measuring distances and direction from stationary landmarks. If possible, photograph the location.
3. Record the date, time, and sampler's name/initials on all sample containers and on the sample control log. Cover all container labels with wide transparent waterproof tape to ensure label integrity.
4. Force the corer into the sediment with a smooth, continuous motion.
5. Twist the corer and withdraw in a single smooth motion.
6. Decontaminate the sampling equipment before collecting the next sample.
7. Store and transport at <4°C, if required, and place custody seals on the cooler lid so that the cooler cannot be opened without breaking the seals.

## 6.6 Parameters to Be Analyzed

Soil samples will be collected and analyzed at a soil testing laboratory accredited by the National Environmental Laboratory Accreditation Program (NELAP) and the New Mexico Environment Department (NMED) for the soil characteristics summarized in Table 6-2. While performing the field sampling, the New Mexico Copper

Corporation (NMCC) representative will measure pH and electrical conductivity as necessary in order to "field-calibrate" for these parameters. Rock fragments will be removed from samples in the field and will be estimated by percentage by the soils scientist. In addition to the analyses outlined in Table 6-2, measurements of electrical conductivity, saturation percentage, and salinity will be collected following USDA guidelines (U.S. Salinity Laboratory Staff, 1954). Sodium adsorption ratio, a measure of the sodicity of the soil, will be calculated from the parameters of paste calcium, magnesium, and sodium in units of milliequivalents per liter.

## 6.7 Maps Showing Proposed Sampling Locations

A total of six samples will be taken: three from the tailings impoundment and one each from the North, West, and East Waste Rock disposal areas. Figure 6-1 shows the general boundaries of these locations at the Site.

## 6.8 Laboratory and Field Quality Assurance Plans

Sampling will be conducted in accordance with the sampling procedures described above. Soil sampling will be conducted by a qualified NMCC representative, who will document the sample location on a map, take a GPS reading, and record observations in a logbook. Sample handling and chain-of-custody procedures will be followed to prepare soil samples for shipment to the off-site analytical laboratory. Laboratory analyses will be conducted in accordance with methods described in *Methods of Soil Analysis, Parts 1 and 2* (Klute, 1986, and Weaver, 1994, respectively). NMCC will select a laboratory that operates under a quality program and has expertise and experience with the approved soil analytical methods.

## 6.9 Discussion in Support of Proposal

The proposed data collection will allow the characterization and establishment of baseline topsoil conditions across the Site in advance of mining and will supplement existing topsoil data. A deficit in volume of topsoil for Site reclamation is expected. The topsoil required to compensate for the deficit is expected to be obtained from within the tailings impoundment area (SRK, 1996).

## 6.10 References

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Weaver, R.W., ed., 1994, Methods of soil analysis, Pt. 2, Chemical and microbiological properties: Madison, Wis., Soil Science Society of America, Inc., 1692 p.

**Figure**

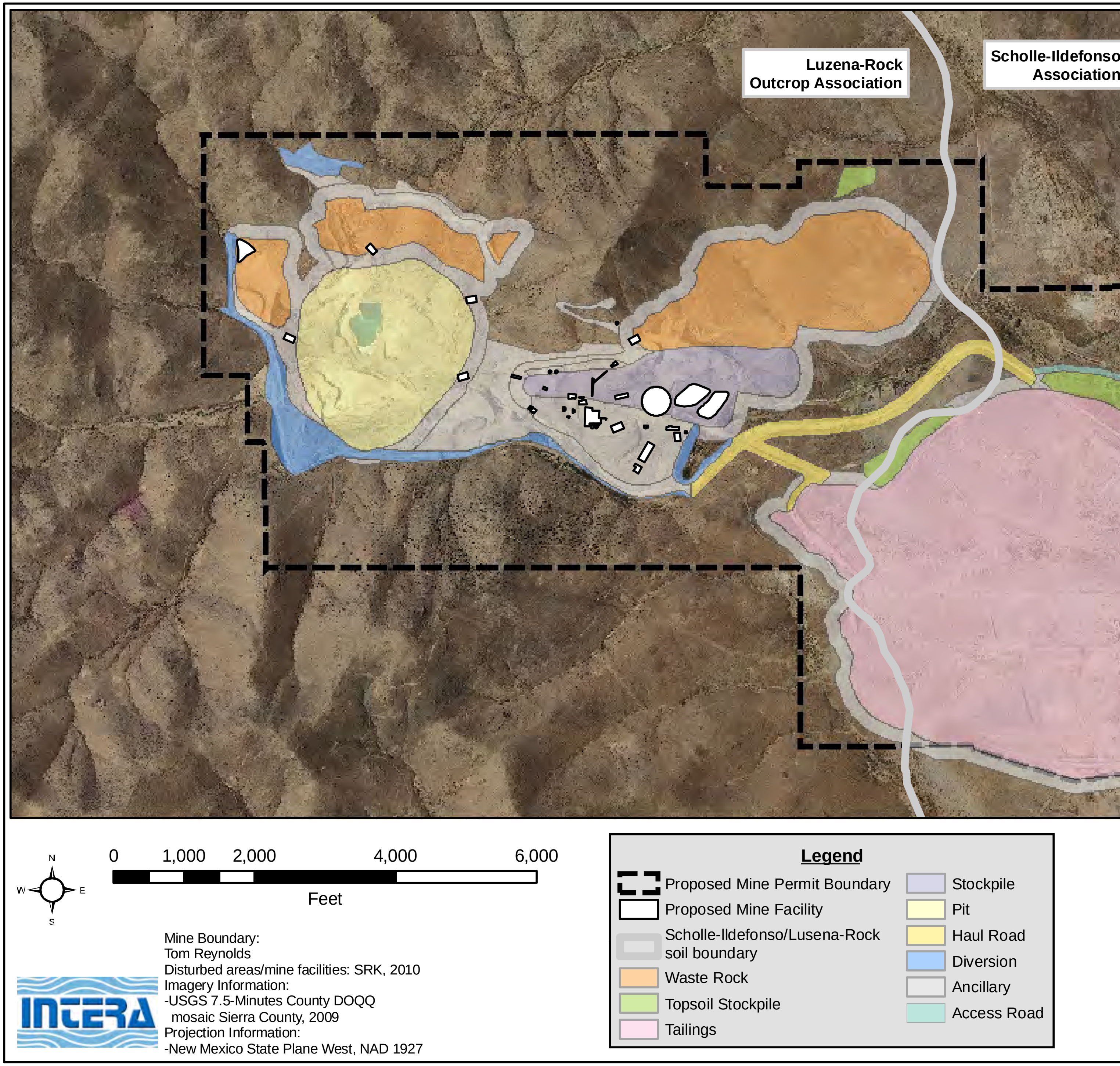


**Figure 6-1**
**Topsoil Sampling Locations**

**New Mexico Copper Corporation**

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# Tables

**Table 6-1**

**Topsoil Data Needs**

| Data Need | Plan to Address Data Need |
|---|---|
| Determine accurate soil depths in areas to be disturbed to ensure proper topsoil volume calculation. | Measure soil depths in areas where planned disturbances will take place (locations will be entered into a GPS unit). |
| Determine suitability of stripped material for use as topsoil during reclamation. | Send soil samples to a laboratory for analysis to determine characteristics and suitability as topsoil. |
| Determine need for additional topsoil. | Estimate the available topsoil based on the results of the soil survey and calculate topsoil deficit by subtracting the available topsoil from the topsoil needed. Any topsoil deficit will be addressed identifying additional on-site borrow areas or other potential borrow sources in the immediate vicinity of the mine. |
| Sample and characterize any material needed from borrow pits to complete reclamation efforts. | Conduct soil characterization and analysis on soils that may be used as a borrow source. |

## Table 6-2
## Soil Characteristics and Methods Used
(Sampling requires 125 ml/4 oz wide mouth glass jar.)

| Analytical Parameter | Analysis Method | Lab Detection Limit for Sediments (mg/kg unless noted) |
|---|---|---|
| Nitrate-nitrite | EPA Method 353.2 | 0.05 |
| Phosphorous | EPA Method 365.2 | 2.5 |
| Arsenic | EPA Method 200.7 | 1.0 |
| Boron | EPA Method 200.7 | 2.0 |
| Cadmium | EPA Method 200.7 | 0.1 |
| Calcium | EPA Method 200.7 | 5.0 |
| Copper | EPA Method 200.7 | 0.2 |
| Iron | EPA Method 200.7 | 1.0 |
| Lead | EPA Method 200.8 | 0.25 |
| Magnesium | EPA Method 200.7 | 5.0 |
| Manganese | EPA Method 200.7 | 0.1 |
| Mercury | M7471A CVAA | 0.03 |
| Molybdenum | EPA Method 200.7 | 0.4 |
| Nickel | EPA Method 200.7 | 0.5 |
| Potassium | M6010C ICP | 10 |
| Selenium | EPA Method 200.7 | 1.0 |
| Sodium | EPA Method 200.7 | 5.0 |
| Zinc | EPA Method 200.7 | 0.25 |
| pH | EPA Method 150.1 | NA |
| Grain size | Plumb, 1981 | NA |

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# 7 Geology

This section provides an overview of the regional and local stratigraphy and structural geology, as well as the mineralization at the Copper Flat Mine Permit Area (Site). The information has been summarized primarily from the BLM Preliminary Final Environmental Impact Statement (PFEIS) for Copper Flat (1999), Raugust (2003), and SRK (2010).

## 7.1 Regional Geologic Setting

The Copper Flat Mine lies within the Mexican Highlands portion of the Basin and Range Physiographic Province. It is located in the Hillsboro Mining District in the Las Animas Hills, which are part of the Animas Uplift, a horst on the western edge of the Rio Grande valley (Raugust, 2003). The Animas Uplift is separated from the Rio Grande by nearly 20 miles of Santa Fe Group alluvial sediments, referred to as the Palomas Basin of the Rio Grande valley. To the west of the Animas Uplift is the Warm Springs valley, a graben that parallels the Rio Grande valley (BLM, 1999; Raugust, 2003). Further west, the Black Mountains form the backbone of the Continental Divide, rising to about 9,000 feet above mean sea level (amsl). The surface geology of the Copper Flat region is shown in Figure 7-1, and a schematic geologic cross section is shown in Figure 7-2.

Basement rocks in the area consist of Precambrian granite and Paleozoic and Mesozoic sandstones, shales, limestones, and evaporites. Sedimentary units that crop out within the Animas Uplift include the Ordovician Montoya Limestone, the Silurian Fusselman Dolomite, and the Devonian Percha Shale. The Cretaceous-age Laramide orogeny, which was characterized by the intrusion of magma associated with the subduction of the Farallon plate beneath the North American plate, affected this region between 75 and 50 million years ago (Ma). Volcanic activity during the late Cretaceous and Tertiary periods resulted in localized flows, dikes, and intrusive bodies, some of which were associated with the development of the nearby Tertiary Emory and Good Sight-Cedar Hills cauldrons (Figure 7-3); later basaltic flows resulted from the tectonic activity associated with the formation of the Rio Grande rift. Tertiary and Quaternary alluvial sediments of the Santa Fe Group and more recent valley fill overlie the older Paleozoic and Mesozoic units in the area. The regional stratigraphy of the lower Rio Grande Valley is summarized in Table 7-1 (BLM, 1999).

The geologic structure of the region is characterized by block and rift faulting (Figure 7-3). The Tertiary cauldrons associated with the earlier block faulting formed between 35 and 45 Ma. Rift faulting and associated north-south block faulting associated with continental extension and the formation of the Rio Grande rift began approximately 25 to 30 Ma. The Las Animas Hills are bounded by faults associated with rifting (Dunn, 1982). Continental extension continues to the present, as evidenced by north-south trending grabens represented by the Rio Grande and Warm Springs valleys.

## 7.2 Geology of Copper Flat Mine Site

### 7.2.1 Stratigraphy

As shown in Figure 7-4, the dominant geologic feature of the Animas Hills and Hillsboro district is the Copper Flat strato-volcano, a circular body of Cretaceous andesite that is 4 miles in diameter (Raugust, 2003). The andesite is generally fine-grained with phenocrysts of plagioclase (andesine) and amphibole in a groundmass of plagioclase and potassium feldspar and rare quartz. Some agglomerates or flow breccias are locally present, but the andesite is generally massive. Magnetite is a common association with the mafic phenocrysts, and accessory apatite is found in nearly every thin section (Dunn, 1984).

The strato-volcano is eroded to form a topographic low; the total depth of erosion is uncertain (SRK, 2010). To the east of the Site, this andesite body is in fault contact with Santa Fe Group sediments, which are at least

2,000 feet (ft) thick in the area. Near-vertical faults characterize the contacts on the remaining perimeter of the andesite body; these faults juxtapose the andesite with Paleozoic sedimentary rocks. Drill holes indicate the andesite is more than 3,000 ft thick. This feature, combined with the concentric fault pattern, indicate that the local geology represents a deeply eroded Cretaceous-age volcanic complex (Dunn, 1982).

The core of the volcanic complex is a Cretaceous-age quartz monzonite stock that intruded into the center of the andesite body. Known as the Copper Flat Quartz Monzonite (CFQM), this irregular-shaped stock underlies a surface area of approximately 0.25 square miles and has been dated to approximately 75 million years before present (Raugust, 2003; BLM, 1999; and McLemore et al., 2000). The monzonite crops out in only a few isolated areas, and the andesite at these contacts shows no obvious signs of contact metamorphism (Dunn, 1984). The CFQM is a medium- to coarse-grained, holocrystalline porphyry composed primarily of potassium feldspar, plagioclase, hornblende, and biotite; trace amounts of magnetite, apatite, zircon, and rutile are also present, along with localized mineralized zones containing pyrite, chalcopyrite, and molybdenite (McLemore et al., 2000). About 15 percent of the monzonite is quartz, which occurs both as small phenocrysts and as part of the groundmass; however, quartz is absent in some parts of the stock (Dunn, 1984).

Numerous dikes, mostly latite, radiate from the CFQM stock, some nearly a mile in length. Most of the dikes trend to the northeast or northwest and represent late stage differentiation of the CFQM stock (Raugust, 2003). Immediately south of the quartz monzonite, the andesite is coarse-grained, perhaps indicating a shallow intrusive phase. An irregular mass of andesite breccia along the northwestern contact of the quartz monzonite contains potassium feldspar phenocrysts and andesitic rock fragments in a matrix of sericite with minor quartz; this may represent a pyroclastic unit. Magnetite, chlorite, epidote, and accessory apatite are also present in the andesite breccia (Dunn, 1984).

The southwestern edge of the andesite body was intruded by the Warm Springs Quartz Monzonite pluton, which dates to approximately 73 Ma (Hedlund, 1974). Unlike the CFQM and the andesite, this monzonite body is not cut by the latite dikes (SRK, 2010), indicating that the dikes were emplaced prior to the Warm Springs Quartz Monzonite.

The Sugarlump Tuff (35 Ma) and the Kneeling Nun Tuff (34 Ma) unconformably overlie the local andesite flows. These tuffs erupted from the Emory caldera, and indicate that the Copper Flat volcanic/intrusive complex was buried during the Oligocene and exhumed during Miocene uplift (around 21.7 ±3.6 Ma) (Kelley and Chapin, 1997). Both the andesite and the quartz monzonite intrusions are cut by black, scoriaceous basalt dikes. These dikes remain unaltered, and appear to be associated with locally abundant Pliocene alkali basalt flows from around 4 Ma (Seager et al., 1984).

### 7.2.2 Structure

Three principal structural zones are present at the Site and surrounding area, the most prominent of which is a northeast-striking fault trend that includes the Hunter and parallel faults. In addition, west-northwest striking zones of structural weakness are marked by the Patten and Greer faults, and east-northeast striking zones are marked by the Olympia and Lewellyn faults. All faults have a near-vertical dip; the Hunter fault system dips 80°W, and both the Olympia and Lewellyn fault systems dip between 80°S and 90°S (SRK, 2010; Dunn, 1984). These three major fault zones appear to have been established prior to the emplacement of the CFQM and controlled subsequent igneous events and mineralization (SRK, 2010).

The CFQM emplacement is largely controlled by the three structural zones. The southern contact parallels and is cut by the Greer fault, although the contact is cut by the fault, and the southeastern and northwestern contacts are roughly parallel to the Olympia and Lewellyn faults, respectively. The elongate neck of the stock parallels the Hunter fault system. Whether there was movement along the fault zones before the emplacement of the stock has not been determined (SRK, 2010; Dunn, 1984).

Although the latite dikes strike in all the three principal fracture directions, most of the dikes strike northeast. A narrow zone of fault gouge commonly occurs along the contact between the dikes and the andesite, with the mineralization post-dating fault movement (Harley, 1934). The northeast fault zones contain a high proportion of wet gouge, often with no recognizable rock fragments. Underground exposures of the Hunter fault zone (in previously existing mine workings) material has the same consistency as wet concrete and has been observed to flow in underground headings. However, the material in the east-northeast fault zones contains only highly broken rock and little obvious gouge. The width of the fault zones in both systems varies along strike from less than a foot to nearly 25 ft in the Patten fault east of the Project. Despite intense brecciation, the total displacement along the faults does not appear to exceed a few tens of feet (Dunn, 1984). At the western edge of the Site, a younger porphyritic dike was emplaced in a fault that had offset an early latite dike, indicating that fault movement occurred during the time that dikes were being emplaced (Dunn, 1984).

Post-dike movement is evident in all the three principal fault zones, and both the Hunter and Patten fault systems show signs of definite post-mineral movement. Fault movement has smeared sulfide deposits and offset the breccia pipe as well as the zones within the breccia pipe. Post-mineral movement along faults has resulted in wide, strongly brecciated fault zones. Some of the post-mineral dikes have been emplaced within these fault zones (SRK, 2010; Dunn, 1984).

NMCC has mapped the pit area and diversion cuts in detail at 1 inch:40 ft (1:480) and has examined the pre- and post-mineral stress orientations in the andesites and CFQM. Findings indicate no significant difference in the stress fields before and after mineralization (SRK, 2010).

## 7.3 Description of the Ore Body

Copper Flat is an alkalic copper-gold mineralized breccia pipe, associated with and genetically-linked to an alkalic porphyry system. Copper Flat is situated along the eastern edge of the Cretaceous Arizona-Sonora-New Mexico porphyry copper belt, and, along with Tyrone, New Mexico, forms a linear mineralized feature known as the Santa Rita lineament (SRK, 2010; McLemore et al., 2000). Copper Flat is the easternmost and one of the oldest known porphyry deposits in the southwestern U.S. (Hedlund, 1974; Dunn, 1982; Titley, 1982). Analogous deposits include Terrane Metal’s Mount Milligan, British Colombia deposit and the Continental breccia pipe located in the Central Mining district of New Mexico (SRK, 2010).

### 7.3.1 Structure and Model

Mineralization at the Site is concentrated in a breccia pipe within the CFQM stock (Raugust, 2003; BLM, 1999). The eastern portion of the breccia pipe is outside the outline of the main mineralization; however, the rest of the breccia pipe is higher grade than the surrounding CFQM, hosting nearly half of the copper at the Site, but only about one-third of the total resource tonnage (SRK, 2010). Drillholes spaced approximately 100 ft apart within the center of the deposit indicate the breccia pipe occurs as a single, continuous body, approximately 1,300 ft long by approximately 600 ft wide at the surface with the long axis perpendicular to the predominant northeast fracture direction. It is exposed in only a few places, but extends vertically to over 1,000 ft; veins of coarse pegmatitic material have been found at approximately 1,700 ft below ground surface (bgs) in one drillhole (Dunn, 1984).

Mineralized polymetallic quartz veins, commonly associated with the dikes that radiate outward from the central stock, have been the target of historical mining activities in the Hillsboro district. The breccia pipe zone has been cut by numerous, randomly oriented, irregular veins that are thicker and coarser grained than the narrow fracture-controlled veinlets in the surrounding stock.

Mineralization appears to have been contemporaneous with pipe formation (SRK, 2010). The lack of rock flour or gouge in the matrix suggests that brecciation was not the result of tectonic movement, while the apparent lack of appreciable movement between the fragments and the gradational contact between the breccia and the zone of stockwork veining indicate that an explosive mechanism was not the source of the brecciation. Likewise, the process of mineralization stoping described by Locke (1926), which would have resulted in appreciable downward movement and mixing of the fragments, is not supported by field observations. Thus the mechanism responsible for the formation of the Copper Flat mineralized breccia pipe appears to be autobrecciation resulting from retrograde boiling, a phenomenon that occurs when the pressure of the mineralizing hydrothermal fluid exceeds the confining pressure (Phillips, 1973). The matrix of the breccia, the irregular veins in the surrounding crackle breccias, and the open space filling in the breccias consist of hydrothermal minerals and part of the second stage mineralization occurred as replacement, which modified the original breccia texture (SRK, 2010).

Unlike most deposits in the southwestern U.S., Copper Flat shows very little supergene enrichment or the symmetrical and telescoped zoning of alteration types that is considered typical of most porphyry copper deposits. Instead, hypogene mineralization and alteration, including the formation of the breccia pipe, was the result of the final crystallization of the CFQM melt and related dikes (SRK, 2010).

The current model used by NMCC for further exploration at the Site is based on Richards (2003), who interprets the area as an eroded volcano. According to this model, mineralization occurred at similar depths to that found at El Teniente in Chile; since the Copper Flat breccia pipe now crops out at the surface, this assumption indicates that approximately 0.5 to 2 kilometers (km) of volcanic rocks have been eroded from the central zone of mineralization. Fluid inclusion work by Norman et al. (1989) and McLemore et al. (2000) suggest that the breccia pipe and veins formed at a depth of 1 to 2 km bgs and at temperatures ranging from 226° to 360°C.

### 7.3.2 Mineralization

During the early mining days, a 20- to 50-foot leached oxide zone existed over the ore body, but this material was stripped during the mining activities that occurred in the early 1980s. Most of the remaining ore is unoxidized and consists primarily of chalcopyrite and pyrite with some molybdenite and traces of galena and sphalerite. Appreciable amounts of silver and gold are also present (BLM, 1999; SRK, 2010). The proven and probable reserves are estimated at more than 50 million tons of ore with 0.45 percent copper (Hydro Resources, 2002).

The breccia consists largely of fragments of mineralized CFQM, with locally abundant mineralized latite where dikes exposed in the CFQM projected into the brecciated zone. Andesite occurs only as mixed fragments partially in contact with intrusive CFQM and appears to represent the brecciation of andesite xenoliths in the CFQM (Dunn, 1984). The matrix contains varying proportions of quartz, biotite (phlogopite), potassium feldspar, pyrite, and chalcopyrite, with magnetite, molybdenite, fluorite, anhydrite, and calcite locally common. Apatite is a common accessory mineral. Much of the quartz-feldspar matrix has a pegmatitic texture. Breccia fragments are rimmed with either biotite or potassium feldspar, and the quartz and sulfide minerals have generally formed in the center of the matrix (Dunn, 1984).

The andesite in contact with the CFQM, dikes, and veins is typically altered into one of three types of mineral assemblages: biotite-potassic, potassic, or sericitic alteration (Fowler, 1982). The highest copper grades are associated with the biotite-potassic alteration, which is characterized by hydrothermal biotite, potassium feldspar, quartz, and pyrite, and which occurs in veinlets and as replacement assemblages in the monzonite (McLemore et al., 2000).

The total sulfide content ranges from 1 percent (by volume) in the eastern part of the breccia pipe and the surrounding CFQM to 5 percent in the CFQM to the south and west (SRK, 2010). Sulfide content is highly variable within the breccia, with portions containing as much as 20 percent sulfide minerals. Sulfide mineralization is restricted to the CFQM and breccia pipe, and drops abruptly at the andesite contact. Minor pyrite mineralization extends into the andesite along the pre-mineral dikes (SRK, 2010; Dunn, 1984).

Pyrite and chalcopyrite are disseminated within the CFQM and also occur along fracture-controlled veinlets and as disseminations associated with mafic minerals. Typically, pyrite is more abundant than chalcopyrite in two areas (SRK, 2010):

- A narrow zone that surrounds and overlies the western end of the breccia pipe, which has the highest grade CFQM mineralization, characterized by abundant chalcopyrite in quartz-sulfide veinlets.
- Outcrops to the southeast of the breccia and south of Grayback Wash, where disseminated chalcopyrite is present with no associated pyrite.

Molybdenite occurs occasionally in quartz veins or as thin coatings on fractures. Minor sphalerite and galena are present in both carbonate and quartz veinlets in the CFQM stock (Dunn, 1984).

## 7.4 Geochemical Sampling

NMCC has hired a contractor to conduct geologic sampling to address the potential for geologic strata to create acid rock drainage, or degradation of the surface or groundwater quality, or cause a hindrance to reclamation. NMCC proposes the use of the following geochemical characterization program at Copper Flat.

An assessment of waste rock geochemistry is proposed to predict the potential geochemical reactivity of waste rock that will be exposed during the proposed mining operation, and to provide input into a future pit lake hydrogeochemical model. This assessment will also include characterization of ore-grade materials that will be processed and deposited as tailings in the tailings impoundment.

The material characterization described in this program will address mineralogy, bulk geochemical characteristics, and the potential of the waste rock and processed ore (tailings) to generate acid or net neutral drainage, as well as a prediction of future water quality that would result from precipitation contacting the material, and what influence this may have on groundwater, surface water, and pit lake quality at the site. As appropriate, the assessment may identify waste rock management measures that would mitigate or reduce future liabilities.

NMCC proposes a phased approach that will ensure that the geologic sampling program applied addresses all the regulatory objectives and requirements. The following is a general breakdown of each step.

### 7.4.1 Step 1: Data Review and Material Type Delineation

NMCC's contractor will review all data available from the previous and current exploration drilling programs, including the drill hole database, drill logs, assay data, and bulk element geochemistry. From this review, the main rock types, alteration types, and oxidation states identified by SRK in the late 1990's will be reviewed and modified as needed. The combination of these parameters will be used to define material types for the project that will be the focus of the characterization program.

The block model and proposed pit outlines prepared by NMCC and its contractor will also be reviewed to identify ore and waste zones within the proposed pit boundaries and ensure that the proposed sample suite is spatially representative (both vertically and horizontally) of waste rock and ore. The estimated tonnages of the waste rock and ore material types will be obtained from the block model in order to define the number of samples required to characterize each material type. The sampling program will focus on the main material types with more samples being collected from the material types with the greatest predicted tonnage. This characterization will include both ore- and waste-grade material.

### 7.4.2 Step 2: Sample Interval Selection

Several types of geologic material are available from the exploration drill programs for sampling including coarse rejects and half-split core from the core and rotary drilling. However, the core will be the preferred sample material. The half-split core material is currently being stored on-site in a sheltered area and oxidation of this material from weather is anticipated to be minor. A significant amount of the core material from the mineralized zones may have been mostly consumed for metallurgical testing; however, half-split core material should be available for most of the waste intervals. Therefore, the half-split core material from the waste intervals has been identified as the best material available for geochemical testing and will be targeted in the waste rock characterization portion of this sampling program. In addition, exploration drilling is currently ongoing in the expansion areas. This drilling presents an opportunity to collect additional samples for geochemical testing from rotary and core holes, provided the coarse rejects are properly stored prior to sample collection.

In the late 1990s, SRK collected 46 samples for Acid Base Accounting (ABA) testing, 59 for Net Acid Generation (NAG) testing, 1 for short-term leach testing, and 5 for humidity cell kinetic tests. In addition, 14 samples were collected from the historic tailings impoundment for static test analysis, and approximately 130 samples of waste rock and pit walls were collected for field NAG test and paste chemistry. These samples were characterized by lithology, alteration, oxidation, and absence/presence of sulfides. Samples were generated by collecting material from consecutive intervals within the same drill hole, and each sample consisted of a single material type as defined by rock type, alteration type, and oxidation state. These samples were submitted to certified laboratories in Reno, Nevada for sample preparation and laboratory testing.

Additional samples will be required for waste rock characterization in order to create a sample database that is vertically and horizontally representative of waste rock associated with the current project. In addition, ore-grade samples will need to be collected. Following the data review and development of estimated waste rock and ore volumes in Step 1, NMCC’s contractor will select sample intervals from exploration drill holes to fill the identified data gaps.

NMCC’s approach to sample selection is designed to ensure that samples with the end-member reactivity are sufficiently sampled to provide a comprehensive and representative understanding of the full range of geochemical characteristics for each of the material types. To this end, NMCC’s contractor will focus on understanding the geological controls on the geochemical behavior of the different materials as the basis for sample selection. As additional mineralogical and geochemical data become available through sample analysis, these data will be combined with the previous data to define subsequent sample sets.

### 7.4.3 Step 3: Sample Collection and Field Screening

Samples will be collected by qualified geologists from consecutive intervals within the same drill hole and each sample will consist of a single material type as defined by rock type, alteration type, and oxidation state.

Once the main material types are delineated and sampled, a number of field tests can be performed to assess broad geochemical behavior of the identified material types and confirm the geological classification of the materials. Because these tests are inexpensive and quick, a significant amount of data can be collected quickly with minimal cost. By using the field screening to define a representative sample set, the “representativeness” of the sample set is more defensible and the number of samples selected for the more expensive static test suite can be minimized. This is in contrast to another commonly applied approach of selecting a set number of samples based on the predicted amount of waste rock, which usually results in an unnecessarily large sample set. This method also allows us to focus on materials that the initial geological work and testing indicate may be of concern, or which demonstrate an uncertain or highly variable geochemical behavior.

### 7.4.4 Step 4: Geochemical Test Work

Based on the geologic logging and field screening, a representative number of larger samples will be selected for standard static testing, including: multi-element analyses, acid base accounting (ABA) with sulfur speciation, Meteoric Water Mobility Procedure (MWMP), and Net Acid Generation (NAG). These static tests are intended to define the potential of a material to generate acid, buffer acid, and/or leach constituents under field conditions.

Based on the results of the field work and static testing, samples of material with an uncertain acid generation potential or leaching characteristics may be selected for kinetic testing. Because the static test work assumes that all minerals that have the potential to generate acid, buffer acid, or leach metals will react completely, they can only define the chemical/mineralogical potential of the rock and do not take into account reaction rates that will ultimately control whether the material will actually generate acid, buffer acid, or leach metals under field conditions.

The samples collected in Step 3 will be submitted to a certified laboratory for sample preparation and the first phase of static testing at Nevada certified laboratories as follows:

1. Whole rock analysis using four-acid digest and ICP analysis to determine total metal and metalloid chemistry for 48 elements (ALS Chemex Method ME-MS61).
2. ABA using the modified Sobek method (Memorandum No. 96-79) with sulfur speciation.
3. NAG test reporting final NAG pH and final NAG value after a two-stage hydrogen peroxide digest.
4. MWMP (ASTM D5744-96) with geochemical analysis of the leachate for applicable constituents.

This work will be supervised by NMCC's contractor at McClelland Laboratories of Sparks, Nevada with analysis by Western Environmental Testing Laboratory (WETLab) of Sparks, Nevada; ALS Chemex of Reno, Nevada; and SVL Laboratories of Kellogg, Idaho.

The first phase of geochemical testing will be completed to assess the range of reactivity of each of the material types and the results will be used to select samples for MWMP testing with geochemical analysis of the leachate for applicable constituents (Table 7-2). Samples demonstrating end-member reactivity, as determined from the first phase of static laboratory testing, will be selected for MWMP testing to provide a comprehensive and representative understanding of the leaching characteristics of the different material types associated with the Copper Flat deposit. It is estimated that 80 samples will be selected for static testing (Figure 7-5), of which 40 samples would be selected for MWMP testing. Mineralogical analysis will also be completed on about 20 samples to provide a better understanding of the influence geologic controls have on the geochemical behavior of the waste rock and ore.

As the additional MWMP and mineralogical data become available, they will be combined with the previous dataset to refine the preliminary geochemical predictions for each material type.

### 7.4.5 Step 5: Kinetic Testing Program

Based on the results of the static testing described above, any material types that exhibit uncertain or highly variable geochemical behavior will require further characterization using kinetic test methods to determine the rates and character of longer-term leaching. Based on the results of previous static testing and interpretation, representative samples will be selected for kinetic test work. Although the number of samples that will require kinetic testing will be based on the static test results, it is estimated that about 20 samples will be selected from the static test database for humidity cell testing (ASTM D-5744-96-7).

### 7.4.6 Step 6: Data Validation and Compilation

The geochemical data will be reviewed as it is received to ensure the quality of data and consistency in analyses. NMCC's contractor will then verify the quality of all data and confirm that no anomalies are related to laboratory error prior to interpretation and reporting. At a minimum, NMCC's contractor will utilize their internal standard data validation procedures, although guidance from other sources may also be considered (e.g., U.S. Environmental Protection Agency). All geochemical data collected as part of the static testing program will be compiled into a single database for evaluation.

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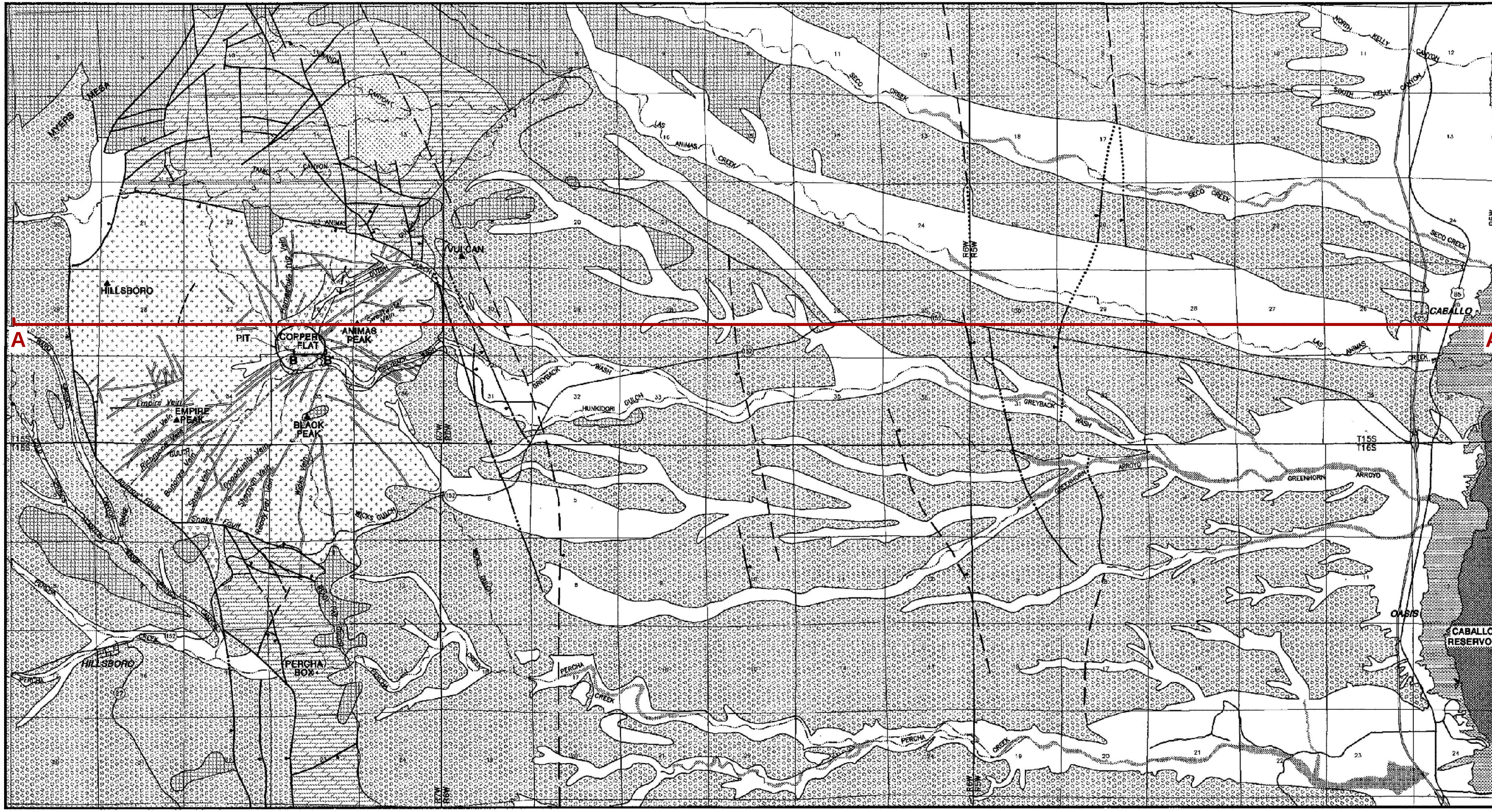
# Figures




## STRATIGRAPHY

| TERTIARY - QUATERNARY | CRETACEOUS | PALEOZOIC AND PRECAMBRIAN |
|---|---|---|
| Quaternary Alluvium (Qvy+Qvo) | Late Cretaceous – Silicic Intrusives (Kll) | Paleozoic Siliciastic and Carbonate Sedimentary Rocks (pC through PM) |
| Tertiary Volcanics (TQb+Tv) | Cretaceous Latite – Andesite Intrusives (Kql+Kd+Kls) | |
| Tertiary Santa Fe Group (Tsfp+Tsf) | Andesite rocks near Copper Flat (Ka) | |

## LEGEND

NORMAL FAULT, BALL ON DOWNTHROWN SIDE; DASHED WHERE INFERRED, DOTTED WHERE BURIED.

CONTACT

A A' CROSS SECTION LOCATION

SOURCES:
(1) HARLEY (1934)
(2) SEAGER ET AL. (1982)
(3) HEDLUND (1977)
(4) ALMINAS ET AL. (1975)

NORTH

0 5,825 11,650
FEET

(see Figure 7-2 for cross section detail)

INTERA

from BLM, 1999

**Figure 7-1**
**Regional Surface Geology**
**New Mexico Copper Corporation**

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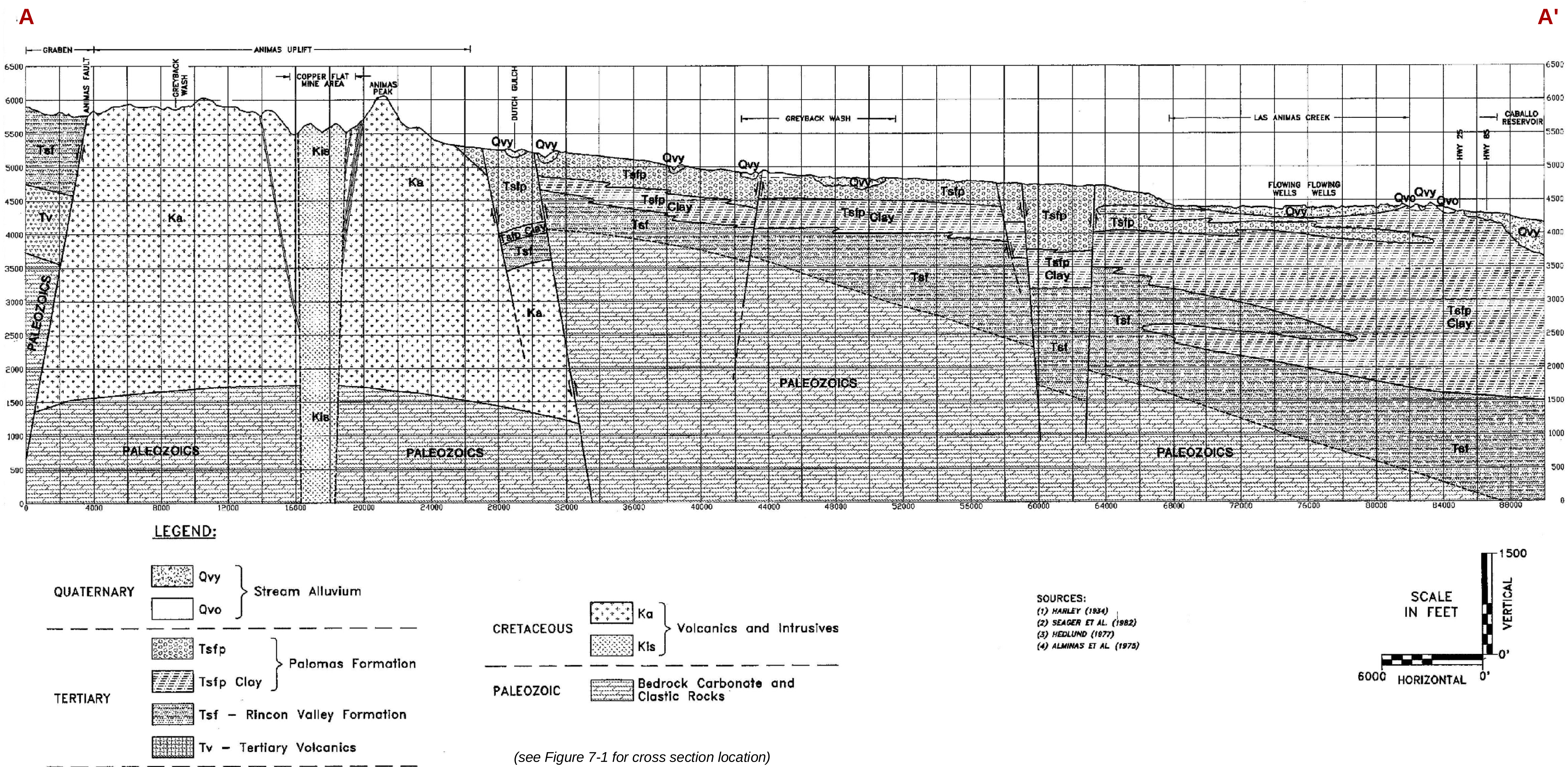
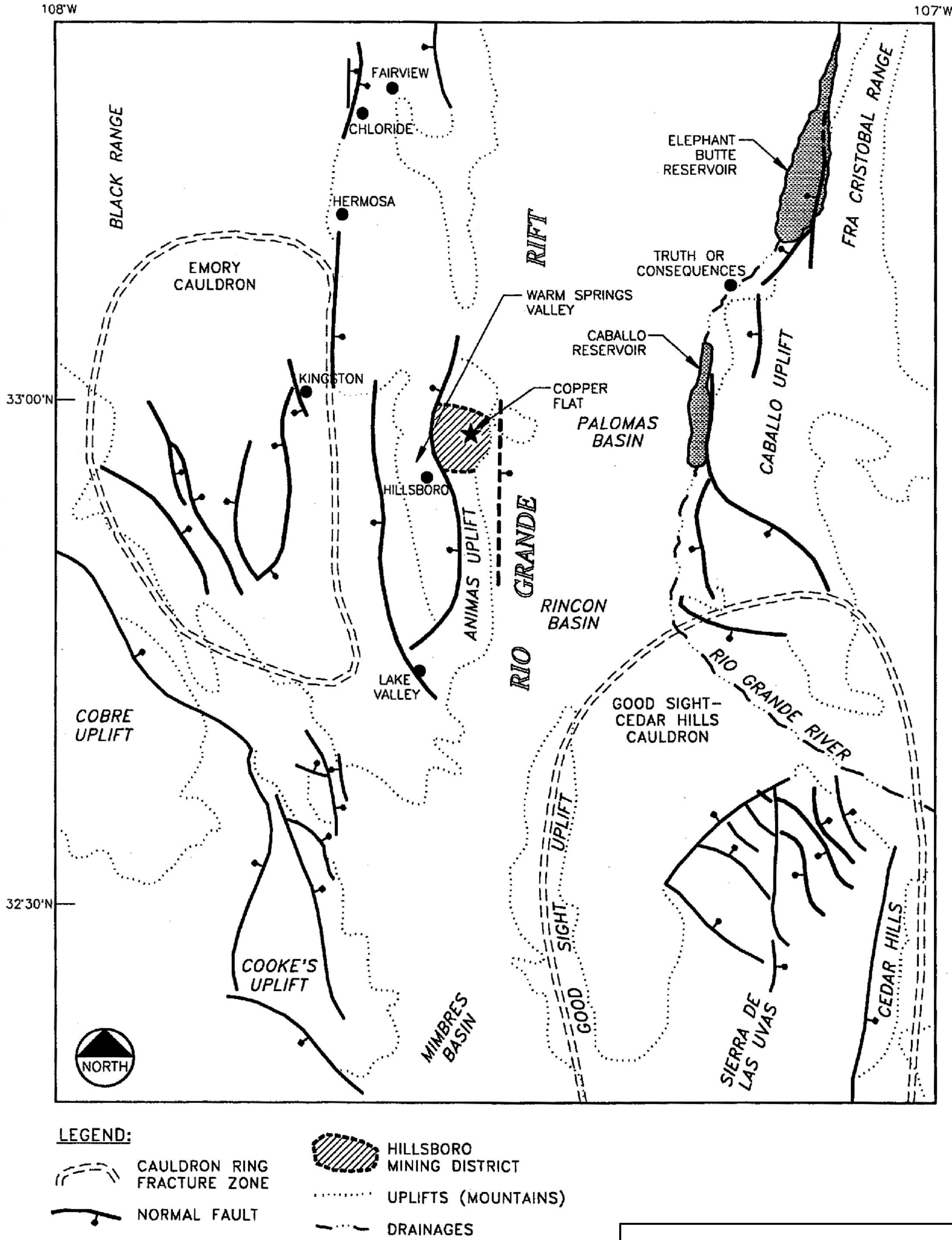



*(see Figure 7-1 for cross section location)*

from BLM, 1999

**Figure 7-2**
**Schematic Geologic Cross Section (A-A')**
**New Mexico Copper Corporation**




from BLM, 1999

**Figure 7-3**
**Geologic Structural Features of the Region**

**New Mexico Copper Corporation**

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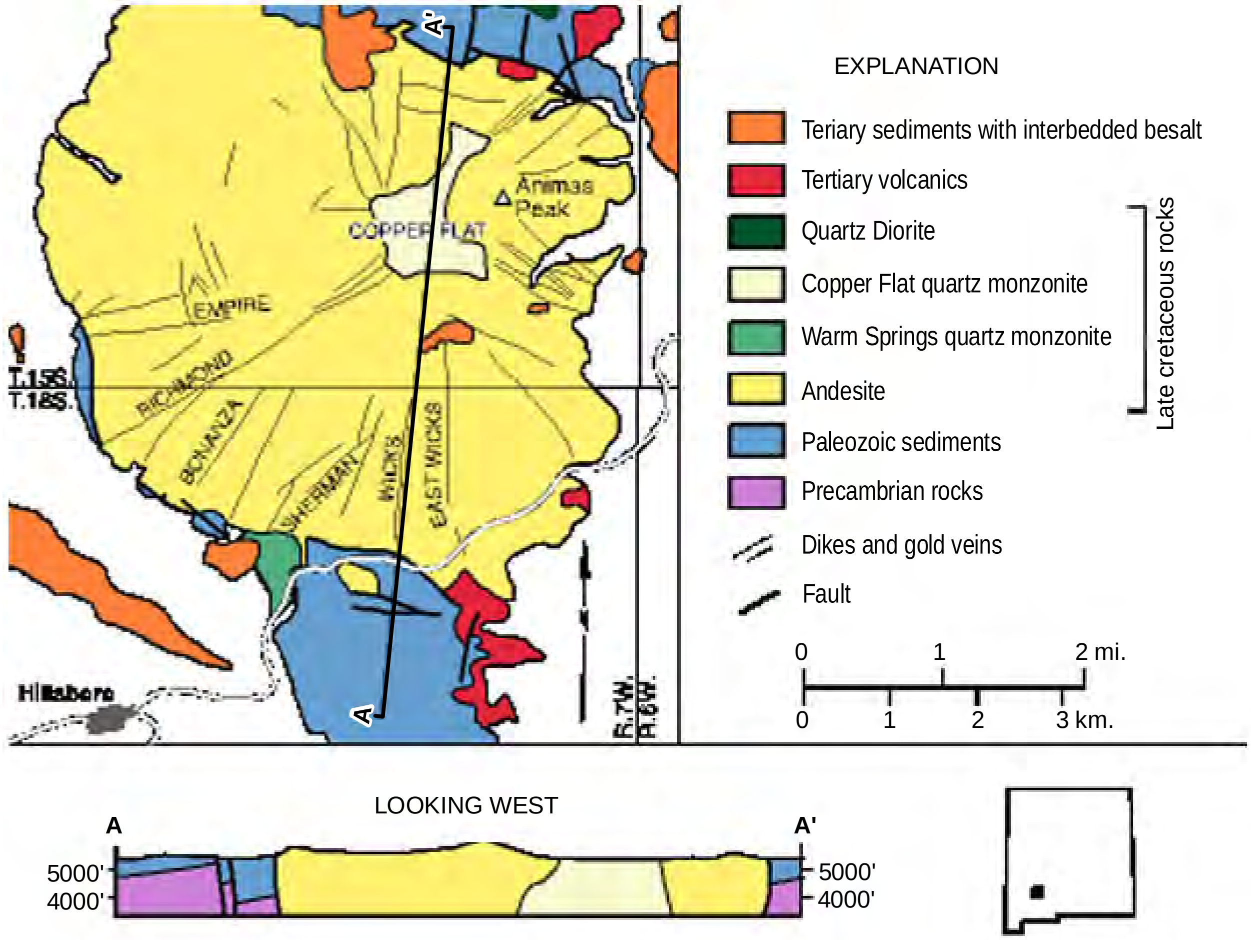
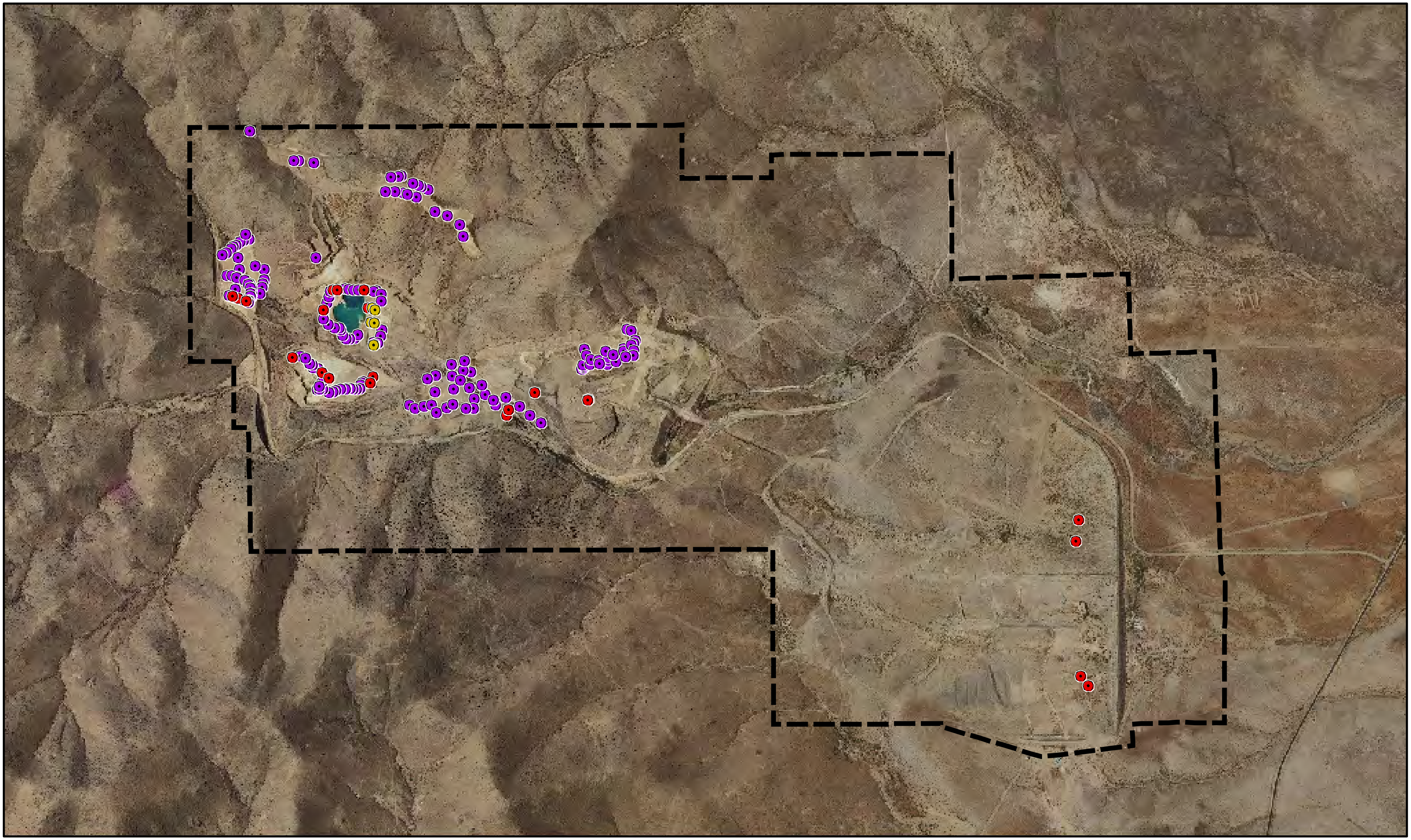



from McLemore et al., 2000; Dunn, 1982; Hedlund, 1985

**Figure 7-4**
**Geologic Schematic of the Hillsboro Mining District, New Mexico**

**New Mexico Copper Corporation**



N
W E
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Mine Boundary:
Tom Reynolds
Samples:
SRK, 2010
Imagery Information:
-USGS 7.5-Minutes County DOQQ
mosaic Sierra County, 2009
Projection Information:
-New Mexico State Plane West, NAD 1927

0 1,000 2,000 4,000
Feet

**Legend**
Proposed Mine Permit Boundary
Surface Grab Sample
Drillcore Sample
1997 Sample

**Figure 7-5**
**Locations of**
**Geologic Samples**
**New Mexico Copper Corporation**

S:\Projects\NMC-001_New Mexico Copper Corporation\GIS\Maps\SAP_7-2010\7_geology\7-5_sample-locations.mxd 09/03/2010

## Tables

## Table 7-1
## Stratigraphy of the Copper Flat Area

<table>
<tr><th>Age</th><th colspan="2">Geologic Unit</th><th>Thickness (ft)</th></tr>
<tr><td rowspan="6">Cenozoic<br>0–65 million years ago (Ma)</td><td colspan="2">Pleistocene and Holocene valley alluvium</td><td>10–70</td></tr>
<tr><td colspan="2">Pleistocene river, arroyo, and fan deposits</td><td>50–100</td></tr>
<tr><td colspan="2">Pliocene basalt flows, dikes, and plugs</td><td>50–200</td></tr>
<tr><td colspan="2">Upper Santa Fe Group fanglomerates (Palomas Formation)</td><td>300–100</td></tr>
<tr><td colspan="2">Santa Fe Group, Rincon Formation</td><td>1000–2000</td></tr>
<tr><td colspan="2">Tertiary volcanics</td><td>1000</td></tr>
<tr><td rowspan="7">Mesozoic<br>65–225 Ma</td><td>Quartz latite dikes</td><td rowspan="4">Copper Flat volcanic and intrusive (mineralization associated with emplacement)</td><td rowspan="4">>3000</td></tr>
<tr><td>Intermediate composition intrusive</td></tr>
<tr><td>Late Cretaceous andesite dikes</td></tr>
<tr><td>Late Cretaceous silicic intrusives</td></tr>
<tr><td colspan="2">Sandstone</td><td></td></tr>
<tr><td colspan="2">Mancos Shale (not exposed)</td><td>300–400</td></tr>
<tr><td colspan="2">Dakota Sandstone (not exposed)</td><td>100–200</td></tr>
<tr><td rowspan="5">Paleozoic<br>225–570 Ma</td><td colspan="2">Manazano Group sedimentary rocks. Abo Sandstone, Yeso Formation shales, sandstones, and gypsum deposits, and San Andres Limestone. Not exposed west of Rio Grande at Site.</td><td>1000–2000</td></tr>
<tr><td colspan="2">Pennsylvanian carbonate rocks including Syrena, Oswaldo, and Magdalena Groups, minor conglomeratic sandstone and cherty massive limestone.</td><td>400–1000</td></tr>
<tr><td colspan="2">Devonian and Mississippian carbonate rocks (Kelly Limestone, Lake Valley Limestone, Caballero Formation) and Percha Shale.</td><td>200–500</td></tr>
<tr><td colspan="2">Ordovician Montoya Group and Fusselman Dolomite.</td><td>250–600</td></tr>
<tr><td colspan="2">Cambrian-Ordovician Bliss Sandstone and El Paso Group Limestone.</td><td>500–700</td></tr>
<tr><td>Precambrian<br>570–1,500 Ma</td><td colspan="2">Precambrian massive granite</td><td></td></tr>
</table>

Source: BLM, 1999, Tables 3-1 and 3-2

**Table 7-2**

**Proposed Analytical Parameters with Method Reporting Limits**

| Parameter | Method | Method Reporting Limit |
|---|---|---|
| Alkalinity, CaCO3 (Acidity) | SM 2320B | 1 |
| CO3, CaCO3 | SM 2320B | 1 |
| HCO3 | SM 2320B | 1 |
| Aluminum | EPA 200.7 | 0.045 |
| Antimony | EPA 200.8 | 0.0025 |
| Arsenic | EPA 200.8 | 0.005 |
| Barium | EPA 200.7 | 0.01 |
| Beryllium | EPA 200.7 | 0.001 |
| Bismuth | EPA 200.7 | 0.1 |
| Boron | EPA 200.7 | 0.1 |
| Cadmium | EPA 200.8 | 0.001 |
| Calcium | EPA 200.7 | 0.5 |
| Chloride | EPA 300.0 | 1 |
| Chromium | EPA 200.7 | 0.005 |
| Cobalt | EPA 200.7 | 0.01 |
| Copper | EPA 200.8 | 0.05 |
| Fluoride | EPA 300.0 | 0.1 |
| Gallium | EPA 200.7 | 0.1 |
| Iron | EPA 200.7 | 0.01 |
| Lead | EPA 200.8 | 0.01 |
| Lithium | EPA 200.7 | 0.1 |
| Magnesium | EPA 200.7 | 0.5 |
| Manganese | EPA 200.7 | 0.005 |
| Mercury | EPA 200.8 | 0.0001 |
| Molybdenum | EPA 200.7 | 0.01 |
| Nickel | EPA 200.7 | 0.01 |
| Nitrate as N | EPA 300.0 | 1 |
| Nitrite as N | EPA 300.0 | 1 |
| pH (s.u.) | SM 4500-H+ B | -- |

| Parameter | Method | Method Reporting Limit |
|---|---|---|
| Phosphorus | EPA 200.7 | 0.5 |
| Potassium | EPA 200.7 | 0.5 |
| Scandium | EPA 200.7 | 0.1 |
| Selenium | EPA 200.8 | 0.005 |
| Silver | EPA 200.7 | 0.005 |
| Sodium | EPA 200.7 | 0.5 |
| Strontium | EPA 200.7 | 0.1 |
| Sulfate | EPA 300.0 | 1 |
| Thallium | EPA 200.8 | 0.001 |
| Tin | EPA 200.7 | 0.1 |
| Titanium | EPA 200.7 | 0.1 |
| Total Dissolved Solids | SM 2540C | 10 |
| Uranium | EPA 200.8 | 0.002 |
| Vanadium | EPA 200.7 | 0.01 |
| Zinc | EPA 200.7 | 0.01 |

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# 8 Surface Water

The Copper Flat area falls within the Lower Rio Grande watershed, as defined by the New Mexico Water Quality Control Commission (WQCC). This watershed includes approximately 5,000 square miles in Catron, Socorro, Sierra, and Doña Ana Counties and is dominated by the Rio Grande and its tributaries as well as the two large reservoirs of Elephant Butte and Caballo. Numerous ephemeral tributaries feed into the Rio Grande from the west, but none contribute perennial flow to the Rio Grande.

Subsection 8.1 provides background information about surface water resources in the vicinity of the Copper Flat Mine Permit Area (Site), and Subsection 8.2 summarizes resources for pertinent historical data related to surface water sampling. The rest of this section focuses on the proposed sampling plan for surface water at the Site. Surface water baseline studies have been completed in the project area since the 1960s, and relevant information and data are referenced in subsequent sub-sections throughout Section 8.

## 8.1 Surface Water Characteristics of Site and Vicinity

The Site is drained by ephemeral streams (arroyos) within the Greenhorn Arroyo drainage basin, a 6$^{th}$ level sub-watershed defined by the Hydrologic Unit classification system (Seaber et al., 1987) that drains 29,414 acres of land on the eastern slope of the Animas Uplift to a single outlet into the Rio Grande (Figure 8-1). Flows within the Greenhorn Arroyo drainage basin are ephemeral, as they only occur in direct response to precipitation. As a result, this drainage, similar to others in the region, does not contribute any perennial surface water flow to the Rio Grande.

Numerous arroyos contribute to the trunk channel of Greenhorn Arroyo. Of these, Grayback Arroyo is the primary drainage through the Site. Grayback Arroyo originates west of the Site and drains eastward along the Site axis until it converges with the trunk channel of Greenhorn Arroyo approximately 8 miles east of the Site boundary (Figure 8-1). In pre-mining times, Grayback Arroyo drained directly through the mine area, but was later re-routed around the southern perimeter of the mine area for flood control purposes (Raugust, 2003). Newcomer and Finch (1993) measured flow rates in Grayback Arroyo of 12.5 gallons per minute (gpm) in March 1993 at a point east of the pit and former plant site. Three seeps have been identified along Grayback Arroyo (BLM, 1999). One seep with riparian vegetation is located near a buried storm water collection pond, a second is located downstream from the first seep and supports a small cottonwood/willow stand, and the third is south of the operations area (Figure 8-1).

Two creeks drain basins directly to the north and south of the Greenhorn Arroyo drainage basin: Las Animas Creek in the north and Percha Creek to the south (Figure 8-1). Both Las Animas and Percha Creeks have ephemeral, intermittent, and perennial reaches. Streamflow in Las Animas Creek varies from perennial to intermittent from the area near sampling site MAS (Figure 8-1) to Caballo Reservoir (BLM, 1999). For example, Davie and Spiegel (1967) show flow rates ranging from about 450 to 900 gpm in the upper reach (T14S R7W, Sections 34 through 36, near sampling sites LAC-A and LAC-B in Figure 8-1) and middle reach (within T15S R5W) of the creek; according to Davie and Spiegel, these reaches are "losing reaches" of the creek. Streamflow in Percha Creek is intermittent in the Hillsboro reach and perennial in the area known as the Percha Box, a steep-walled reach of the drainage that has incised into Paleozoic bedrock (BLM, 1996) (Figure 8-1). SRK (1995) reported measurable streamflows just east of the Percha Box of roughly 200 to 250 gpm. This was the only reach of Percha Creek with measurable flows during the SRK sampling period. Though both Las Animas Creek and Percha Creek have perennial reaches, neither creek contributes perennial flow to the Lower Rio Grande Basin.

Two springs are located within the Greenhorn Arroyo drainage basin to the north and west of the Site (Figure 8-1). Other unnamed seeps occur in the pit walls surrounding the pit lake after precipitation events;

these are likely the result of fractured flow through the bedrock exposed in the pit wall. Several springs in the Percha Creek basin and one in the Las Animas Creek basin have been identified for sampling, but have been studied less than those within the Greenhorn Arroyo basin. As a result, there is little information on their flow rates or quality, although Newcomer and Finch (1993) did attempt to measure flow.

The open pit that was mined during the early 1980s now contains a lake. Since 1989, the pit lake has been sampled for water quality approximately 65 times at various locations and depths, including samples collected by past operators of the mine, state regulatory agencies, and academic researchers studying the mine (BLM, 1999). For the proposed operations, the New Mexico Copper Corporation (NMCC) would consume the pit lake waters for mine operations and dust suppression. If necessary, pit water could be temporarily stored in a reservoir in the plant area (SRK, 2010a).

Mine water from milling operations would be discharged into an evaporation pond or re-used for several purposes: (1) plant processing streams, (2) the tailings facility with pump-back to the plant, and/or (3) dust control (SRK, 2010a). Both a National Pollution Discharge Elimination System permit and a New Mexico Environment Department (NMED) groundwater discharge permit are required for NMCC to discharge mine water. In preparation for both permits, NMCC will characterize the water quality of the mine discharge through scheduled gauging and sampling of discharge. In addition, NMCC will design a storm water management system to manage discharge for the proposed facilities. Mine water discharge is not expected to reach the Lower Rio Grande or any lake, spring, reservoir, riparian, or wetland areas.

## 8.2 Historical Data

Existing surface water data relevant to the NMCC sampling plan are discussed in this section and are summarized in Table 8-1. Surface water at the Site was most recently investigated by ABC (1996), who collected flow and water quality from Percha Creek and Las Animas Creek. Newcomer et al. (1993) performed a hydrologic assessment of the Greenhorn Arroyo drainage basin, measuring flow and water quality along Grayback Arroyo and at a number of seeps and springs. The oldest known surface water investigation at the Site was performed by Davie and Spiegel (1967), who collected flow data for Las Animas Creek. In addition, the surface water chemistry of Grayback Arroyo was initially investigated in 1977 at three locations as part of an environmental assessment prepared by the BLM in response to an application by Quintana Minerals Corporation for an open pit copper mine at the Site (BLM, 1978). The three locations sampled in 1977 generally correspond to the sampling locations proposed in Figure 8-1, with one location upstream of the permit boundary, one within the Site approximately 300 yards from the mine rim, and a third located where the arroyo leaves the Site (BLM, 1978). Water samples were collected in January, March, and July of 1977. Results of these investigations were compiled by Raugust (2003) and are also summarized in the Bureau of Land Management’s (BLM) preliminary final environmental impact statement (PFEIS) for Copper Flat (1999).

Spring and seep flow rates are infrequently reported in the available literature for the Site and surrounding areas. Several springs and seeps have been identified within the Greenhorn Arroyo drainage basin. Two springs, identified as BG and BG-2, are located to the north and west of the Site (Figure 8-1) and several unnamed seeps occur in the walls surrounding the pit lake. BG and BG-2 were judged by Newcomer et al. (1993) to be ephemeral. The seeps along the pit walls are observed to flow in response to precipitation events, and, as mentioned above, are likely the result of fractured flow through the bedrock exposed in the pit wall. All known springs and seeps in the Greenhorn Arroyo drainage basin are upgradient of the proposed mine water discharge location. Other seeps and springs shown in Figure 8-1 have not been measured in the past and thus have no associated historical flow information.

The 12.8-acre lake that has formed in the existing pit (Figure 8-2) is estimated to be about 40 ft deep, based on a pit bottom elevation of 5,380 ft above mean sea level (amsl) and water level elevation of 5,420 ft amsl as measured in 1986 (SRK, 2010b). The water quality of the pit lake has been sampled over 65 times at various depths and locations since the initial samples were collected on April 13, 1989, by the New Mexico Environment Improvement Board (Raugust, 2003); the latest samples were collected in January 2010. Raugust (2003) concluded that the collective data show several trends in the variability of water quality over time, mainly that evapoconcentration and buffering processes are influencing the quality of the lake water. Pit water has historically exceeded the WQCC standards for sulfate, chloride, TDS, manganese, and uranium (20.6.2.4103 of the New Mexico Administrative Code) and has, at times, dropped below the acceptable pH range of 6 to 9.

Other key studies that discuss the water quality are summarized in SRK (1997) and include hydrogeologic and hydrogeochemical studies (SRK, 1995), post-closure pit water balance model calculations (SRK, 1997), water quality and host-rock geochemical studies (SRK, 1997), and post-hearing submittals that followed the 1997 New Mexico Mine Permit public hearing.

Evaluating these existing historical data is essential to completing a comprehensive Baseline Characterization Report. The statistical analysis method proposed to evaluate these historical volumetric flow and water quality data as baseline characterization data is discussed in detail in Section 9.1.5 of the SAP (see Section 9 – Groundwater). This statistical analysis will be used to justify the use of historical data, per the New Mexico Energy, Minerals and Natural Resources Department (EMNRD) Mining and Minerals Division (MMD) draft Guidance Document for Part 6 New Mining Operations Permitting under the New Mexico Mining Act (MMD Guidance Document). Additionally, statistical analysis will be used to determine if the current baseline data are significantly different from existing baseline data where temporal data are available for the monitoring wells.

## 8.3 Sampling Objectives

The objective of sampling surface water is to characterize the volumetric flow and water quality of seeps, springs, streams, and the pit lake. Table 8-2 lists the frequency, location, and method for the proposed sampling program.

This information will be used for the following purposes:

1. Develop the discharge plan application for water produced during dewatering.
2. Further describe the seasonal variations in surface water quantity and quality in the vicinity of the Site.
3. Determine the likely impacts on the hydrologic regime, such as the quality and quantity of surface water systems in the vicinity, including dissolved and suspended solids under seasonal conditions.

Sources that could affect surface water quality include the disposal of mill tailings, acid rock drainage from mine stock piles, and erosion associated with reduced land cover and increased land disturbance. Dewatering activities associated with the pit as well as groundwater development for mine operations could affect surface water quantity. This plan outlines how, when, and where data will be collected to characterize baseline conditions in support of mitigating impacts to surface water quality and quantity.

## 8.4 Sampling Frequency

Perennial streams, springs, and the pit lake will be sampled four times over a 12-month period. Ephemeral or intermittent streams, springs and seeps will be sampled during opportunistic sampling events after precipitation events. The frequency of samples by location is presented in Table 8-2.

## 8.5 List of Data to Be Collected

A variety of data needs are associated with surface water. These needs are provided in Table 8-3 along with a plan for how each need will be addressed through this sampling and analysis plan.

## 8.6 Methods of Collection

In general, the methods used to collect surface water samples will follow the standard operating procedures defined by the NMED Surface Water Quality Bureau (SWQB) (2007) for streamflow measurement and water quality sampling, as described below. Methods deviate from NMED standard operating procedures for sampling volumetric flow and water quality from springs and seeps and water quality and sediment in the pit lake, as described in Section 8.6.2.

### 8.6.1 Surface Water Samples from Springs and Drainages

#### 8.6.1.1 Volumetric Flow Measurements

*Streams.* Streamflow measurements will be made using classical techniques for open-channel flow. For reaches with perennial flow (Table 8-2), volumetric flow will be measured using a flow meter such as the Marsh-McBirney Flo-Mate™ 2000, which is designed for characterizing open-channel flow; a top-setting wading rod; and a tape measure or tagline. Assembly, calibration, and operation of the flow meter will follow the procedures described in NMED SWQB (2007). At each stream location listed in Table 8-2 that does not have an auto-sampler installed, a sampling station will be established by identifying (as close to the designated location as possible) a straight reach of the stream where the streambed is uniform and relatively free boulders and aquatic vegetation. The width of the stream will be measured using a tape measure, then subdivided so that each stream section between vertical profiles will contain no more than 10% of discharge (e.g., if the stream is <5-ft wide, vertical profiles would be 0.5 ft apart). Following procedures in NMED SWQB (2007), if the stream depth is greater than 2.5 ft, stream velocity will be measured at 20 percent, 60 percent, and 80 percent of the total depth of the stream at each profile location along the cross-section. If stream depth is more than 0.15 ft but less than 2.5 ft, the velocity measurement will be taken at a depth that is equal to 60 percent of the total depth when measured from the surface of the water (NMED SWQB, 2007). Following the same NMED SWQB procedures, if the stream is less than 0.15 ft deep, flow will be measured using the equation $0.9 \times Umax$, where $Umax$ is the maximum velocity recorded throughout the entire flow (Marsh-McBirney, 1990). Once measurements have been recorded, flow will be calculated in the field and recorded in the field book.

Given the unpredictable nature of flow in intermittent and ephemeral reaches of streams, streamflow in many of these locations will be recorded using deployed, portable, automatic sampling devices (auto-samplers). An auto-sampler, such as the Global Water FSS Flow Sampling System (or similar), will be installed to collect streamflow during periods in which there is measurable flow. A datalogger will record flow measurements in the unit's random access memory (RAM) and will be available for download onto a laptop computer following the storm event. Five auto-samplers will be installed within and in the vicinity of the Site, three within Greyback Arroyo, one in Percha Creek, and one in Las Animas Creek, as listed in Table 8-2 and shown in Figure 8-1.

Sites were selected for flow measurement following methods presented in NMED SWQB (2010). Established monitoring stations with historical data on each watershed were selected to examine trends in water flow. These include stream sampling stations listed in Table 8-2. Grayback Arroyo SWQ-1, SWQ-2, and SWQ-3 all have historical measurements for streamflow, but the data are sparse because auto-samplers were not installed and measurements were made by hand. These stations, however, are well positioned for the purposes of characterizing upstream, on-site, and downstream conditions because Site SWQ-1 is located upstream of the

Site, SWQ-2 is located within the Site, and SWQ-3 is located downstream of the portion of the Site that has been most disturbed by mining activities and still exhibits ephemeral flow. SWQ-1 is proposed as a reference site, as the water quality at this location has received the least amount of impact from past mining activities and the geology, gradient, and precipitation characteristics of SWQ-1 are similar to the sampling locations within and downstream of the Site, which have been more impacted by past mining operations and are likely to be more affected by the proposed NMCC mining operation. The selection of locations for the installation of auto-samplers in Percha and Las Animas Creeks was based on the criteria for site selection defined in NMED SWQB (2010), and reflects the fact that past measurements at these locations demonstrates that flow has occurred historically within the given reach.

*Springs and Seeps.* Volumetric flow from springs and seeps can be measured with a portable V-notch weir box or adjustable flume, if sufficient flow exists and channel conditions are appropriate. The V-notch weir box operates under the principle that discharge is related to the height of the water above the bottom of the V-shaped notch; the shape ensures that a small change in the discharge will effect a large change in the height of the water. Flow can be calculated from measurement methods defined for V-notch weirs by the U.S. Bureau of Reclamation (USBR, 2001).

If flows are insufficient for the use of a flume or V-notch weir (e.g., <0.1 cfs [44.8 gpm]), volumetric flow will be estimated using the "timed fill" method, as described by NMED SWQB (2007). This method uses a stopwatch to measure the time it takes to fill a 5-gallon bucket by diverting the entire flow of the spring or seep into the bucket below a weir or waterfall (NMED SWQB, 2007). To calculate flow using this procedure, 5 gallons per unit time may be converted to cfs using the following equation:

$$5 \text{ g} = 0.6684 \text{ ft}^3\text{, thus } 440.6684/\text{elapsed time (seconds)} = \text{cfs}$$

### 8.6.1.2 Water Quality Sampling

*Streams.* Individual samples collected over a period of 15 minutes or less (i.e., grab samples) will be collected by the auto-samplers installed in Grayback Arroyo, Percha Creek, and Las Animas Creek at the locations listed in Table 8-2. Each sample will represent water quality conditions at the time the sample was collected. The auto-sampler consists of a 2.5-gallon polyethylene sample bottle, a peristaltic sampling pump, a pickup hose, a circuit board controller, a rechargeable gel cell battery, and a battery charger. With the exception of the pickup hose, the components are housed in a waterproof case mounted aboveground next to the sampling location, which is outside of the ordinary high water mark of channel.

Once the sample is collected, a radio unit in the sampler will communicate to a receiver installed in the meteorological tower (see Section 2), which will in turn notify the NMCC surface water lead via telemetry that a surface water sample has been collected. The sample will be retrieved by on-site mine staff, placed in a laboratory-provided sample container, and shipped overnight to the designated laboratory for analysis. All equipment preparation and cleaning, sample collection, and sample preservation will follow the standard operating procedures defined by NMED (NMED SWQB, 2007).

*Springs and Seeps.* During quarterly measurements of flow from seeps and springs, water quality samples will be collected using non-isokinetic, open-mouth samplers following U.S. Geological Survey protocols for sample equipment selection described in Lane et al. (2003). Methods will follow the 2007 NMED/SWQB Standard Operating Procedures for Data Collection, §7.3 Routine Water Chemistry Sampling.

Samples will be collected in clean polyethylene Cubitainer® containers. Where water flows at sufficient depth, samples will be collected by immersing the container by hand or by rod beneath the surface. Otherwise, water will be collected in a plastic bucket or disposable bailer held with nylon rope or twine, if necessary. Care will be taken to avoid contamination with debris from the rope or twine and the sampling area. Buckets and bailers will be rinsed three times with source water and sampling personnel will rinse their hands with source water before collecting samples. Samples will be collected immediately following rinsing. Buckets will be rinsed with spring water following use and cleaned with Liquinox and warm water prior to the next use.

Water will be transferred from the collection vessel to the sample container with a peristaltic pump or syringe, filtering as appropriate. Dissolved concentration samples will be filtered; total concentration samples will not be filtered. All samples for dissolved constituent analytes will be filtered with a 0.45-micron pore-size disposable in-line filter cartridge. Filters will be rinsed with sample water according to the manufacturer’s recommendations prior to sampling.

Every effort will be made to take sonde readings in flowing water. When this is not possible, sonde readings will be made from the bucket or bailer after the sample has been collected and a note to this effect will be made on the field sheet.

#### 8.6.1.3 Sediment Sampling in Streams

Sediment samples will be collected at each of the surface water sampling locations identified in Table 8-2. Sample collection methodology will depend on sample location. Field personnel will visit the locations and determine the best approach for ensuring collection of samples based on field reconnaissance. The objective in selecting a sample site is to obtain recently deposited fine sediment. Depositional zones include areas on the inside bend of a stream; areas downstream from obstacles such as boulders, islands, or sand bars; or simply shallow waters near the shore. Where possible, fine-grained surficial sediments will be obtained from several depositional zones that represent various flow regimes within a stream reach, and will be composited to yield a sample representing average conditions. However, depositional zones on small, ephemeral drainages may be limited in size, necessitating that a single zone be regarded as representative.

Samples will be collected following NMED SWQB Standard Operating Procedures for Data Collection (NMED SWQB, 2007), as follows:

1. Samples will be collected in a plastic or Nalgene® jar.
2. The sample will be composited from several representative depositional zones into an appropriate mixing container after decanting any excess water over the back of the scoop.
3. The sample will be mixed well.
4. An aliquot of the mixed material will be transferred to the final, labeled sample container (a 4-ounce, wide-mouthed glass jar) and placed on ice for transport to the analytical facility. If shipment cannot be accomplished in a timely manner, the sample will be frozen prior to shipment. (Sediment samples are not preserved.)

If water and sediment samples are to be collected at the same location, water samples will be collected (1) before collecting sediment samples, as sampling sediment will disturb the stream, and (2) downstream of sediment samples, as water sampling may disturb representative depositional zones. Personnel collecting samples will employ proper sample handling techniques, including wearing latex or nitrile gloves, avoiding hand contact with contaminating surfaces, and minimizing the number of sample handling steps. Sample containers will be covered while being moved to minimize the atmospheric input. All sample collection equipment will be rinsed as soon as possible after use and thoroughly rinsed with ambient water at each new sampling station before collecting a sample. Equipment used will be inert with respect to the analytes to be collected.

### 8.6.2 Pit Lake Sampling

#### 8.6.2.1 Water Sampling

Lake water from a sampling station located at the deepest point in the lake will be sampled four times within a 12-month period, with one set of samples collected during each season. Only one sampling station is proposed, as the size of the lake is less than 100 acres, which is typically the threshold for establishing additional sampling stations (see Section 2.0 of NMED SWQB, 2010). The deepest point of the lake will be identified by surveying the lake bathymetry along predetermined parallel depth profiles. These parallel profiles will be spaced to provide adequate coverage with the addition of two tie lines perpendicular to the profiles to ensure consistency in the interpretation of water depth between each profile. Given the size of the pit lake, 5 profiles and 2 tie lines are proposed, as shown in Figure 8-2. The depth along each profile will be measured using a portable acoustic transducer tethered to the side of the boat 2 inches below the water surface. Each predetermined profile will be pre-loaded into a global positioning system (GPS) with horizontal accuracy of ≤3 meters (9.8 ft) to ensure that depth measurements follow the proposed profile lines in the field.

During each of the four quarterly sampling events, vertical profiles of temperature, pH, oxygen/reduction potential, dissolved oxygen, and conductivity will be measured at a resolution of up to every 12 inches. These profiles will be used to define seasonal trends in the water column and the discrete depths at which surface water quality samples should be collected.

Based on the results from the vertical profile, a surface water sample will be collected from up to three depths at the deepest point within the lake. These three samples, taken quarterly, are needed to determine whether the lake is either thermally or chemically stratified and to support geochemical modeling of the pit lake system. If the vertical temperature profile shows that no thermocline present in the lake (i.e., there is less than 1$^{o}$C difference between the temperature of the surface and bottom of the lake), then three water-quality samples will be collected from within the euphotic zone. The euphotic zone is defined as the depth of light extinction, which will be measured by lowering a secchi disk into the water and measuring the depth below water at which the disk is no longer visible through a secchi disk viewer. Following the NMED SWQB (2007) procedures for sampling lakes, 5-liter samples from the top, middle, and bottom of the euphotic zone will be collected for the water quality analyses listed in Table 8-4; a rinsed Kemmerer® water bottle will be used for sample collection. The 5-liter samples will be composited in a 5-gallon, acid-washed container. If a thermocline is present (i.e., if there is greater than 1°C difference between the surface and bottom temperatures of the lake), 5-liter samples will be taken from the top, middle, and bottom of the entire water column instead of just the euphotic zone. The 5-liter samples will then be composited in a 5-gallon, acid-washed container.

Each 5-liter water-quality sample will be collected using a Wildco® discrete-depth sampler that is capable of collecting a continuous column of water from a desired depth. A 5-gallon Cubitainer® will be filled with water from each of the three samples to create a composited sample. Following NMED SWQB (2007) sampling protocols for lakes, all water quality samples will be poured off from the composited sample into their respective containers, which will be either individually rinsed, 1-liter Cubitainers® or other containers as prescribed by the analysis to be performed. Dissolved nutrient and metal samples will be filtered prior to being poured into individually rinsed, 1-liter Cubitainers®. After the composited sample is divided into individual containers, the samples for total and dissolved nutrients will be preserved in the field with 2 milliliters (ml) of concentrated sulfuric acid per liter of sample water (to reduce pH to < 2). Samples for total and dissolved metal analyses are preserved with 5 ml of concentrated nitric acid per liter of sample water (to reduce pH to <2). Samples for cyanide are preserved with 8 to 10 tablets of NaOH per liter of sample water (to increase pH to >12).

#### 8.6.2.2 Sediment Sampling

A core of recently deposited fine-grained sediment will be collected from the lake during the first sampling event using a Glew Corer (Glew, 1988; Glew et al., 2001), a gravity-driven coring device composed of cylindrical aluminum alloy and a Teflon body with a nominal diameter of 2.8 inches. The upper part (core body) houses the closing piston, release mechanism, and captive float. The float relays the motion of the messenger to the trigger and gives the corer vertical stability in the water. The core body caries a sleeve and clamping device that secures a 2.5-inch diameter Lexan-core tube capable of collecting up to 24 inches of undisturbed sediment. The Glew Corer is specially designed to collect undisturbed samples from the sediment-water interface where the bed material is loosely consolidated. In contrast to other sediment sampling devices, the flow of water through the Glew Corer is not impeded because the design of the coring device allows water to pass freely through the device with little resistance. As a result, the Glew Corer eliminates the hydraulic pressure that normally forms ahead of other devices. This hydraulic pressure can cause the top sediment to blow out when the device is lowered to the sediment-water interface, which results in sample loss even before the sample is collected by the device.

The sediment sample will be collected from a boat held in position over the deepest point in the lake by at least three anchors. The corer will be assembled and tested according to Glew et al. (2001). First, the messenger weight and Lexan core tube will be attached to the line and core body, respectively. The core tube will be attached flush with the core body to ensure there is a tight seal. Once assembled, the corer will be lowered slowly from the side of the boat approximately 1 to 2 ft above the sediment-water interface. Holding the messenger weight in one hand, the corer will penetrate the sediment by letting the rope slide through the other hand. Once the corer has penetrated the sediment, the messenger weight will be dropped to trigger the closing piston. The corer will then be lifted by hand to a level where the bottom of the core tube remains just the water surface. A rubber stopper will be inserted by a gloved hand into the bottom of the core tube before the core tube is lifted above the water surface.

Once the corer is on the boat, the piston sealer will be lifted from the core body and the tube removed by unscrewing the band clamp that holds the core tube onto the corer. Holding the core tube upright, the core body will be detached from the tube and capped immediately before bringing the core back to shore. On shore, core samples will be extruded from core tubes into sampling jars in the field using an extruding device specifically designed for the Glew Corer (see Glew, 1988 and Glew et al., 2001). The extruding device will push the sediment through the top of the core tube and into sampling jars provided by the laboratory. The sample extruded from the core tube will be homogenized and then sub-sampled into a container submitted to a laboratory for analysis for the parameters listed in Table 8-4. The sediment sample will be collected only after the required water sample has been collected to avoid disturbing or suspending sediment that would contaminate the surface water sample.

## 8.7 Parameters to Be Analyzed

During the year of sampling, 12 water quality samples from the pit lake (1 sample site x 3 sample depths x 4 quarterly sampling events) will be collected. The samples will be analyzed for the suite of parameters and methods provided in Table 8-4. Additionally, it is assumed that the streams, seeps, and springs listed in Table 8-2 will be analyzed for the same suite of parameters.

## 8.8 Maps Showing Proposed Sampling Locations

Locations for proposed sampling locations for streams and springs are shown in Figure 8-1. These locations were selected by NMCC because they were sampled in the past (e.g., SWQ series in Grayback Arroyo, PC series in

Percha Creek, and select sites within the LAC series along Las Animas Creek) or represent an area of interest where volumetric flow or water quality data would be of importance to understanding regional characteristics of surface water quality and quantity. The water quality and sediment samples collected from the deepest point in the lake will be based on the results of the depth profiles shown in Figure 8-2.

## 8.9 Laboratory and Field Quality Assurance Plans

Data collected to characterize the water quality and flow of surface water resources discussed in this section of the Sampling and Analysis Plan will conform to the NMCC Quality Assurance Project Plan (Attachment 1) with respect to field methods, sampling procedures, and recording of field notes. If procedures for sampling or analysis are not specifically defined in Attachment 1, by the sampling method, or by the analytical method, the NMED SWQB (2007) protocols for field data sampling, equipment calibration and cleaning, sample containment and handling, and photographic documentation will be followed as appropriate and/or applicable to the site conditions.

The samples for chemical analysis will be properly preserved and field filtered, if necessary, before shipment to an analytical laboratory certified by the U.S. Environmental Protection Agency. All samples will be shipped within the holding times defined by the analytical method to be used. In addition, containers specific to a given analytical method will be used as appropriate. To provide quality control, duplicates and/or equipment blanks will be collected/used. Analytical results will be stored in a project database that will be provided to the New Mexico Mining and Minerals Division electronically as well as in hard-copy as an attachment to the Baseline Summary Report.

## 8.10 Discussion in Support of Proposal

The existing water quality and flow data for surface water within and in the vicinity of the Site will be bolstered by the new data collected as outlined in this section of the Sampling and Analysis Plan. New data will establish baseline conditions in that they will represent the nature of flow and quality of surface water and sediment prior to any operations or activities by NMCC. These data will also help guide future planning and designing decisions with regard to mine water discharge.

## 8.11 References

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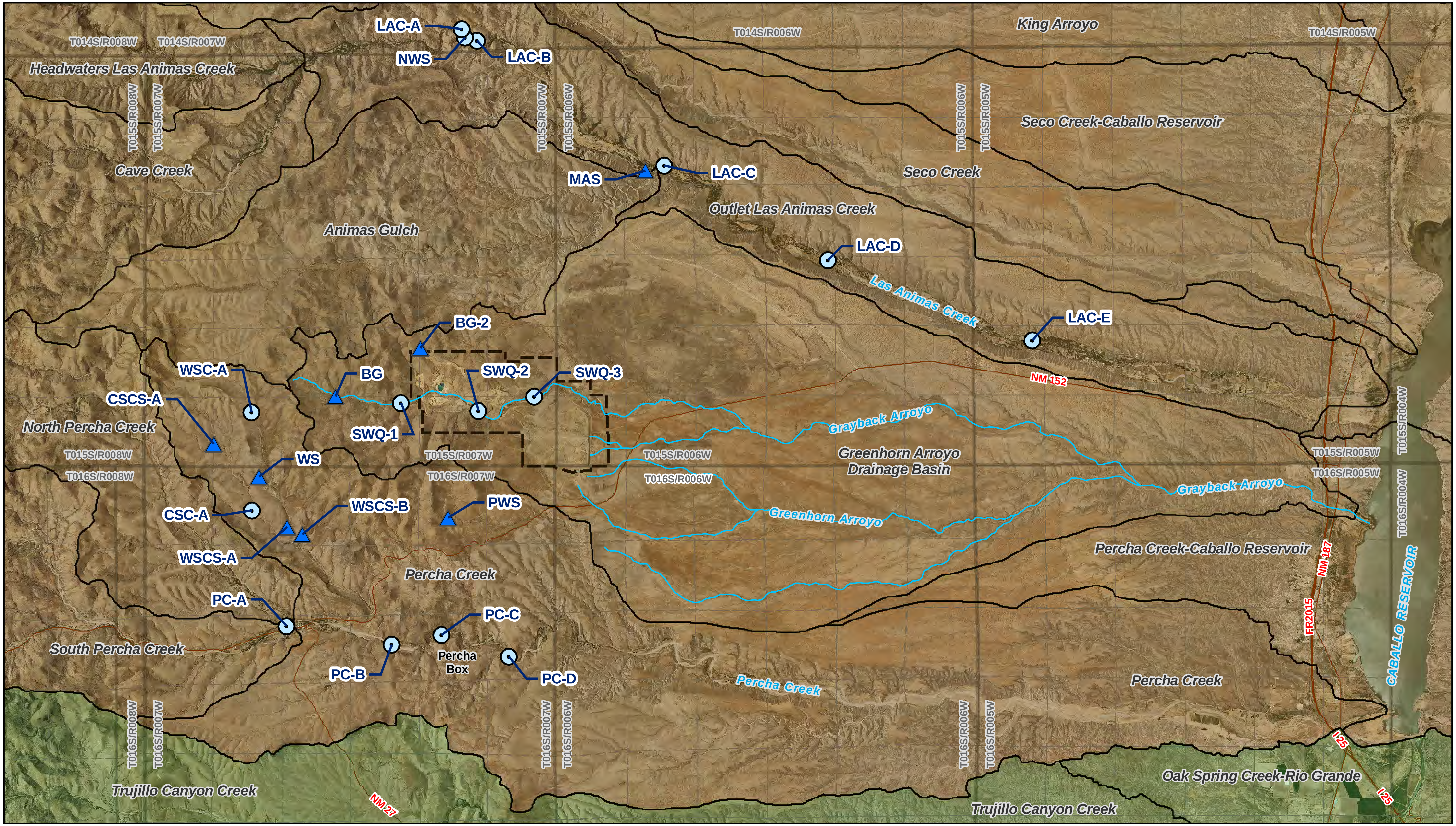
# Figures




Watersheds:
USGS Hydrologic Unit Map
Mine Boundary:
Tom Van Bebber
Imagery Information:
-USGS 7.5-Minutes County DOQQ mosaic
Sierra County, 2009
Projection Information:
-New Mexico State Plane West, NAD 1927

0 3,500 7,000 14,000 21,000
Feet

**Legend**

- Stream Sample
- Spring Sample
- Proposed Mine Permit Boundary

Watersheds
- Caballo
- El Paso-Las Cruces
- Sub-Watershed

**Figure 8-1**
**Proposed Surface Water Sampling Locations**
**New Mexico Copper Corporation**

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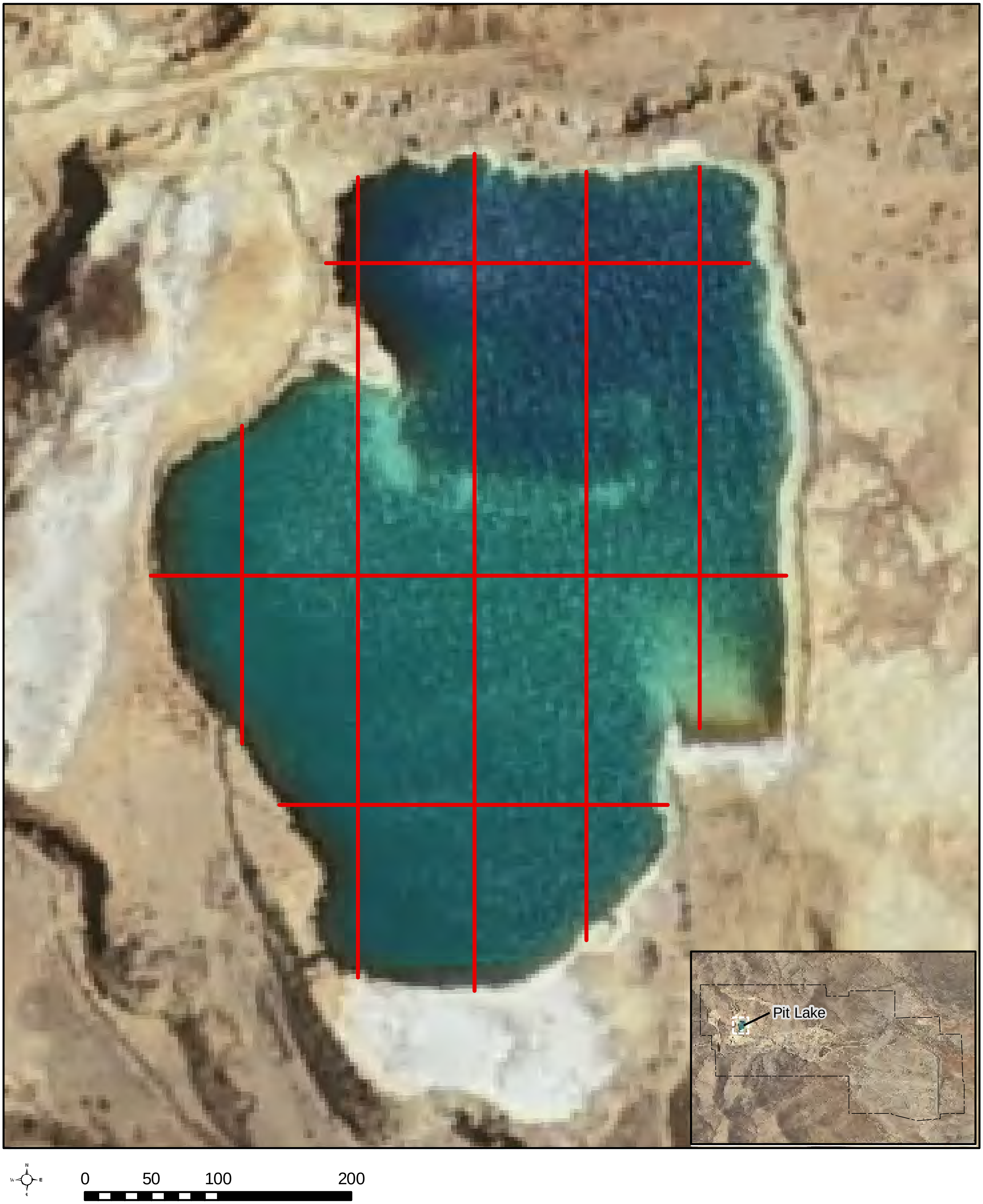


Imagery Information:
-USGS 7.5-Minutes County DOQQ mosaic
Sierra County, 2009
Projection Information:
-New Mexico State Plane West, NAD 1927

**Legend**

Profile Line

INTERA

**Figure 8-2**
**Proposed Parallel Profiles for Pit Lake Survey**

**New Mexico Copper Corporation**

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# Tables

**Table 8-1**

**Historical Flow and Water Quality Parameters**

| Location | Date | Description | Flow (cfs) | pH | Conductivity (µS/cm) | Temperature (°C) |
|---|---|---|---|---|---|---|
| Las Animas Creek | 1967 | Upper Reach | 1.0 – 2.0 | NM | NM | NM |
| Las Animas Creek | 1967 | Middle Reach | 1.0 – 1.5 | NM | NM | NM |
| Las Animas Creek | 1996 | LAC-E | 0.546 | 8.2 | 400 | 17 |
| Percha Box | 1996 | 1200' u/s of Box entry | Dry | NA | NA | NA |
| Percha Box | 1996 | 700' u/s of Box entry | 0 | 8.1 | 600 | 32 |
| Percha Box | 1996 | 400' u/s of Box entry | Dry | NA | NA | NA |
| Percha Box | 1996 | Box entry | 0.265 | 7.7 | 500 | 23 |
| Percha Box | 1996 | 1500' d/s of Box entry | 0.446 | 8.2 | 500 | 23 |
| Percha Box | 1996 | Box exit | 1.02 | 8.4 | 400 | 25 |
| Percha Box | 1996 | 2400' d/s of Box exit | 0 | 9.3 | 400 | 32 |
| Percha Box | 1996 | 2500' d/s of Box exit | Dry | NA | NA | NA |
| Percha Box | 1996 | 5000' d/s of Box exit | 0.394 | 9.0 | 400 | 28 |
| Percha Box | 1996 | 5400' d/s of Box exit | 0 | 9.0 | 400 | 32 |
| Percha Box | 1996 | 5500' d/s of Box exit | Dry | NA | NA | NA |
| Percha Box | 1996 | 3 miles d/s of Box exit | Dry | NA | NA | NA |
| Percha Box | 1996 | 5 miles d/s of Box exit | Dry | NA | NA | NA |
| Grayback Arroyo | 4/1/93 | SWQ-1 | 1 – 2 | 8.3 | 1150 | NM |
| Grayback Arroyo | 5/7/93 | SWQ-1 | Dry | NA | NA | NA |
| Grayback Arroyo | 3/31/93 | SWQ-2 | < 1 | 7.7 | 3150 | NM |
| Grayback Arroyo | 3/31/93 | SWQ-3 | 12.5 | 8.1 | 3330 | NM |
| Spring/Seep | 4/1/93 | BG | 1 – 2 | 8.2 | 1090 | NM |
| Spring/Seep | 5/7/93 | BG | Dry | NA | NA | NA |
| Spring/Seep | 4/1/93 | BG-2 | < 1 | 8.2 | 1030 | NM |
| Spring/Seep | 5/7/93 | BG-2 | < 1 | NM | NM | NM |
| Spring/Seep | 1997 | PW-2 | NM | 8.16 | NM | NM |
| Spring/Seep | 1967 | WS | 0.8 | NM | NM | 81.5 |
| Spring/Seep | 4/2/93 | WS | 0.00735 | 8.5 | 1980 | NM |

**Notes:**

Box = Percha Box
u/s = upstream
d/s = downstream
NA = no water present for sampling
NM = parameter not measured or not available

## Table 8-2

## Proposed Surface Water Monitoring Locations (shown on Figure 8-1) with Method of Measurement and Frequency of Collection

| Sample Location | Location Type | Likely Flow Type | Description of Location | Quarterly or Opportunistic Flow Measurement | Method of Collection | Quarterly Water Quality Sample |
|---|---|---|---|---|---|---|
| LAC-A | Stream | Perennial | Las Animas Creek u/s of North Warm Spring (NWS) | Quarterly | Flow meter | |
| LAC-B | Stream | Perennial | Las Animas Creek d/s of North Warm Spring | Quarterly | Flow meter | |
| LAC-C | Stream | Intermittent | Las Animas Creek d/s of Meyers Animas Spring (MAS) | Opportunistic | Auto sampler | X |
| LAC-D | Stream | Intermittent | Las Animas Creek at site previously named STA8 | Quarterly | Flow meter | |
| LAC-E | Stream | Intermittent | Las Animas Creek at site previously named LAC-1 | Quarterly | Flow meter | |
| SWQ-1 | Stream | Ephemeral | Grayback Arroyo at site previously named GA-A | Opportunistic | Auto sampler | X |
| SWQ-2 | Stream | Ephemeral | Grayback Arroyo at site previously named GA-B | Opportunistic | Auto sampler | X |
| SWQ-3 | Stream | Ephemeral | Grayback Arroyo at site previously named GA-C | Opportunistic | Auto sampler | X |
| PC-A | Stream | Intermittent | Percha Creek u/s of Warm Springs Canyon | Quarterly | Flow meter | |
| PC-B | Stream | Intermittent | Percha Creek u/s of Percha Box | Quarterly | Flow meter | |
| PC-C | Stream | Perennial | Percha Creek in Percha Box | Opportunistic | Auto sampler | X |
| PC-D | Stream | Ephemeral | Percha Creek in Sec. 21 T16S R5W | Quarterly | Flow meter | |
| WSC-A | Stream | Ephemeral | Upper Warm Springs Canyon | Quarterly | Flow meter | |
| CSC-A | Stream | Ephemeral | Upper Cold Springs Canyon | Quarterly | Flow meter | |
| NWS | Stream | Perennial | North Warm Spring on Las Animas Creek | Quarterly | Flow meter | |
| WS | Spring | Ephemeral | Warm Spring | Quarterly | Weir | |
| BG | Spring | Ephemeral | BG Spring | Quarterly | Weir | X |
| BG-2 | Spring | Ephemeral | BG-2 Spring | Quarterly | Weir | X |
| PWS | Spring | Ephemeral | Paxton Well Spring | Quarterly | Weir | |
| MAS | Spring | Ephemeral | Meyers Animas Spring | Quarterly | Weir | X |
| CSCS-A | Spring | Ephemeral | Cold Spring Canyon spring | Quarterly | Weir | |
| WSCS-A | Spring | Ephemeral | Warm Spring Canyon spring #1 | Quarterly | Weir | X |
| WSCS-B | Spring | Ephemeral | Warm Spring Canyon spring #2 | Quarterly | Weir | X |

**Table 8-3**

**Surface Water Resources Data Needs**

| Data Need | Plan to Address Data Need |
|---|---|
| Nature of flow and water quality in Grayback Arroyo | Three sampling stations are proposed to characterize streamflow and water quality by collecting opportunistic samples and measurements during storm events. Sites are proposed upstream, within, and downstream of the mine operations at sites that have been sampled in the past. Installation of auto-samplers along this ephemeral reach will enable opportunistic sampling. |
| Nature of flow and water quality in Percha Creek | Three sampling stations along perennial, intermittent and ephemeral reaches are proposed to characterize streamflow and water quality by collecting quarterly samples and measurements and a fourth sampling station on an intermittent reach is proposed to characterize streamflow and water quality opportunistically. Sites are proposed upstream, within, and downstream of the Percha Box at locations that have been sampled in the past. Installation of an auto-sampler along the intermittent reach will enable opportunistic sampling. |
| Nature of flow and water quality in Las Animas Creek | Four sampling stations along perennial and intermittent reaches are proposed to characterize streamflow and water quality by collecting quarterly samples and measurements and a fifth sampling station on an intermittent reach is proposed to characterize streamflow and water quality opportunistically. Sites are proposed in the upper, middle, and lower reaches of Las Animas Creek at sites that have been sampled in the past. Installation of an auto-sampler along the intermittent reach will enable opportunistic sampling. |
| Potential of mine discharge to have a significant, quantifiable effect on intermittent or perennial flow | Opportunistic streamflow and water quality samples collected at three sites Grayback Arroyo. |
| Seasonal variability in water quality conditions in the pit lake, including stratification | High-resolution, vertical profiles of water quality coupled with discrete-depth samples taken from the epilimnion, metalimnion, and hypolimnion (if present) on a quarterly basis. |
| Geochemical characteristics of sediment | Sediment samples will be collected concurrently with surface water samples collected from perennial reaches of streams and from the pit lake. The list of sediment parameters to be analyzed is presented in Table 8-4. |
| Nature of flows from springs and seeps | Eight springs are proposed to characterize spring flow and water quality by collecting quarterly water samples and measurements. Sites are proposed within the Greenhorn Arroyo drainage basin, Percha Creek drainage basin, and Las Animas Creek drainage basin. |

## Table 8-4

## Analytical Parameters and Analysis Methods for Surface Water and Sediment Samples

(Sediment samples will be prepared using EPA Method 1312-SPLP, Synthetic Precipitation Leaching Procedure, to determine the concentrations of water-soluble constituents in the sediments.)

| Analytical Parameter | Analysis Method for Water | Lab Detection Limit (mg/L unless noted) | Analysis Method for Sediment | Lab Detection Limit for Sediments (mg/kg unless noted) |
|---|---|---|---|---|
| **Anions** | | | | |
| Fluoride | EPA Method 300.0 | 0.1 | NA | NA |
| Chloride | EPA Method 300.0 | 0.1 | NA | NA |
| Nitrogen, Nitrite (as N) | EPA Method 300.0 | 0.1 | NA | NA |
| Nitrogen, Nitrate (as N) | EPA Method 300.0 | 0.1 | NA | NA |
| Nitrogen, Ammonia (as N)[§] | EPA Method 300.0 | 0.1 | NA | NA |
| Sulfate | EPA Method 300.0 | 0.5 | NA | NA |
| **Dissolved Metals** | | | | |
| Aluminum | EPA Method 200.7 | 0.02 | EPA Method 200.7 | 1.0 |
| Antimony | EPA Method 200.8 | 0.005 | EPA Method 200.8 | 0.25 |
| Arsenic | EPA Method 200.8 | 0.02 | EPA Method 200.8 | 1.0 |
| Barium | EPA Method 200.7 | 0.002 | EPA Method 200.7 | 0.1 |
| Beryllium | EPA Method 200.7 | 0.002 | EPA Method 200.7 | 0.1 |
| Boron | EPA Method 200.7 | 0.04 | EPA Method 200.7 | 2.0 |
| Cadmium | EPA Method 200.7 | 0.002 | EPA Method 200.7 | 0.1 |
| Calcium | EPA Method 200.7 | 0.50 | EPA Method 200.7 | 5.0 |
| Chromium | EPA Method 200.7 | 0.006 | EPA Method 200.7 | 0.3 |
| Cobalt | EPA Method 200.7 | 0.006 | EPA Method 200.7 | 0.3 |
| Copper | EPA Method 200.7 | 0.0003 | EPA Method 200.7 | 0.2 |
| Iron | EPA Method 200.7 | 0.02 | EPA Method 200.7 | 1.0 |
| Lead | EPA Method 200.7 | 0.005 | EPA Method 200.7 | 0.25 |
| Magnesium | EPA Method 200.7 | 0.50 | EPA Method 200.7 | 5.0 |
| Manganese | EPA Method 200.7 | 0.002 | EPA Method 200.7 | 0.1 |
| Mercury | EPA Method 7470 CVAA | 0.0002 | M7471A CVAA | 0.03 |
| Molybdenum | EPA Method 200.7 | 0.008 | EPA Method 200.7 | 0.4 |
| Nickel | EPA Method 200.7 | 0.01 | EPA Method 200.7 | 0.5 |
| Potassium | EPA Method 200.7 | 1.0 | EPA Method 200.7 | 10 |
| Selenium | EPA Method 200.8 | 0.02 | EPA Method 200.8 | 1.0 |
| Silicon | EPA Method 200.7 | 0.08 | EPA Method 200.7 | 4.0 |
| Silver | EPA Method 200.7 | 0.005 | EPA Method 200.7 | 0.25 |

| Analytical Parameter | Analysis Method for Water | Lab Detection Limit (mg/L unless noted) | Analysis Method for Sediment | Lab Detection Limit for Sediments (mg/kg unless noted) |
|---|---|---|---|---|
| Sodium | EPA Method 200.7 | 0.5 | EPA Method 200.7 | 5.0 |
| Thallium | EPA Method 200.7 | 0.01 | EPA Method 200.7 | 0.5 |
| Titanium | EPA Method 200.7 | 0.005 | EPA Method 200.7 | 0.25 |
| Uranium | EPA Method 200.8 | 0.01 | EPA Method 200.8 | 0.5 |
| Vanadium | EPA Method 200.7 | 0.005 | EPA Method 200.7 | 0.25 |
| Zinc | EPA Method 200.7 | 0.005 | EPA Method 200.7 | 0.25 |
| **Solids** | | | | |
| Total Suspended Solids (TSS) | SM 2540D | 1.0 µg/L | NA | NA |
| Total Dissolved Solids (TDS) | SM 2540C | 10 | NA | NA |
| Percent Solids | NA | NA | CLPSOW290 Part F, D-98 | NA |
| **Alkalinity** | | | | |
| Alkalinity, total (as $CaCO_3$) | SM 2320B | 20 | NA | NA |
| Carbonate | SM 2320B | 20 | NA | NA |
| Bicarbonate | SM 2320B | 20 | NA | NA |
| **Other** | | | | |
| pH | 150.1 | 12.45 | NA | NA |
| Specific Conductance | 120.1 | 0.01 µS/cm | NA | NA |
| Cyanide | Kelada-01 | 0.005 | M9012A | 0.5 |
| Temperature§ | EPA Method 170.1 | ND | NA | NA |
| Dissolved Oxygen§ | EPA Method 360.1 | ND | NA | NA |

**Notes:**

NA = not applicable as sample will not be analyzed for a given parameter
ND = not determined or dependent on the instrument
§ = run for pit lake sample only and not run for samples from stream, spring, or seep

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# 9 Groundwater

Groundwater is a major supply of water for domestic and agricultural use in southern New Mexico. The high evaporation rate during the long, hot summers coupled with low average annual precipitation in the area result in surface waters being an unreliable source of water on a year-round basis. The Rio Grande is the only significant surface water resource in the Copper Flat Mine Permit Area (Site). Intermittent streams that feed the Rio Grande, such as Las Animas Creek and Percha Creek in the Site area, are local sources of water for at least part of the year. The river and associated shallow alluvial deposits of its inner valley also served as the ultimate discharge zone for pre-development groundwater flow from the adjacent Greenhorn Arroyo, Las Animas Creek, and Percha Creek drainage basins (Hawley et al., 2005, Wilson et al. 1981). Additional water comes from shallow domestic and agricultural wells. This section provides a description of the regional and local groundwater along with a proposed sampling and analysis approach to characterizing baseline conditions of groundwater resources. Baseline studies have been completed in the project area since the 1960s, and relevant information and data are referenced in subsequent sub-sections throughout Section 9.

## 9.1 Regional Hydrogeology

The Site is located in the Lower Rio Grande Underground Water Basin (LRGB), which extends from Elephant Butte Dam to the Texas Border near El Paso and is one of New Mexico's principal agricultural regions (Figure 9-1). The LRGB was declared by the NM State Engineer on September 11, 1980. In doing so, the underground waters of the LRGB are administered by the State Engineer. In response to drought conditions in New Mexico, the Office of the State Engineer (OSE) designated the LRGB for Active Water Resource Management (AWRM) in 2004, emplacing additional restrictions on groundwater development. In addition, a water master district that encompasses Hot Springs, Las Animas Creek, and LRGB Underground Water Basins was created to assist with water administration in the region.

Groundwater in the LRGB generally flows from the highlands on either side of the basin through bedrock and valley alluvium to the center of the basin and to the Rio Grande. Figure 9-2 illustrates the conceptual model of groundwater flow at the Site. The bedrock aquifer in the Paleozoic sedimentary rocks are recharged by rainfall and snowmelt through bedrock faults and bedding planes exposed in the highlands west of the site. This water generally flows along a hydraulic gradient toward the approximate center of the Rio Grande Valley. Occasionally, this deep regional flow discharges at the ground surface as springs along faults where the Paleozoic bedrock crops out within the valley. This occurs in at several locations within the Las Animas Creek and Percha Creek drainage basins (Figure 9-3). The water table elevation near the existing pit lies at approximately 5,450 to 5,500 feet (ft) above mean sea level (amsl). Groundwater near Caballo Reservoir lies at about 4,200 ft amsl, indicating a drop of 1,300 ft over approximately 14 to 15 miles.

Valley alluvium is generally recharged by precipitation along mountain fronts where the alluvial fans are exposed and by streams that flow out of the highlands and lose water to the alluvium as they flow toward the Rio Grande. Many intermittent streams in the area are "losing streams" over at least part of their courses and provide recharge to the alluvial groundwater system. This alluvial groundwater then flows downgradient to the Rio Grande. Most areas within the LRGB that have not been significantly disturbed by human activity are in hydraulic equilibrium. That is, water coming into the system by precipitation recharge is balanced by outflow to major streams, evapotranspiration, and interbasin flow.

### 9.1.1 Hydrogeology of the Permit Area

Three aquifers exist in the Site area, as shown schematically on Figure 9-2. The deepest aquifer is the crystalline bedrock aquifer that receives water from the highlands to the west of Animas Peak and carries this water along bedding planes, faults, and solution cavities toward the center of the LRGB. The crystalline bedrock aquifer consists of Cretaceous andesite and monzonite breccias underlain by Paleozoic rocks in the Animas Uplift area, Tertiary volcanic rocks to the west of the pit lake in the graben associated with the Animas uplift, and Paleozoic sedimentary rocks to the east of the pit lake area in the Palomas Basin (see Section 7.0). The Santa Fe Group aquifer system, which consists of interbedded sandstones, silts, and clays, overlies the Paleozoic bedrock units to the east of the pit lake area within the Palomas Basin. This aquifer system receives water from precipitation and from the losing reaches of streams. The uppermost aquifer at the Site is the Quaternary alluvial aquifer along Las Animas and Percha Creeks (Figure 9-2). This alluvium is up to 40-ft thick in the Las Animas Creek area and carries water that is in hydraulic equilibrium with the water flowing in Las Animas Creek (BLM, 1999). The Percha Creek alluvial aquifer is less studied than the Las Animas Creek alluvial aquifer, and as a result, less historical data about its aquifer characteristics are available. The aquifers of greatest importance in terms of water supply in the area are within the Palomas Basin to the east of the pit lake and include the intermediate Santa Fe Group aquifer system and the alluvial aquifer associated with Las Animas Creek.

Figure 9-4 from the Adrian Brown Consultants (ABC) (1998b) presents a piezometric contour map showing the general configuration of groundwater level elevations at the Site as interpreted at that time. Groundwater levels near the existing pit are approximately 5,450 ft amsl, and at Caballo Reservoir, the levels are about 4,200 ft amsl. The map indicates that groundwater flow is generally to the east toward Caballo Reservoir. Hydraulic gradients are relatively large (closely spaced contours) in the western portion of the Site, reflecting lower transmissivity in the bedrock aquifer and in the western portion of the Palomas Basin in the Santa Fe Group aquifer system. The wider spacing of contours in the eastern portion of the Site suggests that transmissivity of the Santa Fe Group aquifer increases toward Caballo reservoir. The widest spacing of contours (highest transmissivity) appears to occur in the area of the groundwater production wellfield (wells PW-1, 2, 3, and 4 on Figure 9-4). This area coincides with an interpreted graben structure (see Section 7), which reflects an increased thickness of the Santa Fe Group in this area.

### 9.1.2 Aquifer Characteristics in the Permit Area

#### 9.1.2.1 Crystalline Bedrock Aquifer Characteristics

Groundwater within the mining district and the area of the present open pit occurs in andesitic volcanic rocks and quartz monzonite breccia intrusive rocks (Figure 9-2). The current pit lake was reported by SRK (1997) to be at an elevation of 5,442 ft amsl, which is about 50 to 100 ft below the pre-mining ground elevation (5,500 to 5,540 ft amsl reported in the Preliminary Final Environmental Impact Statement (PFEIS) (BLM, 1999). Groundwater levels measured in the pit and tailings areas as of 1997 are shown on Figure 9-5. Newcomer et al. (1993) reported a pre-mining (1981) water level of 5,370 ft amsl in well GWQ-5, which is approximately 4,000 ft east-southeast from the pit and within the old plant site area. These authors also reported a water level of 5,360 ft amsl in the Hillscher West well (GWQ-6), which lies approximately 2,500 ft southeast from well GWQ-5. These limited groundwater elevation data suggest that the groundwater gradient in the andesitic volcanic rocks may be to the east or southeast from the current pit lake area as shown on Figure 9-5. Within 500 ft of the pit lake (see Figure 9-6, however, groundwater gradients are toward the pit lake, which may act as a local evaporative sink (BLM, 1999).

In January 2010, NMCC resurveyed the pit lake and as many of the groundwater monitoring wells established for the PFEIS as could be located. The pit lake elevation was 5,444 ft amsl in January 2010, revealing that the pit lake elevation remains below the pre-mining water level elevation of 5,500 to 5,540 ft amsl.

#### 9.1.2.2 Santa Fe Group Aquifer System

*Overview*

Overlying the crystalline bedrock aquifer at the Site is the Santa Fe Group aquifer system, a system that is locally represented by two hydrostratigraphic units (HSUs): (1) the Upper Santa Fe Group hydrostratigraphic unit (USF), and (2) the Middle Santa Fe Group hydrostratigraphic unit (MSF). As defined by Hawley and Kennedy (2004), these hydrostratigraphic units are mappable bodies of basin and valley fill that are grouped according to genesis and position in both lithostratigraphic and chronostratigraphic sequences. Informally, these HSUs comprise the major basin-fill aquifer zones, and correspond roughly to the upper (Palomas) and middle (Rincon valley) lithostratigraphic subdivisions of the Santa Fe Group used in local and regional geologic mapping (Hawley and Kennedy, 2004).

The Santa Fe Group is composed chiefly of coalescing alluvial fan deposits that are discontinuous and locally heterogeneous with inter-bedded sandstones, silts, and clays of varying percentages. The Upper Santa Fe Group Palomas Formation (Lozinsky and Hawley, 1986) represents the USF at the Site. This formation grades eastward from the Animas Uplift from coarse alluvial fan material to braided-stream and deltaic sands and silts to clays near the Rio Grande. The interfingering with clays begins approximately 3 to 5 miles west of the current position of the Rio Grande and is responsible for the flowing wells common in this part of the Site (Murray, 1959; Figure 9-2). A basalt flow dated at 4.2 million years before present caps the Palomas Formation gravels near Copper Flat (Seager et al., 1984).

The Middle Santa Fe Group Rincon Valley Formation (Seager and Hawley, 1973) is exposed near Hillsboro, New Mexico, where the reddish-brown clays and clayey silts characteristic of this basal unit are interbedded with basalts dated at 28 million years before present (Seager et al., 1984). The Rincon Valley Formation represents the MSF at the Site and generally contains water, but the yield is low due to the low hydraulic conductivity of the clays. The Rincon Valley Formation lacustrine red clays underlie the Palomas Formation and thicken southward toward Hatch, New Mexico, and the Rincon Basin (Wilson et al., 1981).

*Tailings Dam Vicinity*

The present tailings impoundment facility overlies the old placer workings of Greyback Arroyo and Hunkidori Gulch (Figure 9-3). A study of these placer workings by Segerstrom and Antweiler (1975) showed that the placers were found in paleo-stream terrace alluvium approximately 25 to 30 ft thick that is underlain by a calcium carbonate horizon and reddish-brown clay. SRK (1995) and SHB (1980) confirmed and expanded the areal extent of this reddish-brown clay layer and determined that the top of the Palomas Formation is stratigraphically below the red clay layer. According to the studies completed by SRK and SHB, the clay layer and the 25 to 30 ft of paleo-stream terrace gravels that lie above the clay, have acted to prevent downward migration of water draining from the eastern half of the existing tailings. This clay layer has enabled a mound of water beneath the tailings impoundment to develop and was determined by SRK and SHB to extend eastward beyond the tailings dam. This mounding of water, due to drainage of the tailings, became evident in some tailings dam monitor wells completed above the clay layer. The central and western sections of the existing tailings facility appear to communicate hydrologically with the USF that lies beneath the tailings area because the clay zone thins and disappears in this area, as shown in Figure 9-7.

The thickness of the Palomas Formation increases locally over a graben structure (labeled Dutch Gulch in Figure 9-8), which is reflected in higher transmissivity and relatively low hydraulic gradients in the USF. Based on a 7-day aquifer pumping test (ABC, 1996), the transmissivity of the USF in the tailings dam area is about 187 $ft^2$/day. East of the tailings area (see Figure 9-8) is a 10- to 30-foot thick clayey sand and gravel layer, underlain by a 25- to 100-foot-thick clay layer, which in turn is underlain by a silty sand and gravel layer (SRK, 1995). The lower silty sand and gravel layer is considered by ABC (1996) to be the USF and, based on drilling information, has a thickness of at least 200 ft. The hydraulic gradient in this area is about 30 ft per mile.

East of the graben structure, labeled as Dutch Gulch in Figure 9-8, the Palomas Formation (labeled Tsfp) thins and is interpreted to have significantly reduced transmissivity. The hydraulic gradient in this area ranges from about 130 to 330 ft/mile. The contact between the Palomas Formation and the underlying Rincon Valley Formation clay unit (labeled Tsf in Figure 9-8) is a highly irregular depositional contact. Locally, the Palomas Formation (USF) may be unsaturated, with the water table existing in the underlying Rincon Valley Formation (MSF) (BLM, 1999).

*Production Wellfield Vicinity*

Farther to the east, the hydraulic gradient decreases from 330 ft/mile to about 34 ft/mile in the vicinity of the production wellfield (identified as PW wells on Figure 9-9). This suggests a progressive increase in transmissivity toward the area of the production wellfield. A graben structure below the production wellfield locally increases the thickness of the Palomas Formation to as much as 1,000 ft (Figure 9-8). The transmissivity of the USF in the production wellfield area ranges from about 2,675 to 5,750 $ft^2$/day (SRK, 1995). Farther to the east, towards Caballo Reservoir, sands and gravels in the Palomas Formation are interbedded with clays of the ancient Rio Grande. As a consequence, the transmissivity decreases slightly and the hydraulic gradient Increases to 45 ft/mile. In this area, the USF appears to be confined, leading to artesian flow in wells along the lower reaches of both Las Animas Creek and Percha Creek.

Although the Palomas Formation is described as “sand and gravel” (Davie and Spiegel, 1967), there exist numerous discontinuous clay layers within the sequence. This causes the bulk vertical hydraulic conductivity of the USF to be much lower than the horizontal conductivity. As a consequence, groundwater in deeper portions of the USF can be semiconfined, leading to relatively high vertical hydraulic gradients. The low vertical hydraulic conductivity has two important effects on the groundwater flow system. First, within about 4 miles of Caballo Reservoir, confinement of groundwater is sufficient to create artesian conditions in deeper portions of the USF. Wells drilled to these depths have groundwater levels aboveground surface and produce flowing wells, the locations of which are shown on Figure 9-9. Flow rates for uncapped wells range between a few gallons per minute (gpm) to as high as 40 gpm.

The second effect of low vertical conductivity is to reduce downward leakage between the Quaternary alluvial aquifer in the Las Animas Creek drainage basin and the underlying USF. At the location of monitoring wells MW-9, 10, and 11, north of the production wellfield, the groundwater level in the USF is some 58 ft lower than the water level in the overlying Quaternary alluvial aquifer (ABC, 1996). This results in a downward vertical hydraulic gradient from the Quaternary alluvial aquifer in the vicinity of Las Animas Creek drainage basin to the USF approaching 1 ft/ft. Such downward gradients are interpreted to occur along a substantial length of Las Animas Creek (ABC, 1996). In spite of these gradients, the amount of surface water loss from the Quaternary alluvial aquifer in the Las Animas Creek drainage basin is not significant; suggesting that vertical hydraulic conductivity in the USF is relatively low. Analytical calculations (ABC, 1997) suggest that if the vertical conductivity were much greater than 1 ft/year ($10^{-6}$ cm/second), the Las Animas surface water system would lose essentially all of its water and become an intermittent stream, which clearly does not occur.

The hydraulic connection between the USF and the alluvial aquifer of the Rio Grande has not been evaluated, but groundwater gradients at the Site strongly suggest that water flows from the Palomas Formation to the floodplain alluvium of the Rio Grande.

An aquifer pumping test conducted at the locations of monitor wells MW-9, 10, and 11 suggests that the vertical conductivity of the USF is low in this area (ABC, 1997). Pumping of the wells screened in the USF at this location did not affect a well screened in the Quaternary alluvial aquifer in the Las Animas Creek drainage basin, even though the well screened in the USF had 22 ft of drawdown. Also, monitoring of water levels along Las Animas Creek by Alta (Goff, 1998) for wells screened in both aquifers showed that fluctuations in water levels observed in shallow wells (those screened in the Quaternary alluvial aquifer) are not mirrored in the deeper wells (wells screened in the USF). These data are presented in Table A2-10 of the PFEIS (BLM, 1999).

#### 9.1.2.3 Quaternary Alluvial Aquifer

The uppermost aquifer at the Site is the Quaternary alluvial aquifer, which is composed of channel and floodplain gravels, sands, and silts. Locally, these units are generally 30 to 50 ft thick near the mouths of Las Animas and Percha Creeks (Davie and Spiegel, 1967). Cores from monitoring wells drilled along Las Animas Creek indicate that upper alluvial gravels extend from the surface to a depth of approximately 20 to 60 ft depending on the location along the creek (BLM, 1999). There are fewer data available for the thickness of these deposits in and along Percha Creek.

The Las Animas alluvial aquifer consists of local alluvial deposits adjacent to and underlying Las Animas Creek. Groundwater in this narrow, sinuous aquifer is in direct hydraulic communication with Las Animas Creek surface water. Surface water in the creek and groundwater in the aquifer form a single surface-to-groundwater flow system. Surface water flow from one location to the next may be related, in part, to the proportion of total system flow being carried by the aquifer at each location. Along its course, the Las Animas alluvial aquifer receives recharge by rainfall infiltration. Discharge from the aquifer occurs through evaporation and evapotranspiration from riparian vegetation and existing well pumping. Between the Saladone well and an area of the Lower Animas Artesian well (Figure 9-8), the aquifer loses water to the underlying Palomas Basin alluvial aquifer by slow downward seepage. The total flow rate for surface flow plus flow in the alluvium of the creek drops from around 1,800 to 1,900 gpm to around 1,100 gpm, a loss of 800 gpm over the 8-mile stretch of creek bed. The loss is consistent with slow downward seepage of water at a rate of around 1 foot/year (ABC, 1997). This is the approximate saturated hydraulic conductivity of clay. In the area of the Lower Animas Artesian (Figure 9-9) the Las Animas surface/groundwater system may receive recharge from the USF. At Caballo Reservoir, all water in the Las Animas surface/groundwater system discharges to the reservoir. The nature of artesian conditions in the Percha Creek drainage basin have not been studied in as much detail, and therefore less historical data are available.

Upstream of the artesian wells, Las Animas Creek, the alluvial aquifer can be “perched” above the water table in the Santa Fe Group aquifer system by 20 to 60 ft of unsaturated to partially saturated alluvial sediments (SRK, 1995; ABC, 1997). The alluvial aquifer along Las Animas Creek in the lower reaches loses water to the Santa Fe Group aquifer system by slow downward seepage. The upper reach of Las Animas Creek near the Saladone Well (Figure 9-9) also may be perched above the intermediate aquifer (Minton, 1961).

### 9.1.3 Existing Baseline Groundwater Information

A wealth of groundwater data are available for the Site because the mine was active in the past and was characterized by previous operators that either mined the Site or worked on permit applications to mine the Site. These historical data will be used in conjunction with the baseline groundwater quality data that will be collected under the procedures set forth in this SAP to provide as thorough an understanding as possible of groundwater quality conditions prior to the re-initiation of mining at Copper Flat. Key resources that contain data to be used for the baseline groundwater analysis include: Groundwater monitoring well exceedences provided by SRK (2010); the PFEIS (BLM, 1999); the Hydrologic Assessment, Copper Flat Project Sierra County, New Mexico (Newcomer et. al, 1993); and The Natural Defenses of Copper Flat, Sierra County, New Mexico (Raugust, 2003). A brief summary of the data available in these key reports follows.

The PFEIS (BLM, 1999) provides a summary of groundwater quality data. Summary tables for key wells and key constituents are provided in Table 9-2. The wells identified in this study are illustrated in Figure 9-9. The PFEIS (BLM, 1999) concluded that groundwater quality at the Site was good and generally useable for domestic and agricultural purposes. This document also concluded that past mining in the Hillsboro District, the Copper Flat Mine tailings facility drainage, and the presence of an oxidized sulfide-bearing ore body have impacted groundwater within and immediately adjacent to the area of past mining, resulting in elevated total dissolved solids (TDS) and sulfate that exceed New Mexico Water Quality Control Commission (WQCC) Standards. These impacts were found to be localized within the immediate vicinity of the mine features or associated with wells completed in the ore body.

Newcomer et al. (1993) determined that the quality of groundwater at the Site has changed little since the early 1980s and probably since the 1800s. The authors found that there have been some increases in TDS and sulfate in some wells along Grayback Arroyo below the mine site and down-gradient of the tailings dam, associated with mining and milling activities in the 1980s. Newcomer et al. (1993) determined that the only constituents exceeding the WQCC Standards were barium from a spring sample, and, cadmium and fluoride from a pit lake water sample.

Raugust (2003) compiled historical groundwater data and summarized groundwater quality conditions and, based on his data compilation and analysis, concluded:

- Groundwater pH measurements both up and downgradient of the pit lake range from 7 to 8.2.
- TDS and sulfate values are less than WQCC standards in the wells evaluated for this analysis; however, samples downgradient of the mine have increased gradually over time and are approaching the standards for TDS.
- Historical sampling of well GWQ-5, located east and downgradient of the pit lake, indicates that water quality in the vicinity of the pit lake may have been affected naturally by the presence of the ore body prior to mining in 1982.
- The groundwater upgradient of the mine pit lake is high quality with relatively high proportions of chloride and sulfate. Groundwater downgradient of the pit lake shows relatively higher proportions of bicarbonate and calcium and relatively lower proportions of sulfates.
- Pre-Quintana mining (June 15, 1981) groundwater data collected from wells downgradient of the pit lake show similar anions and cation distributions to post-Quintana mining activities (1996 and 1998). This indicates that groundwater quality downgradient of the ore body reflects the natural weathering of the Copper Flat porphyry system.

### 9.1.4 NMED Stage 1 Abatement Plan Requirements

On August 20, 2008, the NMED sent a letter to the site owner at that time requiring a Stage 1 Abatement Plan (20.6.2.4101 NMAC). The purpose of the Stage 1 Abatement Plan is to provide the data necessary to select and design an effective abatement alternative. The requirements for the Stage 1 Abatement Plan are described in 20.6.2.4106 NMAC. The abatement plan proposal must include an investigation to define the extent and magnitude of any existing groundwater and surface water contamination and to characterize the hydrogeology of the site. These requirements are similar to the EMNRD requirements for completing a Baseline Characterization Report, and these efforts will be conducted in parallel; therefore, the surface water and groundwater requirements of this SAP are relevant to both characterization efforts.

NMCC's meetings with the NMED concerning the abatement requirements have revealed the following key concerns on the part of the NMED:

- Groundwater impacts from the existing unlined tailings impoundment have been documented, but have not been fully characterized.
- Samples of pit lake water quality reveal exceedances of WQCC standards, and NMED is concerned about migration of this water away from the pit, causing additional groundwater impacts as well as ongoing contact with wildlife.
- Acid leaching could be occurring due to ongoing ore exposure.

### 9.1.5 Statistical Analysis of Existing Baseline Data

As discussed in this section, enormous amounts of surface water and groundwater data exist for this Site. These existing baseline data are essential to completing a comprehensive Baseline Characterization Report. As discussed in the EMNRD Mining and Minerals Division (MMD) draft, Guidance Document for Part 6 New Mining Operations Permitting under the New Mexico Mining Act (MMD Guidance Document), "If historic data and information are used as part of the baseline data, the SAP will include supporting material to justify the use of this historic data." As discussed in the previous subsection, baseline data collection has been initiated at the Site. The following sections describe how these data will be collected to maintain compliance with the referenced MMD Guidance. To justify the incorporation of the existing baseline data, statistical analysis will be used to determine if the current baseline data are significantly different from existing baseline data. This subsection describes a proposed approach that may be utilized to answer this question.

To statistically evaluate and compare new and existing baseline data, an Access database will be utilized to incorporate data from the sources listed above, as well as from other key sources that are identified during the baseline characterization program. Standardized queries will be used to easily select common location and parameter combinations.

The database will include the following data-entry features:

- A data qualifier to be applied at the time of data entry. This qualifier will be based primarily on the existence of supporting documentation and the indication that the data have been previously validated.
- Fields for entry of chemical parameters and other significant data, including:
  - Well identification (ID)
  - Parameter
  - Result
  - Units
  - Detection limit
  - Method
  - Non-detect qualifier used
  - Date of collection or analysis
  - Laboratory performing analysis
  - Analytical laboratory data qualifier

- Descriptive summary statistics for the compiled existing baseline dataset and a dataset based on data collected from the current baseline monitoring well network, including:
  - Chemical name
  - Number of detections
  - Number of samples
  - Arithmetic mean
  - Geometric mean (the backtransformed mean of the logtransformed data)
  - Standard deviation
  - Arithmetic mean plus two standard deviations
  - 95-percent upper confidence limit on the arithmetic mean (likely upper value of the arithmetic mean)
  - Minimum reported concentration
  - Maximum reported concentration

Descriptive summary statistics will be calculated separately for each historical data set identified and then a historical data set will be developed to represent existing baseline data. These data will be compared to summary descriptive statistics developed for the current baseline monitoring well network. If possible, the historical data set will be classified into pre-mining, mining, and post-mining periods and summary descriptive statistics will be developed for each classification.

Summary descriptive statistics will be developed for any populations identified by the methods described above. Each historical population identified will be separately compared to current baseline data and an interpretive evaluation of the historical and current datasets will be completed.

## 9.2 Sampling Objectives

The objectives of the baseline groundwater characterization program are as follows:

- Obtain necessary data to evaluate quantity and quality of all aquifers at the Site that could be impacted by mining activities.
- Address data gaps identified during evaluation of the DEIS (BLM, 1996).
- Meet the requirements set forth in the regulations in NMAC Title 19, Chapter 10, Part 6.
- Meet the guidelines set forth in MMD's draft Guidance Document for Part 6 New Mining Operations Permitting under the New Mexico Mining Act.

See Table 9-1 for the activities proposed to meet these objectives.

## 9.3 Sampling Frequency

The MMD Guidance Document requires a minimum of two sampling events over the required 12-month period for baseline groundwater quality sampling. Quarterly groundwater quality sampling will be necessary to address NMED's Stage 1 Abatement and Discharge Plan requirements; therefore, the baseline groundwater quality sampling will be performed for a minimum of four quarters. Additionally, water levels will be obtained on a quarterly basis to evaluate baseline seasonal fluctuations. Table 9-2 provides the current list of groundwater monitoring wells and the sampling frequency for water quality and water level measurements. The locations for these proposed wells are shown in Figure 9-10. NMCC proposes a phased approach to water quality sampling, where water quality samples will be collected initially from the wells identified in Table 9-2 for water quality sampling, then reduced to a subset of ten wells based on the analytical results and consultation with the MMD.

## 9.4 List of Data to Be Collected

The two categories of data to be collected for baseline groundwater characterization are groundwater quality and aquifer parameters. Further discussion of these datasets is included in the following subsections.

### 9.4.1 Groundwater Quality Parameters

The MMD Guidance lists specific groundwater quality parameters that are recommended to comply with the baseline characterization requirements. Table 9-3 shows the list of parameters to be analyzed for and the associated analysis methods and laboratory detection limits.

### 9.4.2 Aquifer Parameters

Water level measurements will be taken from all wells in the monitoring well network on a quarterly basis during the baseline characterization phase to evaluate the pre-mining potentiometric surface (i.e., steady-state condition). This potentiometric surface will form the basis for future modeling required to evaluate potential impacts from mine dewatering and production well pumping. Based on comments made during Alta Gold's permit application phase, the need to install additional monitoring wells for water level measurement, particularly outside the permit area, will be evaluated (DBS&A, 1998).

In addition to water level monitoring, groundwater modeling requires hydraulic parameter data, specifically, hydraulic conductivity, transmissivity, and storativity for the key aquifers. Several pumping tests have been performed in the tailings dam, production well, and the Las Animas Creek areas to evaluate the aquifer characteristics (Greene and Halpenny, 1976; Atkins, 1992; ABC, 1996b; and ABC, 1998). The details and analytical results of these tests are summarized by SRK (1995) and in Table 9-4. The existing data and recommendations will be evaluated during the baseline characterization phase, and a determination will be made as to the adequacy of the existing data to support the hydrologic impact analysis. If necessary, additional aquifer tests may be completed.

## 9.5 Methods of Collection

As discussed in the previous sections, three major categories of data will be collected for the baseline groundwater characterization:

1. Well information (water levels and total depth)
2. Groundwater quality samples for general chemistry and metals
3. Aquifer parameters (hydraulic conductivity, transmissivity and storativity)

The following sections provide general Standard Operating Procedures (SOPs) for water level and total depth measurements, groundwater sampling, and aquifer testing. Procedures will be modified as necessary to conform to site-specific requirements. Additionally, if new wells are added to the monitoring well network, they will be constructed in compliance with the NMED Monitor Well Construction Guidelines.

### 9.5.1 Water Level and Total Depth Measurements SOP

This SOP is concerned with the measurement of water levels in monitoring wells and the total depth of wells. Step-by-step procedures are outlined in the following sections.

#### 9.5.1.1 Groundwater Level Measurement

If necessary, a plastic sheet can be placed around the well, creating a clean surface onto which the measurement and sampling equipment can be positioned. Do not place meters, tools, equipment, etc., on the sheet unless they have been cleaned first. After unlocking and/or opening a monitoring well, water level measurements will be made using an electric water level meter.

Equipment

- Socket wrenches and/or open-end wrenches
- Screw driver
- Key or combination for monitoring well lock
- Electric water level meter
- Decontamination equipment (buckets, brushes, Alconox™, distilled or deionized water, brushes, and paper towels)
- Safety equipment (sample gloves and other Personal Protective Equipment [PPE] as required for the job)
- Air monitoring equipment as required

Groundwater Level Measurement Procedures

- Unlock and/or open the monitoring well.
- Check for the measuring point at the top of the well. The measuring-point location should be clearly marked on the innermost casing or identified in previous sample-collection records. If no measuring point can be determined, a measuring point should be established. Typically, the top (i.e., the highest point or the north-facing point) of the innermost well casing will be used as the measuring point. The measuring-point location should be described on the monitoring-well gauging data form and should be the same point used for all subsequent sampling efforts.
- Obtain a water level measurement by lowering the probe of the electric water level meter into the monitoring well. Take care that the probe and electric line hang freely in the monitoring well and do not adhere to the wall of the well casing. Lower the probe into the well until the sound and light (if present) on the meter are activated. At this time, the precise measurement should be determined (to a hundredth of a foot) by repeatedly raising and lowering the tape to converge on the exact measurement. The water level measurement should be entered on an appropriate field form (i.e., monitoring-well gauging data form).
- Verify that the water level measurement is indicative of a static water level. The initial water level measurement may not be indicative of static conditions if groundwater pumping recently occured in this vicinity or if the well is screened in a confined aquifer and the well casing does not have a vent hole permitting equilibrium with the atmosphere. A second water level measurement a few minutes after the initial measurement can be used to verify static water level conditions.
- Decontaminate the electric water level meter after use. Generally only the probe and the portion of the tape that enters the well will be cleaned. Ensure that the measuring tape is not placed directly on the ground surface.

#### 9.5.1.2 Total Depth Measurement

If necessary, a plastic sheet can be placed around the well, creating a clean surface on which the measurement equipment can be positioned. Do not place tools, equipment, etc., on the sheet unless they have been cleaned first. Total-depth measurements will be made using a stainless-steel weighted tape.

Equipment

- Socket wrenches and/or open-end wrenches
- Screw driver
- Key or combination for monitoring well lock
- Stainless steel weighted tape
- Decontamination equipment (buckets, brushes, Alconox™, distilled or deionized water, brushes, and paper towels)
- Safety equipment (sample gloves and other PPE as required for job)
- Air monitoring equipments as required

Total Depth Measurement Procedures

- Unlock and/or open the monitoring well.
- Monitor the atmosphere at the wellhead.
- Check for the measuring point of the well. The measuring-point location should be clearly marked on the innermost casing or identified in previous sample-collection records. If no measuring point can be determined, a measuring point should be established. Typically, the top (i.e., the highest point or the north-facing point) of the innermost well casing will be used as the measuring point. The measuring-point location should be described on the water level data form and should be the same point used for all subsequent sampling efforts.
- Obtain a total-depth measurement by lowering a weighted calibrated tape into the monitoring well. Take care that the weighted tape hangs freely in the monitoring well and does not adhere to the wall of the well casing. Lower the weighted tape into the well until the bottom of the well is reached. This can be determined when the weight can no longer be felt and there is slack in the tape. A precise measurement of the total depth of the well should be determined (to a hundredth of a foot) by repeatedly raising and lowering the tape to determine the exact measurement and then adding the probe tip length (e.g., 0.10 ft) that extends below the 0.00-foot mark on the tape/probe. The total-depth measurement and condition of the well bottom (i.e., hard, soft) should be entered on an appropriate field form or field logbook (i.e., water level data form).
- Decontaminate the measurement device after each use. Generally only the portion of the tape that enters the well will be cleaned. Ensure that the measuring tape is not placed directly on the ground surface.

### 9.5.2 Monitoring Well Sampling for Groundwater SOP

This SOP is concerned with the collection of valid and representative samples from groundwater monitoring wells. Groundwater samples are collected and analyzed to determine the presence, absence, or quantity of various contaminants as part of site characterization, remediation, and/or monitoring activities.

#### 9.5.2.1 Equipment

The following list identifies the types of equipment that may be used for a range of groundwater sampling applications. A project-specific equipment list will be selected from this list based on project objectives and well conditions.

- Bailer with rope or string
- Pump with tubing and power source
- pH meter

- Specific conductance meter
- Temperature meter
- Dissolved oxygen meter
- eH (ORP) meter
- Turbidity meter
- Flow-through cell
- Water level measurement equipment
- Water sampling data form
- Filtration apparatus (project-dependent)
- Personal protective equipment
- Decontamination equipment
- Permanent pens
- Field logbook
- Sample coolers
- Sample containers and laboratory-supplied preservatives (if any)
- Sample labels
- Custody seals (if required by Sampling & Analysis Plan/Work Plan)
- Chain-of-custody forms
- Sample control logs

#### 9.5.2.2 Well Purging

Prior to sample collection, purging must be performed for all groundwater monitoring wells to remove stagnant water from within the well casing and/or to ensure that a representative sample is obtained.

*Standard Well Purging.* Monitoring wells will be purged of at least three well casing volumes (moderate- to high-yield formations) or at least one well casing volume for low-yield formations unless micropurge methodology is followed (method described below). To determine the volume of water to be removed, the first step is to measure the depth to water (DTW) and the total depth (TD) of the well casing using the procedures described as outlined in Section 9.5.1. DTW measurements should be made within 48-hours of purging and sampling wells. Once these measurements have been obtained, the well casing volume is determined using the following equation:

$$V_{WC} = \frac{\pi D^2 h}{4}$$

where: $V_{WC}$ ($ft^3$) = well casing volume

D (ft) = internal diameter of the well casing

h (ft) = length of the water column in the well casing (TD-DTW)

As a conservative measure or because of project-specific requirements, total well volumes may be required for purging rather than well casing volumes. Total well volume differs from well casing volume in that it includes the volume of water in the filter pack. Total well volume is calculated using the equation:

$$\text{Total Well Volume} = V_{FP} + V_{WC}$$

where: $V_{FP}$ = volume of water in the filter pack

The volume of water in the filter pack is determined by calculating the volume of the water in the borehole less the well casing volume. Compensation for the porosity of the filter pack is included in the equation, and this relationship is expressed as follows:

$$V_{FP} = \left[\frac{\pi D^2 h}{4} - V_{WC}\right](n)$$

| | | | |
|---|---|---|---|
| where: | $V_{FP}$ ($ft^3$) | = | filter pack volume |
| | D (ft) | = | diameter of the borehole |
| | h (ft) | = | lesser of (a) length of filter pack, or (b) length of water column in the casing |
| | n | = | filter pack porosity (assume 30 percent) |
| | $V_{WC}$ ($ft^3$) | = | well casing volume |

Useful conversions: 1 $ft^3$ = 7.48 gal

1 gal = 0.134 $ft^3$

Indicator parameters (pH, temperature, and conductivity) will be monitored and recorded during purging. Generally, well purging will continue until the pH is within 0.2 standard units, temperature is within 1° C, and electrolytic conductivity is within 10 percent in three consecutive measurements.

Low-yield wells are considered purged after a minimum of one well volume is removed. If possible, low-yield wells should be purged at a rate slow enough so as not to purge the well dry. If a well is purged dry, the well should be sampled as soon as it has recovered enough to have sufficient water volume for the sample. The time between purging and sampling should not exceed 24 hours.

For medium or high-yield wells, samples should be collected within two hours of purging if possible. Under no circumstances should there be more than 24 hours between purging and sampling.

Please note that purging and sampling of a well can be done within 12 hours of well installation (i.e., just after well development), if necessary. However, the greater the time lapse between well installation and well sampling, the more representative the sample will be of formation water. It is recommended that, when project schedules and budget allow, wells should be allowed to stand for 24 hours or greater prior to purging and sampling.

*Micropurging.* Micropurging is an alternate method for purging wells that is distinctly different from the above-mentioned purging methodology. With micropurging, also referred to as low-flow purging, water is withdrawn directly from the screened interval at low enough pumping rates to ensure that the water sampled is formation water just recently entering the screen. As with traditional sampling, the groundwater is not sampled until the water-quality parameters (pH, temperature, and conductivity) have stabilized. Micropurging does not require a certain volume of water to be evacuated from the well. The intake point of the pump or tubing should to be close to the middle of the screen, so the monitoring-well construction details must be known. Micropurging criteria include the following:

- The intake point of the pump or tubing is in the center of the screen.
- Return water is clear and free of debris and has evacuated all major air bubbles in the tubing and flow-through cell.
- The pumping rate does not exceed 1 liter per minute (L/min) (0.1 to 0.5 L/min is usually optimum).
- Drawdown in the well is minimized and does not exceed 10 percent of the screen length.

- Three consecutive measurements of pH, temperature, conductivity, redox potential, and dissolved oxygen have been taken and show changes in value no more than 0.1 for pH, 1°C for temperature, 3 percent for conductivity, 10 millivolts for redox potential, and 10 percent for dissolved oxygen.

#### 9.5.2.3 Well-Purging Methods

Monitoring wells may be developed using either bailers or pumps. It is not recommended that bailers be used for purging, although in many cases bailing may be the most practical method.

Four general types of equipment are used for well purging:

1. Grab samplers (including bailers, Kemmerer samplers, and syringe samplers)
2. Suction-lift pumps (including peristaltic pumps, surface centrifugal pumps, and vacuum pumps)
3. Electric submersible pumps (including centrifugal submersible pumps, helical rotor pumps, and gear pumps)
4. Positive displacement pumps (including gas–drive pumps, piston pumps, inertial lift pumps, and bladder pumps)

Once the type of pump or bailer is selected, the purge rate should be set low enough to avoid turbulent flow that causes entrainment of fines in the sand pack (over development of the well) and potentially causes stripping of volatile organic compounds. As a rule of thumb, the purge rate should not exceed the pumping rate or bailing rate used for well development. In addition, the purge rate should not exceed the recovery rate for the well. Typically, purging rates should not exceed 0.2 to 0.3 L/min.

*Bailing.* In many cases, bailing is the most convenient method for well purging and sampling. Bailers are constructed using a variety of materials such as PVC, stainless steel, polyethylene, and Teflon®. Care must be taken to select a specific type of bailer that suits a study's particular needs. Teflon® bailers are generally the most "inert," while PVC bailers are less expensive and sufficiently resistant to small-term exposure to most common contaminants. Bailers that are not chemically inert and easily decontaminated should not be used to purge and/or sample more than one well. Typically, a bailer can be dedicated to one well and can be hung in the well for subsequent purging and sampling events  Disposable bailers, usually made of polyethylene, are sometimes more practical to use when decontamination time, expense, and the number of sampling events are considered.

Bailing presents three potential problems with well purging and sampling. First, increased suspended solids may be present in samples as a result of the turbulence caused by raising and lowering the bailer through the water column. High solids concentrations may require that total suspended solids (TSS) and the chemical character of the solids be evaluated during sample analyses. In addition, rapid bailing could cause the stripping of volatile organic compounds from the groundwater as a result of bailer agitation and/or groundwater cascading down the sides of the well screen.

Second, bailing may not be practical for wells that require that more than 20 gallons be removed during purging or for wells that are deeper than 50 ft below ground surface. Such bailing conditions mandate that long periods be spent during purging and sample collection, or that centrifugal pumps be used.

Third, bailing typically withdraws water from the top of the water column in the well and this water has already been exposed to the atmosphere. Exposure to the atmosphere can cause volatilization and reactions with carbon dioxide which cause subsequent lowering of the water's pH.

*Suction-Lift Pumps.* Suction-lift pumps are used to purge and sample groundwater from less than 30 ft below ground surface. Suction–lift pumps include peristaltic pumps, surface centrifugal pumps, and vacuum pumps. Vacuum pumps and surface centrifugal pumps (to a lesser extent) are not as appropriate as peristaltic pumps when collecting volatile-sensitive water samples.

*Electric Submersible Pumps.* Electric submersible pumps are commonly used to purge and sample groundwater from a variety of depths. Electric submersible pumps include centrifugal submersible pumps, helical rotor pumps, and gear pumps. The centrifugal submersible pumps are most commonly used, yet cause considerable water agitation due to the movement of the impeller(s). The gear pumps are the best-suited electric submersible pumps for groundwater purging and sampling and one of the best overall pumps for minimizing volatilization of groundwater samples.

*Positive Displacement Pumps.* Positive displacement pumps are widely available pumps often useful for groundwater purging and sampling. Positive displacement pumps include gas-drive pumps, piston pumps, inertial-lift pumps, and bladder pumps. The bladder pump is generally considered the best overall type of pump to collect groundwater samples for inorganic and/or organic analyses. Inertial lift pumps are ideal for well development, but should not be used to collect volatile-sensitive groundwater samples.

#### 9.5.2.4 Purging and Sample-Collection Procedures — Method Specific

Once purging is complete, samples can be collected with either bailers or pumps. In many cases, a well may be purged using a pump and sampled using a bailer. This section discusses specific procedures for collecting samples using bailers and pumps.

*Bailer Sampling.* Obtain a decontaminated or new bailer and rope or cord made out of nylon, polypropylene, or other equivalent material. Tie a bowline knot or equivalent through the bailer loop. Test the knot for security and the bailer itself to ensure that all parts are intact before inserting the bailer into the well. Remove the protective wrapping from the bailer. Lower the bailer to the bottom of the monitoring well and cut the cord at a proper length. Bailer rope should never touch the ground surface at any time during purging and sampling.

Raise the bailer by grasping a section of cord using each hand alternately in a “windmill” action. This method requires the sampler’s hands to be kept approximately 2 to 3 ft apart and the bailer rope to be alternately looped onto or off each hand as the bailer is raised and lowered. Alternate methods may be used to raise the bailer including use of a reel or a plastic-lined bucket into which the rope is manually fed. Bailed groundwater is poured from the bailer into a graduated container to measure the purged water volume.

For slowly recharging wells, the bailer is generally lowered to the bottom of the monitoring well and withdrawn slowly through the entire water column. If possible, the water should be bailed at a rate slow enough so that it does not cascade down the sides of the well screen, which causes stripping of volatile organic compounds. Groundwater should be allowed to recover to 70 percent or greater of its static volume before a sample is collected.

Typically, water samples should be collected at or near the midpoint of the well screen. To collect a groundwater sample using a bailer, slowly lower the bailer into the water column, allowing the bailer to fill slowly from the bottom. Once the bailer has been lowered to approximately the mid-point of the screen, slowly raise the bailer to minimize creating turbulence in the well and minimize drawing fine-grained sediment into the well. Gently empty water directly from the full bailer into sample containers, taking care not to allow contact between the bailer and the sample container.

*Pump Sampling.* When selecting the appropriate pump to use for purging and sampling a well, there are two criteria that must be considered. First, the construction material of the pump and tubing should not contain materials that interact with the constituents of interest and/or contain constituents that may cause the sample to have a false positive analysis. Second, if the sample is to be analyzed for volatile organic compounds, a pump that minimizes sample agitation and subsequent volatilization should be used. As noted previously, the most appropriate pumps under these conditions are the gear pump or the bladder pump.

Prior to inserting a pump into a monitoring well, it should be thoroughly decontaminated by pumping an Alconox™ or equivalent potable water mixture through the pump followed by pumping potable water, followed by a distilled or deionized water rinse. Tubing should be dedicated to a single well and should not be re-used.

During the collection of samples, the pumping rate should be approximately 0.1 L/min. If a greater pumping rate is used for purging, the pumping rate should be reduced during sampling. Groundwater should be pumped directly into the sample containers.

#### 9.5.2.5 Sample Collection Procedures — Method Independent

The following are method-independent sample collection procedures:

- Collect samples intended for volatile organic analysis (VOA) first.
- Fill sample containers quickly and smoothly to avoid agitation, aeration, and loss of volatile components.
- To further avoid loss of volatile components, completely fill samples so that no headspace is present and cap securely with a Teflon®-lined lid.
- Collect samples for semivolatile, metal, or other analyses in the proper sample containers.
- Collect duplicate samples when QA/QC samples are needed for VOA. VOA samples typically consist of two sample vials, referred to as the sample set. Alternating between the primary sample set and the replicate sample set, completely fill each vial and cap immediately in the order shown below:
  - Fill vial #1 - primary sample set
  - Fill vial #1 - replicate sample set
  - Fill vial #2 - primary sample set
  - Fill vial #2 - replicate sample set
- Collect duplicate samples when QA/QC samples are required for sample analyses other than VOA by alternately filling the sample containers as in the VOA procedure, but fill containers incrementally instead of completely, continuing the filling procedure until the sample containers are full.
- Label all sample containers with the following information:
  - Project name and/or number
  - Field sample number
  - Depth interval (if applicable)
  - Initials of collector
  - Date and time of collection
  - Sample type and preservative (if any)

  Replicate and duplicate sample labels require only project name and/or number, field sample number, and sample type and preservative (if any).
- Place samples in coolers as soon as possible and, if required, store and transport them at <4°C (39°F), using frozen ice packs or double-bagged ice.
- Use protective packaging as dictated by the mode of transport.

- Record sample information in the field logbook and on the sample control log as soon as possible after sample collection, in accordance with the procedures set forth in the Quality Assurance Project Plan.
- Complete chain-of-custody forms and placed them in the cooler for shipment to the laboratory.
- If required by the SAP, place custody seals across cooler lids so that coolers cannot be opened without breaking the custody seal. Include the following information on the custody seals:
  - Collector's signature or initials
  - Date of sampling
- Ship samples to the laboratory for analysis, carefully observing all minimum holding-time requirements for degradable constituents.
- Set up a decontamination station near the sampling location to decontaminate equipment that will be reused at the next sampling location.

### 9.5.3 Aquifer Testing and Analysis SOP

All monitoring wells added to the monitoring well network will be installed and completed in accordance with the NMED Monitor Well Construction Guideline.

#### 9.5.3.1 General

An aquifer test or "pumping test" is used to determine the hydraulic properties of an aquifer by pumping one well for a specified length of time while collecting periodic water level measurements. Aquifer properties that can potentially be estimated using a pumping test include transmissivity (i.e., hydraulic conductivity multiplied by aquifer thickness), horizontal or vertical hydraulic conductivity, coefficient of storage, specific yield, and confining layer leakage. The two types of pumping tests most useful in determine aquifer hydraulic properties are the constant rate pumping test and the step-drawdown pumping test. The latter is best suited to determining the well's reduction in specific capacity (i.e., specific yield per unit of drawdown) with increasing yields, while the former is the most widely used pumping test in determining the transmissivity and storage values for an aquifer.

A pumping test can be performed using only the pumping well; however, specific information such as aquifer storage will not be obtainable. The use of observation wells in obtaining additional drawdown and/or recovery data over time is recommended whenever possible, especially when information on aquifer storage, anisotropy, vertical leakage, or the distance to a recharge or no-flow (i.e., barrier) boundary is needed.

In comparison to a slug test, a pumping test is representative of a much larger area and is therefore a better estimation of the hydraulic parameters of an aquifer. Conversely, a pumping test requires a greater commitment of resources (time, money, and equipment) and produces large volumes of water that usually need to be containerized during the test.

Several analytical solution methods are available. Two of the most widely used are the Theis (1935) equation and the Cooper and Jacob (1946) equation (often referred to as the Jacob straight-line method). A multitude of pumping test analysis software is available, though users are cautioned to be sure to understand all model or spreadsheet inputs as well as the assumptions of the governing equations. Far more extensive information on the design and analysis of pumping tests is covered in texts including, to name a few, Driscoll (1986), Kruseman and de Ridder (1991), Dawson and Istok (1991), Osborne (1993), and Fetter (1988).

Analyses of pumping tests require the following assumptions:

- The water-bearing formation is homogeneous, isotropic, uniform in thickness, and infinite in areal extent.
- The formation receives no recharge from any source.
- The pumping well (i.e., the screened section) is fully penetrating the entire thickness of the water-bearing formation.
- The water removed from storage is discharged instantaneously when the head is lowered.
- The pumping well is 100 percent efficient.
- All water removed from the well comes from aquifer storage.
- Laminar flow exists throughout the well and aquifer.
- The water table or potentiometric surface has no slope.

In reality, most pumping tests violate many of the above-mentioned assumptions to some degree or another. However, it is important to take all feasible measures to limit the extent of these violations whenever possible, and discussing these assumptions and any possible violations to them is important to any pumping test report.

*Design Considerations.* Prior to performing an aquifer pumping test, all available site and regional hydrogeologic information should be assembled and evaluated. If retrievable, such data should include groundwater flow direction(s), hydraulic gradients, other geohydraulic properties, site stratigraphy, well construction details, regional water level trends, and the performance of other pumping wells in the vicinity of the test area. This information is used to select test duration, proposed pumping rates, and pumping well and equipment dimensions.

The precise location of an aquifer test is chosen to be representative of the area under study. In addition, the location is selected on the basis of numerous other criteria, including:

- The size of the investigation area.
- Uniformity and homogeneity of the aquifer.
- Distribution of contaminant sources and dissolved contaminant plumes.
- The location of known or suspected recharge or barrier boundary conditions.
- The availability of pumping and/or observation wells of appropriate dimension and screened at the desired depth.
- Requirements for handling discharge.

The dimensions and screened interval of the pumping well must be appropriate for the tested aquifer. For example, the diameter of the well must be sufficient to accommodate pumping equipment capable of sustaining the desired flow rate at the given water depth. In addition, if testing a confined aquifer that is relatively thin, the pumping well should be screened for the entire thickness of the aquifer. For an unconfined aquifer, the wells should be screened at least in the bottom one- to two-thirds of the saturated zone and they may be screened throughout the entire thickness of the saturated zone.

Any number of observation wells may be used. The number chosen is contingent upon both cost and the need to obtain the maximum amount of accurate and reliable data. If at least three observation wells are to be installed and there is a known boundary condition, the wells should be configured such that water levels can be monitored both perpendicular and parallel to the boundary, with the pumping well at the intersection of the two well lines. If two observation wells are to be installed, they should be placed in a triangular pattern, non–equidistant from the pumping well. If observation wells are placed at 90° angles from the pumping well, radial anisotropy can be easily calculated. When observation wells are installed for aquifer testing purposes, they should be located at distances and depths appropriate for the planned method for analysis of the aquifer test data. Observation well spacing should be determined based upon expected drawdown conditions that are the result of the studies of geohydraulic properties, proposed pumping test duration, and proposed pumping rate.

*Equipment.* The equipment necessary to conduct a pumping test includes:

- A pump (suited for site conditions and requirements of the test)
- Water level measuring devices (pressure transducers and/or electronic water level indicators) accurate to at least 0.01 ft
- A flow meter with totalizer (something as simple as a graduated bucket can also suffice, especially as backup)
- A digital watch with stopwatch function (used to keep time and to help determine discharge rate when using graduated containers)
- An electrical source (generator or electrical receptacle on site)
- An electronic data recorder programmed to suitable data collection intervals)
- A barometer
- Water quality meter(s) for noting changes as a function of capture zone
- Hose or pipe to route pumped water away from the test area
- A gate valve
- An adequately sized tank/container for storing water
- A portable computer for preliminary analysis of data (optional)
- Field forms and logbook
- Pen and paper
- Backup equipment if feasible

Pumping equipment should conform to the size of the well and be capable of delivering the estimated range of pumping rates. The selection of flow meter, gate valve, and water transfer lines should be based on anticipated rates of water discharge. Both the discharge rate and test duration should be considered when selecting a tank for storing discharge water if the water cannot be released directly to the ground, sanitary sewer, storm sewer, or nearby water treatment facility.

*Pumping-Test Preperations.* If feasible for the site, slug tests or preliminary pumping tests (constant-rate or step drawdown) should be performed on the pumping well prior to the actual test. The preliminary pumping should determine the maximum drawdown in the well, and the proper pumping rate should be determined by step drawdown testing. If the discharge rate varied by less than 5 percent (i.e., a constant-rate-pumping test), the time versus drawdown data from the pumping well can be used to estimate aquifer transmissivity. The preliminary pumping will also provide redevelopment of the pumping well by removing fines from the adjacent formation and from the filter pack. Redevelopment of the pumping well will improve well efficiency during the pumping test and thus will allow for a better estimation of the aquifer's hydraulic properties. The aquifer should then be given time to recover before the actual pumping test begins (as a rule–of–thumb, one day). A record should be maintained in the field logbook to track when pumping and discharge of other wells in the area occurs and whether the wells' radii of influence intersect the cone of depression of the test well.

Barometric changes may affect water levels in wells, particularly in semiconfined and confined aquifers. Therefore, it is advisable to monitor (perhaps hourly) the barometric pressure and water levels in key wells at least 24 hours (if possible) prior to performing a pumping test. If a groundwater fluctuation trend is apparent, the barometric pressure should be used to develop curves depicting the change in water level versus time. These curves should be used to correct the water levels observed during the pumping test. Groundwater levels and barometric pressures in the background should continue to be recorded throughout the duration of the test. If dataloggers with transducers are used, backup field measurements should be collected in case of datalogger malfunction. All measurements and observations should be recorded in a field logbook or on appropriate field forms.

All equipment should receive calibration, function checks, and fresh or charged batteries if needed.

*Conducting the Pumping Test.* Prior to the start of the pumping test, the following checks should be made:

- Ensure all piping, valves, and flow meters are properly installed.
- Ensure that all containers are in place to capture all pumped water.
- Ensure that the energy needs (batteries, electricity, or gas) for all equipment are provided, including backup energy sources for key equipment.
- Verify all equipment is present and place it at locations where it will be most needed.
- Verify the pump intake is located at the proper interval in the pumping well.
- Verify all transducers are placed at the proper depth and are properly secured so they will not move or be susceptible to contact from site personnel.
- Verify the datalogger is properly programmed to record (typically logarithmically).
- Lower electronic water level tapes to just above the water levels inside each well.
- Warm up all equipment (such as a generator) that perform better after initial operations.
- Ensure all personnel and field forms are in their start-of-test locations.

Immediately prior to starting the pump, the water levels should be measured and recorded for all wells to determine the static-water levels upon which all drawdowns will be based. Dataloggers should be reset for each well to a starting water level of 0.00 foot. At this time, a pumping test is initiated by starting the datalogger and then starting the pump. The datalogger needs to be started at least a split second before the pumping begins. Immediately afterwards, the time that pumping started needs to be recorded along with water level readings, especially at or near the pumping well. A suggested schedule for recording water level measurements made by hand is as follows:

- 0 to 10 minutes – 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, and 10 minutes (It is important in the early part of the test to record with maximum accuracy the time at which readings are taken.)
- 10 to 100 minutes – 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, and 100 minutes
- 120 minutes to end of test – every 1 hour (60 minutes)

At least 10 measurements of drawdown for each log cycle of time should be made both in the test well and the observation wells. Dataloggers can be set to record in log time, which is very useful for data analysis. When logging data by hand, there should initially be sufficient field personnel to station one person at each well used in the pumping test. After the first two hours of pumping, two people are usually sufficient to complete most simplistic tests. It is advisable for at least one field member to have experience in the performance of pumping tests, and for all field personnel to have a basic familiarity with conducting the test and gathering data.

The discharge rate should be measured frequently throughout the test with a flow meter equipped with a totalizer and controlled to maintain a constant pump. This can be achieved, in part, by using a control valve. If used properly, the flow control valve can be pre-set for the test and will not have to be adjusted during pumping. When the pumping is complete, the total gallons pumped are divided by the time of pumping to obtain the average discharge rate for the test.

For a confined aquifer, if possible, the water level in the pumping well should not be allowed to fall below the bottom of the upper confining stratum during a pumping test. The pitch or rhythm of the pump or generator provides a check on performance. If there is a sudden change in pitch, the discharge should be checked immediately and proper adjustments to the control valve or the generator engine speed should be made, if necessary. Do not allow the pump to break suction during the test. If the pump stops working during the test, make necessary adjustments and restart the test after the well has stabilized.

Water pumped from an aquifer during a pumping test should be disposed of in such a manner as to not allow the aquifer to recharge during the test. This means that the water must be piped away from the well and associated observation wells. Also, if contaminated water is pumped during the test, the water must be stored and treated or disposed of according to project specifications. The discharge water may be temporarily stored in drums; a lined, bermed area; or tanks. If necessary, it should be transported and staged in a designated secure area.

Field personnel should be aware that electronic equipment sometimes fails in the field. It is a good idea to record key data in the field logbook or on field forms as the data are produced. That way, the data are not lost should the equipment fail.

The total pumping time for a test depends on the type of aquifer and degree of accuracy desired. Economizing on the duration of pumping may yield less reliable results. It is always recommended to pump long enough to ensure the cone of depression achieves a stabilized condition. The cone of depression will continue to expand at an ever-decreasing rate until recharge of the aquifer equals the pumping rate, and a steady-state condition is established. The time required for steady-state flow to occur varies considerably from site to site. If steady-state conditions cannot be achieved in a reasonable time frame for the project, consider a test duration of at least 24 hours. A longer duration of pumping may reveal the presence of boundary conditions or delayed yield.

Use of portable computers allows time/drawdown plots to be made in the field. If dataloggers are used to monitor water levels, the electronic data can be reviewed by scrolling with the datalogger screen or via a portable computer. It is advisable to download the water level data before transporting the datalogger from the site.

### 9.5.4 Monitoring Well Installation

If additional monitoring wells are required, SOPs for Monitoring-Well Installation and Hollow-Stem Auger Drilling will be followed. These SOPs will be submitted to the MMD prior to installation of additional wells and will meet state requirements for well installation.

## 9.6 Parameters to be Analyzed

See Table 9-3 for analytical parameters and analysis methods.

## 9.7 Maps Showing Proposed Sampling Locations

Figure 9-10 illustrates the current groundwater monitoring network for the baseline characterization study. This network has grown from the initial sampling program conducted in January 2010 (Figure 9-11). The wells have been categorized according to the aquifer being monitored (i.e., Quaternary alluvial aquifer, Santa Fe Group aquifer, or Bedrock aquifer) if known.

## 9.8 Laboratory and Field Quality Assurance Plans

The groundwater sample and data collection will be conducted in accordance with the Quality Assurance Project Plan (QAPP) (see Attachment 1) and the procedures for sampling and recording observations in a logbook. The samples will be properly preserved and sent to an accredited analytical laboratory. Water samples will be collected from Site wells and private wells. Fieldwork to determine which of these wells exist and can be sampled and measured is subject to owner approval. Comments made by the well users visited will be recorded in the logbook.

The parameters of pH, temperature, dissolved oxygen, turbidity, and specific conductivity will be measured in the field at the time of collection for each well. The field instruments will be calibrated by the manufacturer with calibration checks conducted by the user. The calibration certificates will be filed and the field checks will be recorded in the logbook. Groundwater quality control samples will include random duplicate samples.

The Field Leader for the aquifer pump test will be experienced and the field members will be trained to the procedures. The procedures to be used have been developed by professionals in groundwater hydrology. The instruments used for pump tests will be calibrated by the manufacturer. A calibration certificate will be retained as a record. The main instruments used for the pump test are the pressure transducers, E-tape, vented cable, and barometric pressure gage. A preliminary step drawdown test a few days prior to the pump test will afford the field hydrologists a chance to verify that the meter, discharge system, transducers, and generator are working properly.

Water level measurements will be monitored manually with an E-tape as a check on transducer measurements and to ensure that a back-up set of data are available in case of transducer failure. The E-tape and transducers will be compared several times before the pump test to determine the difference in readings. This difference will be recorded. During and after the pump test, several more checks will be made to compare the reading differences. The differences are typically minimal (inches), but will be used as an adjustment for the data interpretation. A similar comparison will be noted for the vented cable and the barometric pressure gage readings. Prior to installation, the transducer probe and cable will be inspected for damage, un-kinked, and cleaned.

The transducer data will be downloaded to a laptop computer on a regular basis. E-tape comparison readings will be taken, often during the initial pumping and again during the initial recovery period and numerous times during the days of pumping. For safety reasons, at least two people will be on-Site during the entire pumping portion of the test.

Personnel will maintain a field logbook in which are recorded weather, field conditions, nearby pumping wells, and any circumstances which influence test results or would be useful to know during interpretation of test results.

## 9.9 Discussion in Support of Proposal

The main objective of the proposed groundwater data collection program is to obtain the data necessary to determine potential impacts of mining activities, including mine dewatering, on local and regional groundwater systems. As this Site has been mined before and has been through several permitting cycles, historical data will play an important role in the evaluation of potential impacts caused by new mining. Therefore, all impact analysis performed using data collected in accordance with this SAP will be supported by concurrent evaluation utilizing historical data where available.

The water quality sampling program will provide current water quality data for a monitoring well network that includes wells with a history of sampling. Current and historical data will be statistically evaluated to determine a range of baseline groundwater quality values for key constituents.

The water level measurement program will provide recent baseline data on local water levels. Existing aquifer pumping test data will be used to obtain hydraulic information and additional tests will be performed as necessary.

The potential impacts of groundwater withdrawals from the Bedrock and Santa Fe Group aquifer system on groundwater levels will be determined using a three-dimensional groundwater flow model. The groundwater flow model will incorporate historical data as well as data collected under this SAP. Defensible, site-specific conceptual and numerical flow models are critical to NMCC for securing the necessary permits and stakeholder acceptance for assessment of potential impacts from dewatering, pit lake evolution, and leaching from waste rock facilities and the tailings impoundment. The potential impacts on water supply wells will be evaluated with this model as well as the potential impacts of the discharge of dewatering water on the alluvial aquifers in Las Animas and Percha Creeks. The groundwater model will be calibrated under pre-development and transient conditions and will represent the most reasonable tool available for estimating impacts of dewatering and appropriation of groundwater on both a local and regional scale.

Given that the existing groundwater flow model developed for Alta Gold (ABC, 1996; ABC, 1997; ABC, 1998b) received significant criticism, NMCC will develop a revised conceptual model for groundwater flow that will be used to construct a MODFLOW numerical model which will in turn be used to assess impacts from mine operations. The revised conceptual model will be primarily based on data collected as part of this baseline characterization work, including historical data that are statistically valid.

A new numerical flow model will be constructed, calibrated, and applied to assess potential impacts from mine dewatering and from post-mining groundwater rebound. This model, which we expect will be a sub-regional scale model, will focus on an area sufficiently large enough to defensibly determine water level and flux changes on identified resources. NMCC proposes to use either MODFLOW or MODFLOW–SURFACT as the flow model code because they have been accepted by both state and federal agencies for mining impact assessments, among other uses. The geologic model from the previous flow model will serve as the foundation for a revised geologic model to be developed by NMCC in close collaboration with MMD staff. Estimates of recharge, evapotranspiration, and other boundary conditions from the previous model will also serve as a starting point for the new numerical flow model.

To assess potential impacts, NMCC will develop and calibrate numerical flow models for the sub-regional scale that represent different periods of mine activity. First, NMCC will construct and calibrate a steady state flow model that represents pre-mining conditions. A transient model that represents mining activities to the present day will be constructed from the steady state model and calibrated to available head and flux data. Potential impacts will be determined from the final transient model that simulates mine activities such as pit deepening and dewatering as well as the post-mining period’s groundwater rebound. Changes in fluxes to surface water bodies and water levels will be used as the performance metrics for the impact assessment.

NMCC efforts for the groundwater impact assessment will include:

- Develop a conceptual model for groundwater flow through the site and its vicinity, including groundwater and surface interactions, and construct a water balance for the site vicinity.
- Present the conceptual model and preliminary numerical model domain to relevant agencies.
- Construct and calibrate a steady state flow model to represent pre-mining conditions.
- Construct and calibrate a transient flow model that simulates historical mine development to the present day.

- Construct and calibrate a transient flow model that estimates drawdown from proposed mine dewatering and groundwater rebound following mine reclamation as well as any potential impacts to groundwater and surface water resources.
- Present the preliminary numerical model results to the relevant agencies.

## 9.10 References

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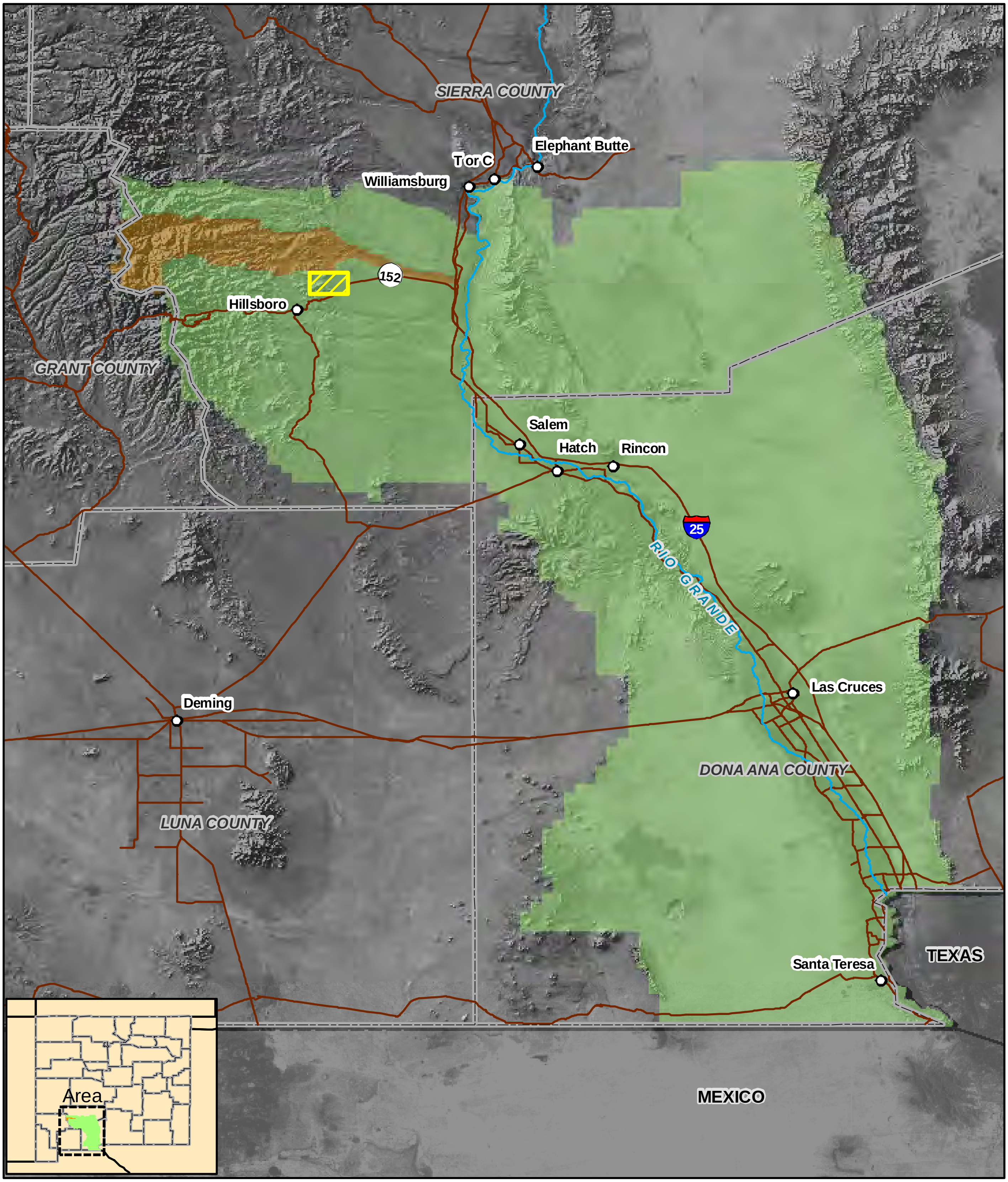
# Figures




0 7.5 15 30

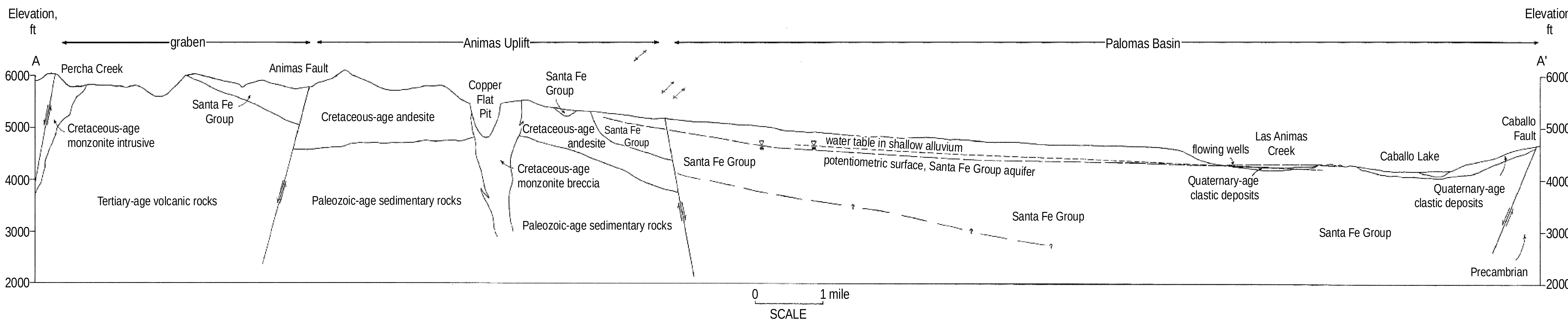
Miles

Basin Boundaries:
RGIS website/NMOSE
Imagery Information:
Landsat imagery from
University of Maryland NLCD

**Legend**

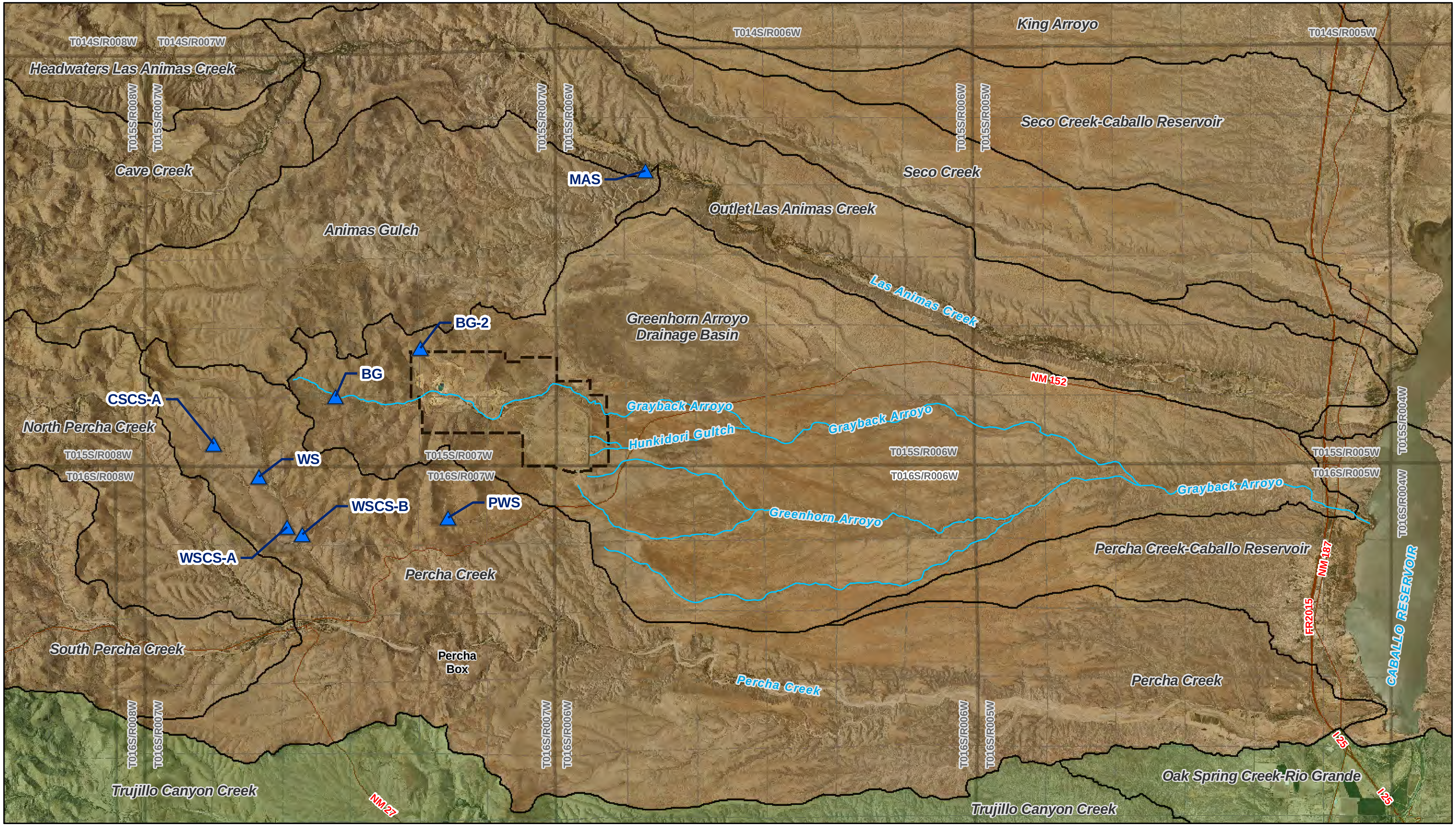
| | | | |
|---|---|---|---|
| | City/Town | OSE Declared Basin | |
| | Site Location | | Lower Rio Grande |
| | Road | | Las Animas |

**Figure 9-1**
**Lower Rio Grande Basin**
**New Mexico Copper Corporation**




from John W. Shomaker, Inc., 1993

**Figure 9-2**
**Conceptual Model of Groundwater Flow System**
**New Mexico Copper Corporation**

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Watersheds:
USGS Hydrologic Unit Map
Mine Boundary:
Tom Van Bebber
Imagery Information:
-USGS 7.5-Minutes County DOQQ mosaic
Sierra County, 2009
Projection Information:
-New Mexico State Plane West, NAD 1927

0 3,500 7,000 14,000 21,000
Feet

**Legend**

- Identified Spring
- Proposed Mine Permit Boundary
- Watersheds
  - Caballo
  - El Paso-Las Cruces
- Sub-Watershed

**Figure 9-3**
**Spring and Stream Locations**
**New Mexico Copper Corporation**

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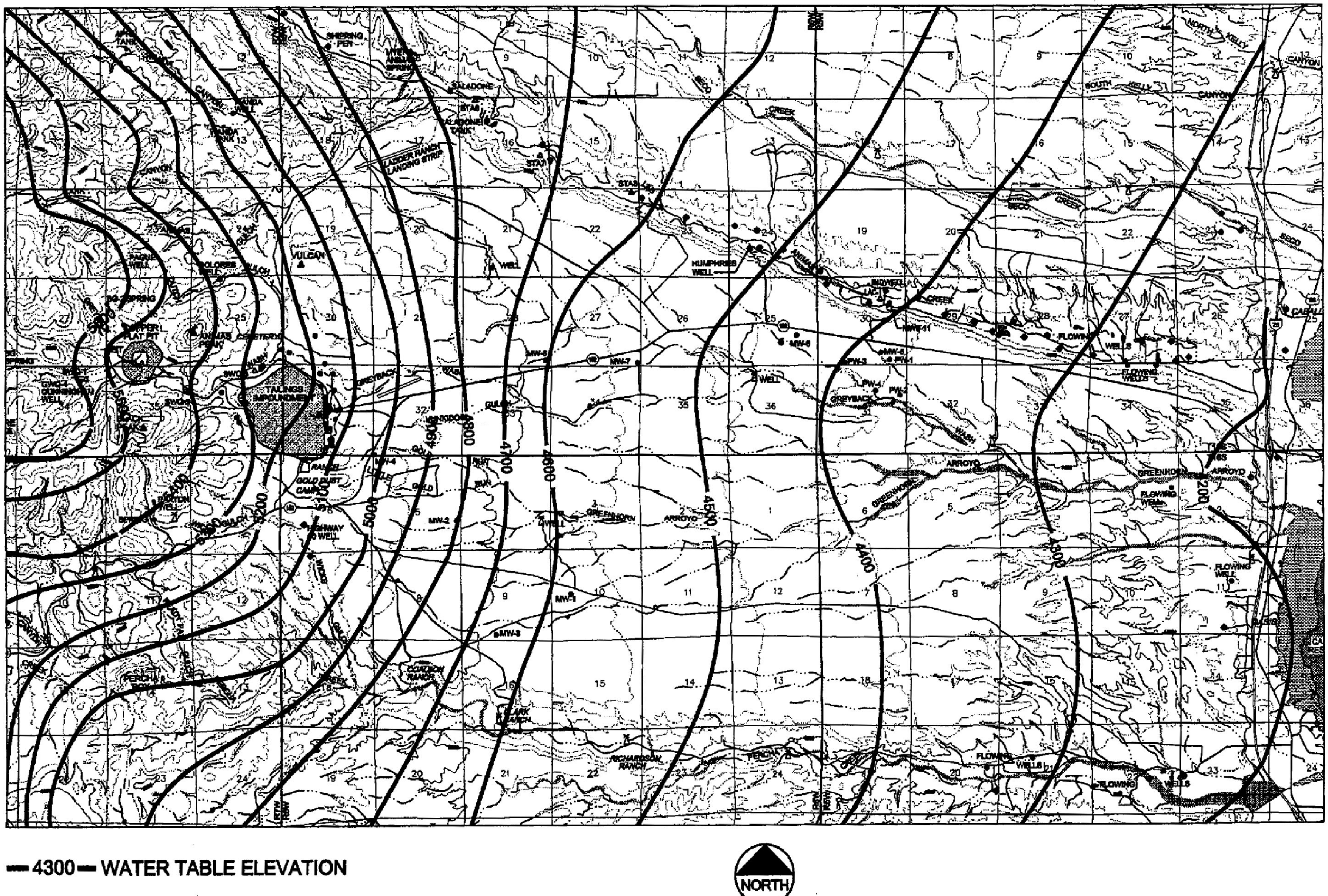
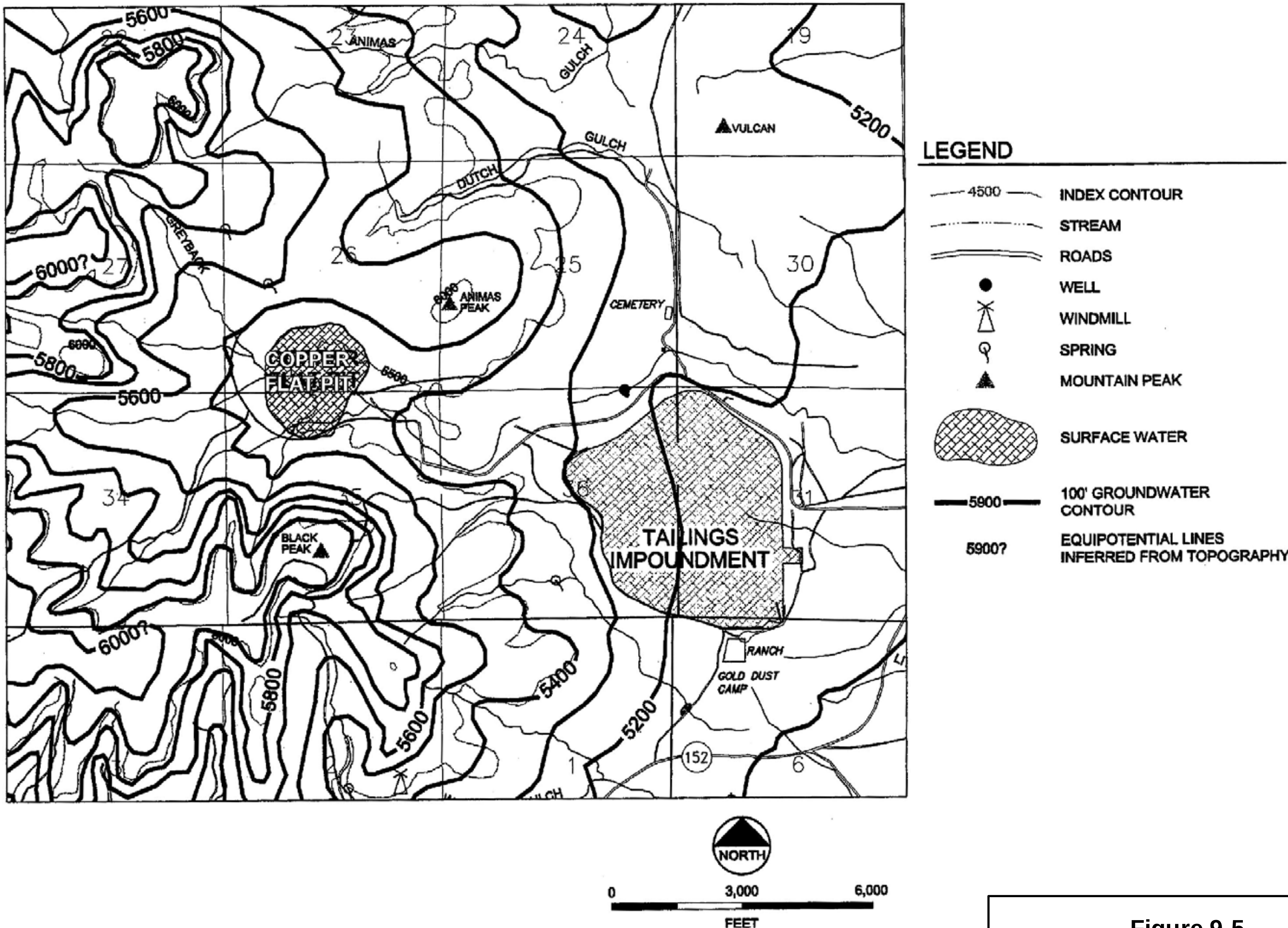



from ABC, 1998B

**Figure 9-4**
**Water Level Contours**
**New Mexico Copper Corporation**




from ABC, 1997

**Figure 9-5**
**Water Level Map of Copper Flat Pit Area**

**New Mexico Copper Corporation**

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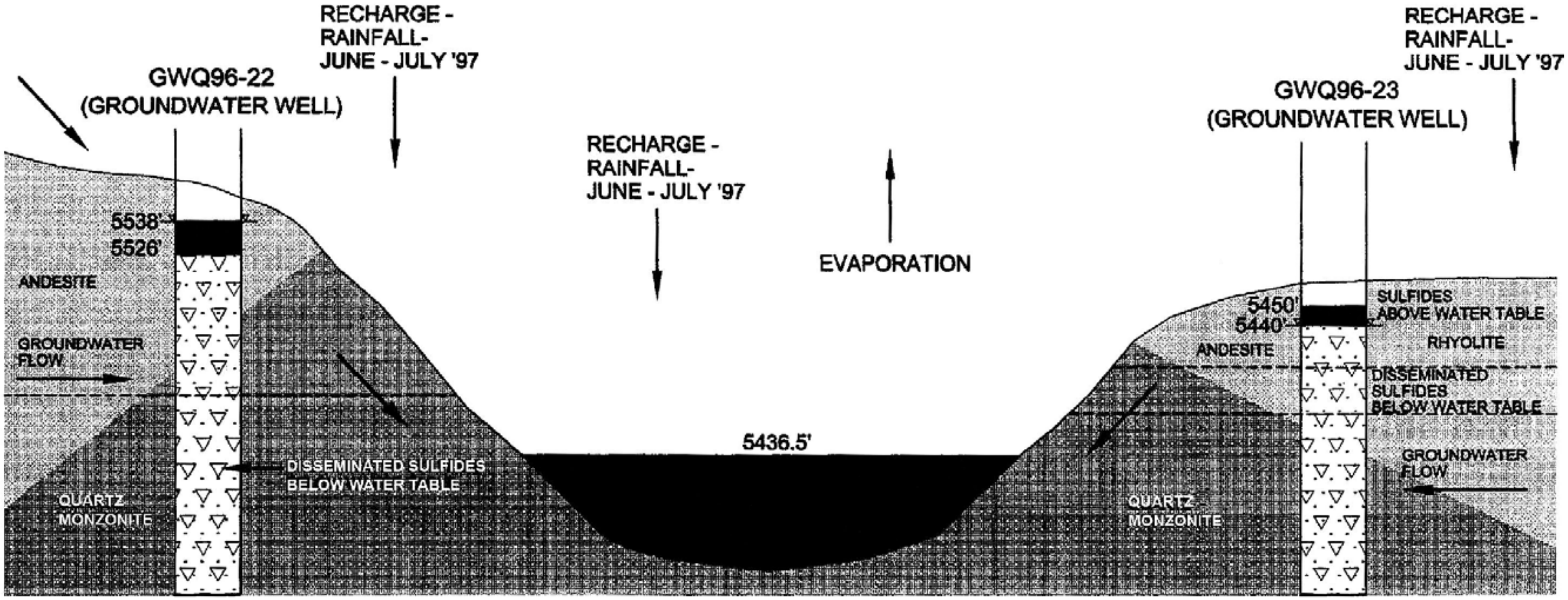


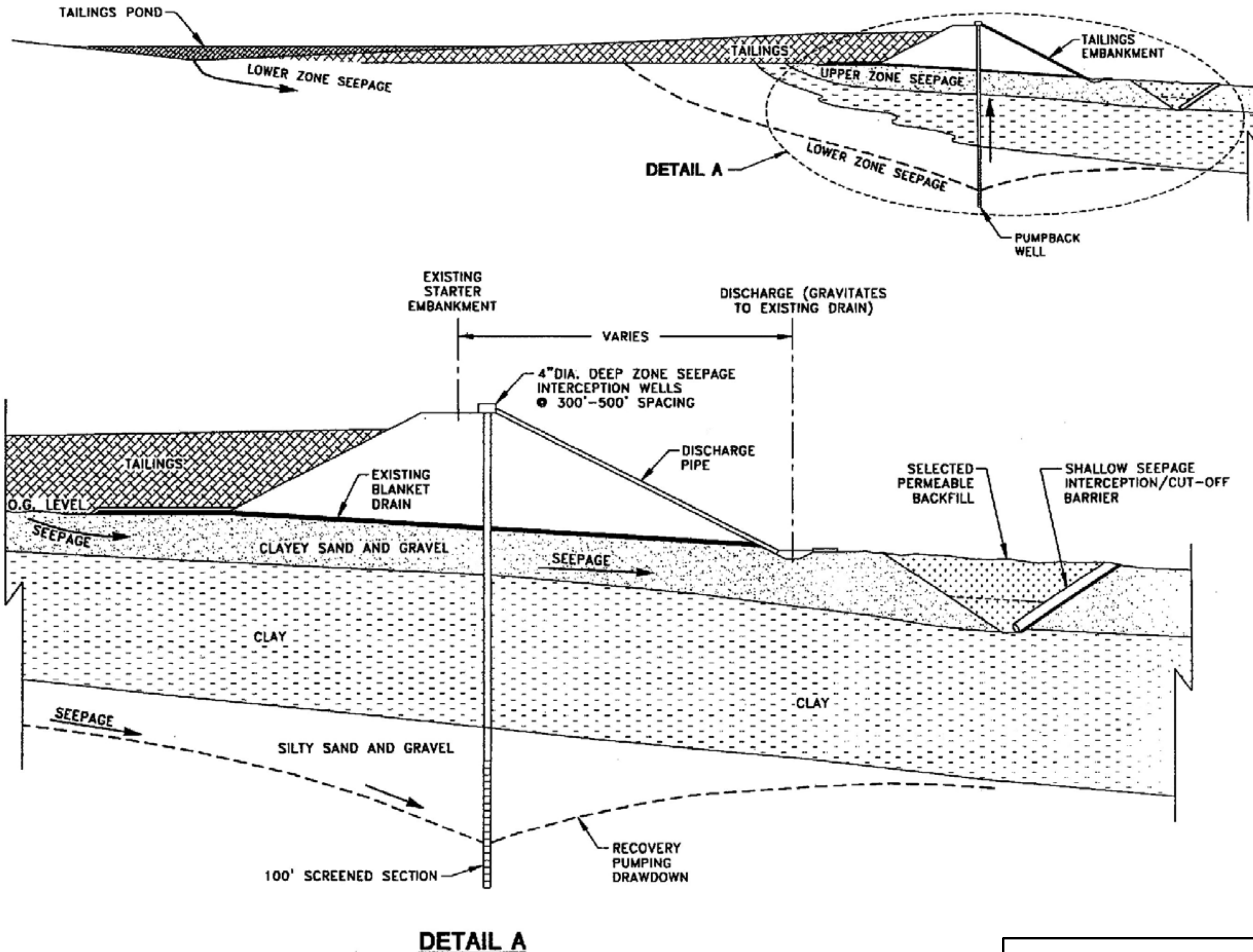

| GWQ96-22 | JULY '96 | AUG '97 |
|---|---|---|
| pH | 7.5 | 7.65 |
| TDS | 700 | 700 |
| $SO_4$ | 250 | 230 |
| Cu | <0.025 | <0.025 |
| Fe | <0.05 | <0.05 |

| PIT LAKE | AUG '95 | AUG '97 |
|---|---|---|
| pH | 8.31 | 8.16 |
| TDS | 4707 | 5021 |
| $SO_4$ | 3170 | 3100 |
| Cu | <0.025 | 0.050 |
| Fe | <0.025 | <0.05 |

| GWQ96-23 | APR '97 | AUG '97 |
|---|---|---|
| pH | 7.89 | 7.68 |
| TDS | 770 | 920 |
| $SO_4$ | 150 | 410 |
| Cu | <0.025 | <0.025 |
| Fe | 6.5 | 0.82 |

INTERA from SRK, 1998

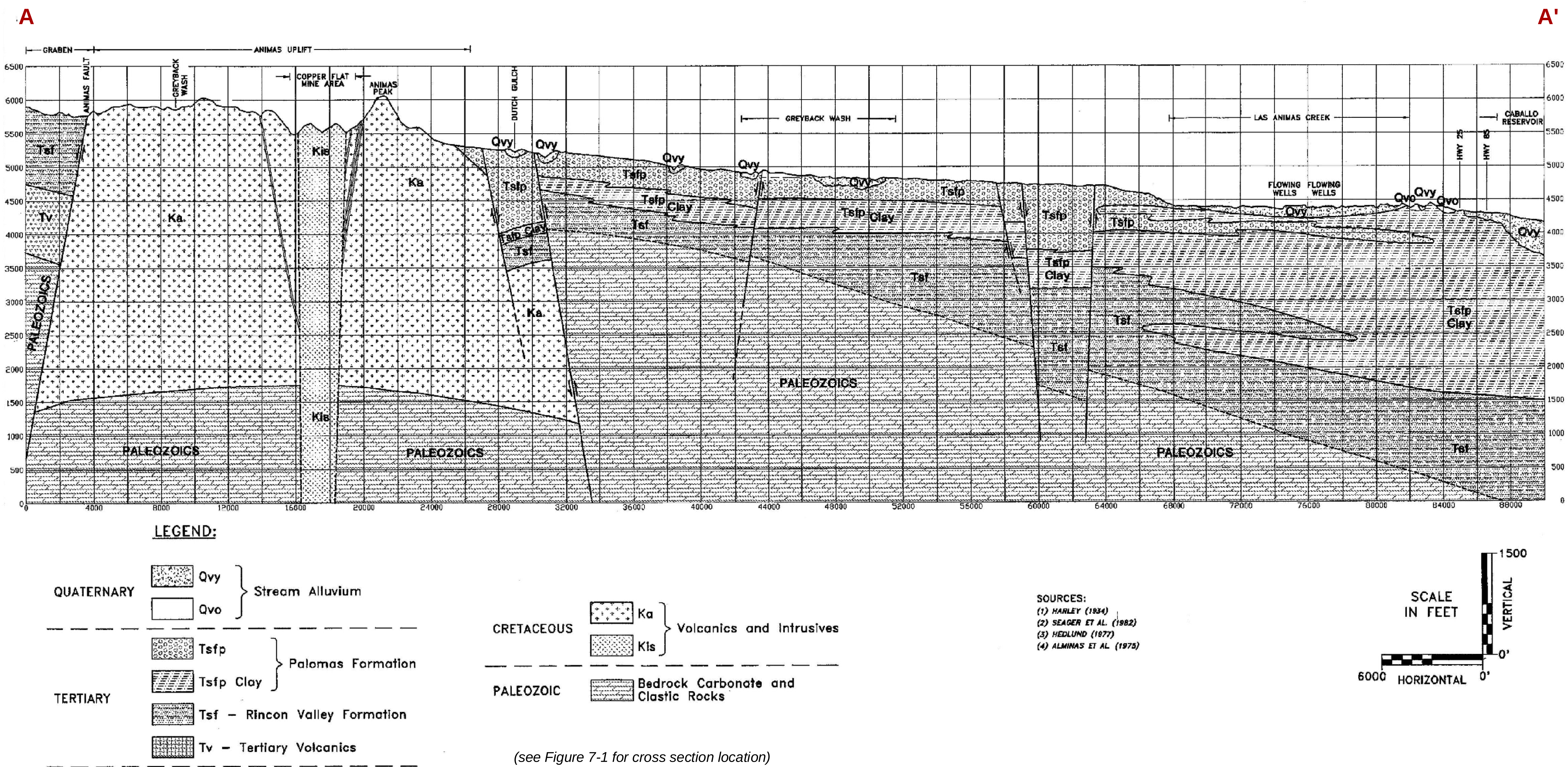
**Figure 9-6**
**Conceptual Model of Pit Lake Monitoring Well Relationship with Water Quality Reports**
**New Mexico Copper Corporation**




from SRK, 1995

**Figure 9-7**
**Conceptual Design,**
**Tailings Seepage Control**

**New Mexico Copper Corporation**




(see Figure 7-1 for cross section location)

from BLM, 1999

**Figure 9-8**
**Schematic Geologic Cross Section (A-A')**
**New Mexico Copper Corporation**

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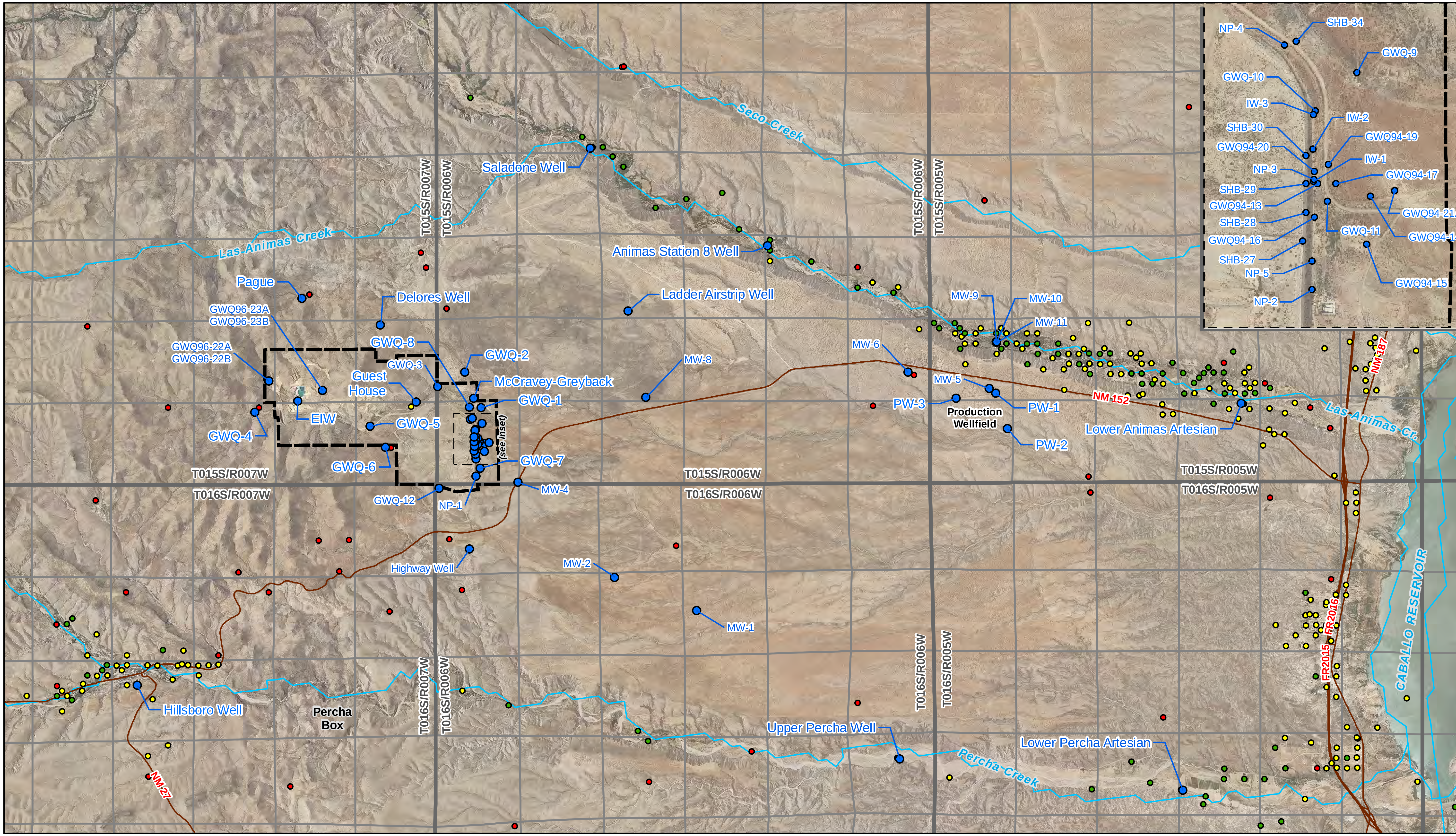


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Well Locations:
SRK or OSE
Mine Boundary:
Tom Van Bebber
Imagery Information:
-USGS 7.5-Minutes County DOQQ mosaic
Sierra County, 2009
Projection Information:
-New Mexico State Plane West, NAD 1927

INTERA

0 3,000 6,000 12,000 18,000
Feet

**Legend**

- Road
- Project Well
- Proposed Mine Permit Boundary

NM OSE Wells (Use)
- Domestic
- Irrigation
- Stock

**Figure 9-9**
**Regional Groundwater Well Locations**
**New Mexico Copper Corporation**

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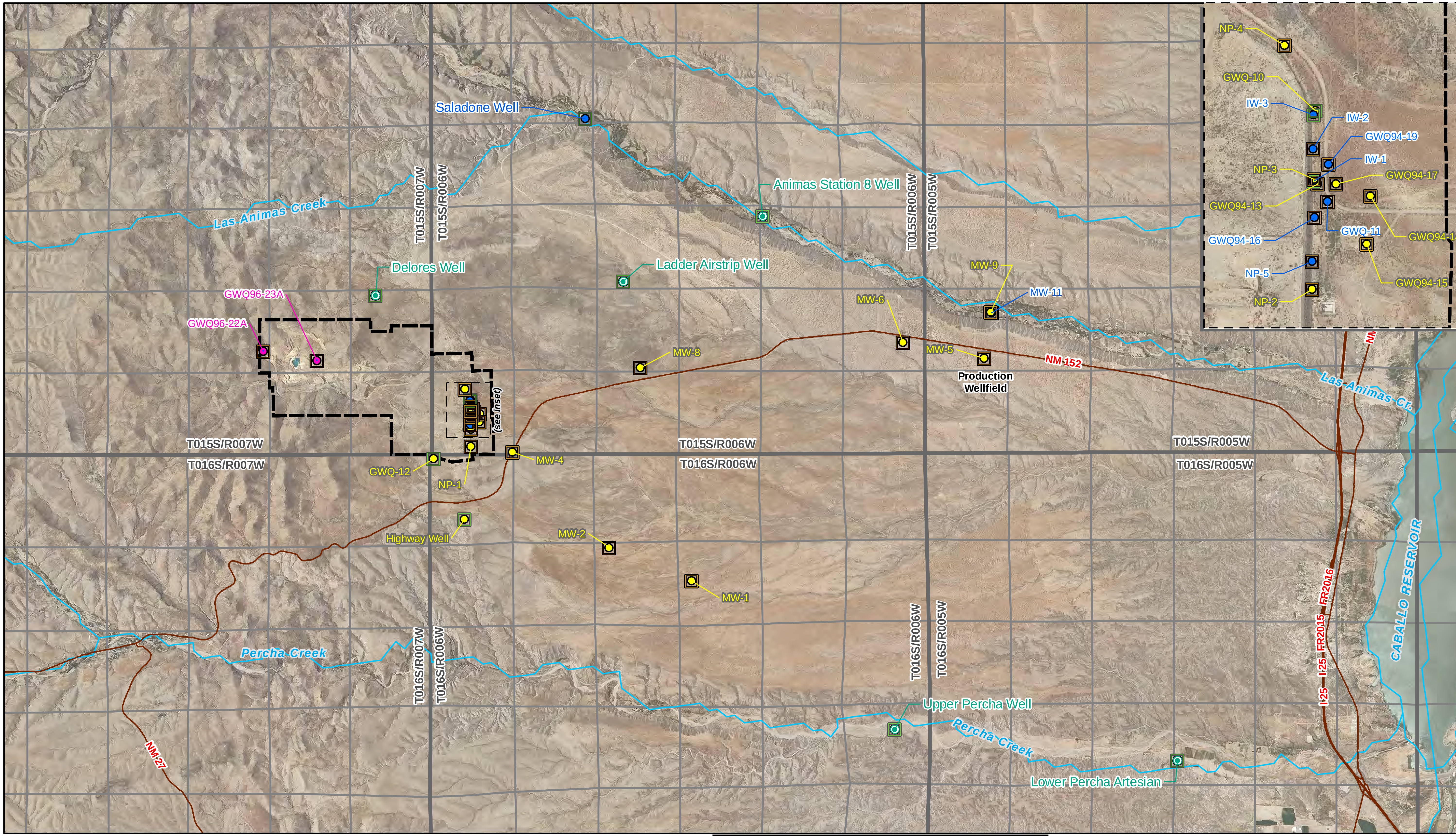


Well Locations:
SRK or OSE
Mine Boundary:
Tom Van Bebber
Imagery Information:
-USGS 7.5-Minutes County DOQQ mosaic
Sierra County, 2009
Projection Information:
-New Mexico State Plane West, NAD 1927

0 3,000 6,000 12,000 18,000
Feet

**Legend**

Proposed Monitoring Well

Aquifer
- Crystalline Bedrock
- Qauternary Alluvium
- Santa Fe Group
- Unknown

- Water Level Only
- Water Level & Water Quality
- Proposed Mine Permit Boundary
- Road

**Figure 9-10**
**Proposed Monitoring Well Program**
**New Mexico Copper Corporation**

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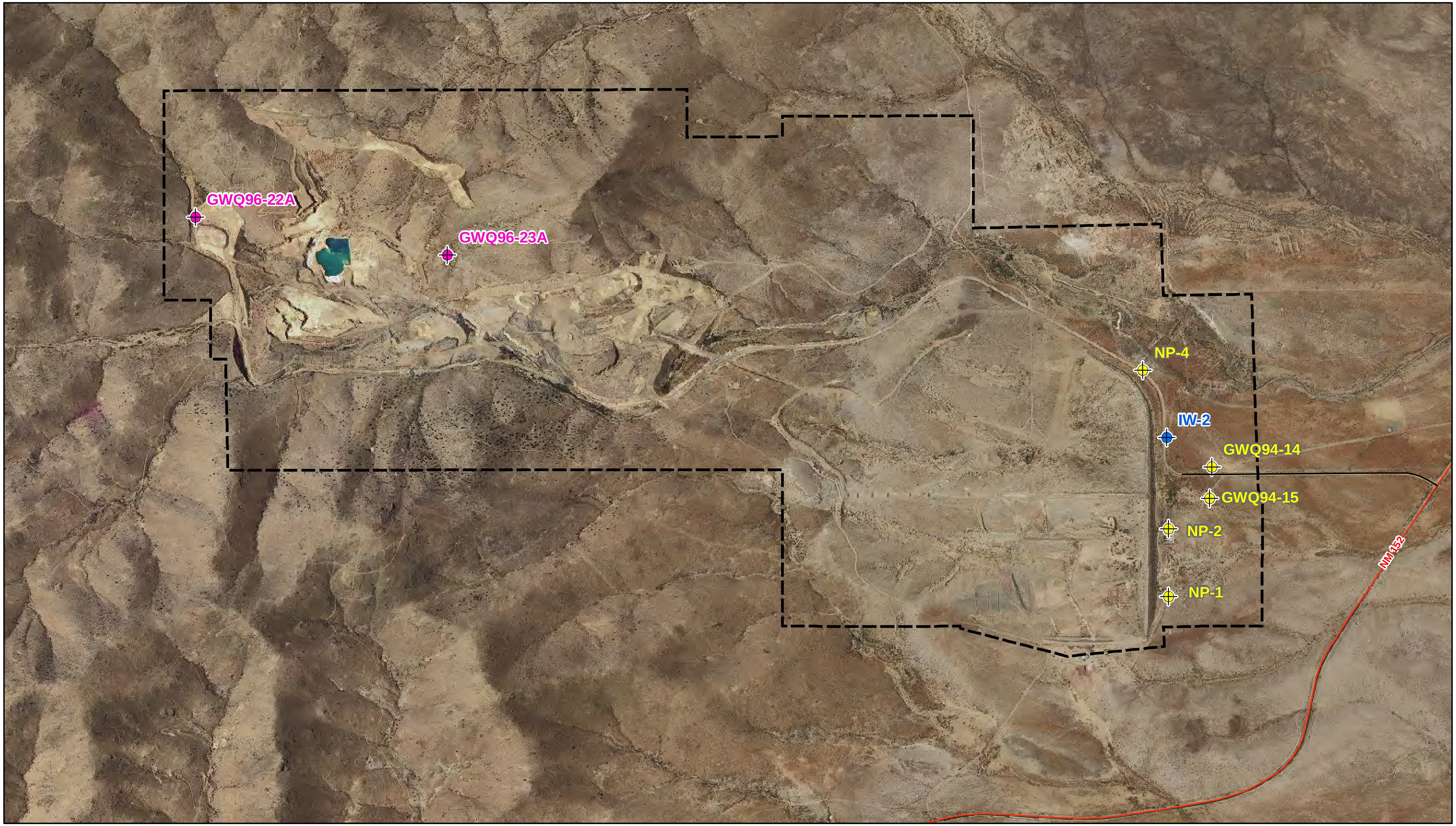


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Mine Boundary:
Tom Van Bebber
Imagery Information:
-USGS 7.5-Minutes County DOQQ mosaic
Sierra County, 2009
Projection Information:
-Geographic, WGS 1984

INTERA

0 750 1,500 3,000 4,500
Feet

Legend

Aquifer
Crystalline Bedrock
Qauternary Alluvium
Santa Fe Group
Proposed Mine Permit Boundary
Road

**Figure 9-11**
**Wells Sampled in January 2010**
**New Mexico Copper Corporation**

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# Tables

**Table 9-1**

**Groundwater Sampling and Data Analysis Plan**

| Proposed Activity | Purpose of Activity |
|---|---|
| Perform a field verification survey of monitoring wells identified by previous investigators, measure depths to water and total depths of wells. | Confirm existing monitor well network in order to evaluate need for additional wells in key aquifers and finalize baseline monitoring well network |
| Install background monitoring wells in Santa Fe and alluvial aquifers. | Establish background water quality for Santa Fe Group and alluvial aquifers |
| Continue water level measurement and sampling of groundwater monitoring network. | Establish baseline (pre-mining) water quality and water levels for the Bedrock, Santa Fe Group, and Alluvial Aquifers |
| Install additional monitor wells as necessary to meet to address data gaps | Further define potential impacts from earlier mining activities and obtain additional pre-mining water levels |
| Determine hydraulic parameters for Bedrock, Santa Fe Group, and Alluvial aquifers | Obtain necessary input for groundwater model to evaluate drawdown from mine dewatering and production well activities |

**Table 9-2**

**Proposed Monitoring Wells for Water Quality Sampling and Water Level Measurements**

| Well Name | Total Depth (ft bgs) | Top of Screen (ft bgs) | Bottom of Screen (ft bgs) | Year Drilled | Diameter (inches) | Inferred Aquifer | Water Quality Sample | Water Level Measurement |
|---|---|---|---|---|---|---|---|---|
| Animas Station 8 Well | NA | NA | NA | NA | NA | ND | | X |
| Delores Well | NA | NA | NA | 1932 | NA | ND | | X |
| GWQ-10 | 121.0 | NA | NA | 1981 | 3 | Santa Fe Group | | X |
| GWQ-11 | 84.5 | NA | NA | 1981 | 3 | Quaternary Alluvium | | X |
| GWQ-12 | 130.0 | NA | NA | 1981 | 3 | Santa Fe Group | | X |
| GWQ94-13 | 112.0 | 74.0 | 104.5 | 1994 | 5 | Santa Fe Group | X | X |
| GWQ94-14 | 158.0 | 127.5 | 157.5 | 1994 | 5 | Santa Fe Group | X | X |
| GWQ94-15 | 148.0 | 112.0 | 142.0 | 1994 | 5 | Santa Fe Group | X | X |
| GWQ94-16 | 45.0 | 25.0 | 45.0 | 1994 | 5 | Quaternary Alluvium | X | X |
| GWQ94-17 | 158.0 | 120.0 | 150.0 | 1994 | 5 | Santa Fe Group | X | X |
| GWQ94-18 | 60.0 | 10.0 | 50.0 | 1994 | 4 | Quaternary Alluvium | X | X |
| GWQ94-19 | 54.0 | 10.0 | 50.0 | 1994 | 4 | Quaternary Alluvium | X | X |
| GWQ96-22A | 240.0 | 170.0 | 240.0 | 1996 | 2 | Bedrock | X | X |
| GWQ96-23A | 100.0 | 50.0 | 100.0 | 1996 | 2 | Bedrock | X | X |
| Highway Well | NA | NA | NA | 1934 | NA | Santa Fe Group | | X |
| IW-1 | 49.0 | NA | 49.0 | 1982 | 4 | Quaternary Alluvium | | X |
| IW-2 | 45.0 | NA | 45.0 | 1982 | 4 | Quaternary Alluvium | X | X |
| IW-3 | 45.0 | NA | 45.0 | 1982 | 4 | Quaternary Alluvium | | X |
| Ladder Airstrip Well | NA | NA | NA | NA | NA | ND | | X |
| Lower Percha Artesian | NA | NA | NA | NA | NA | ND | | X |
| MW-1 | 1000.0 | 350.0 | 1000.0 | 1975 | 8 | Santa Fe Group | X | X |
| MW-11 | 65.0 | 12.0 | 32.0 | 1994 | 8 | Quaternary Alluvium | X | X |

| Well Name | Total Depth (ft bgs) | Top of Screen (ft bgs) | Bottom of Screen (ft bgs) | Year Drilled | Diameter (inches) | Inferred Aquifer | Water Quality Sample | Water Level Measurement |
|---|---|---|---|---|---|---|---|---|
| MW-2 | 1500.0 | 133.0 | 1500.0 | 1975 | 8 | Santa Fe Group | X | X |
| MW-4 | 2000.0 | 123.0 | 1500.0 | 1975 | 8 | Santa Fe Group | X | X |
| MW-5 | 1380.0 | 306.0 | 1000.0 | 1975 | 8 | Santa Fe Group | X | X |
| MW-6 | 1112.0 | 310.0 | 1000.0 | 1975 | 8 | Santa Fe Group | X | X |
| MW-8 | 1004.0 | 366.0 | 1000.0 | 1975 | 8 | Santa Fe Group | X | X |
| MW-9 | 250.0 | 200.0 | 250.0 | 1994 | 8 | Santa Fe Group | X | X |
| NP-1 | 115.0 | NA | 106.0 | 1981 | 4 | Santa Fe Group | X | X |
| NP-2 | 115.0 | NA | 110.0 | 1981 | 4 | Santa Fe Group | X | X |
| NP-3 | 109.5 | NA | 100.0 | 1981 | 4 | Santa Fe Group | X | X |
| NP-4 | 117.0 | NA | 117.0 | 1981 | 4 | Santa Fe Group | X | X |
| NP-5 | 44.0 | 24.0 | 39.0 | 1981 | 4 | Quaternary Basalt | X | X |
| Saladone Well | NA | NA | NA | NA | NA | Quaternary Alluvium | | X |
| Upper Percha Well | NA | NA | NA | NA | NA | ND | | X |

**Notes:**

NA = not available

ND = not determined

**Table 9-3**

**Analytical Parameters and Analysis Methods for Groundwater Samples**

| Analytical Parameter | Analysis Method | Lab Detection Limit (mg/L unless noted) |
|---|---|---|
| **Anions** | | |
| Fluoride | EPA Method 300.0 | 0.1 |
| Chloride | EPA Method 300.0 | 0.1 |
| Nitrogen, Nitrite (as N) | EPA Method 300.0 | 0.1 |
| Nitrogen, Nitrate (as N) | EPA Method 300.0 | 0.1 |
| Sulfate | EPA Method 300.0 | 0.5 |
| **Dissolved Metals** | | |
| Aluminum | EPA Method 200.7 | 0.02 |
| Antimony | EPA Method 200.8 | 0.005 |
| Arsenic | EPA Method 200.8 | 0.02 |
| Barium | EPA Method 200.7 | 0.002 |
| Beryllium | EPA Method 200.7 | 0.002 |
| Boron | EPA Method 200.7 | 0.04 |
| Cadmium | EPA Method 200.7 | 0.002 |
| Calcium | EPA Method 200.7 | 0.50 |
| Chromium | EPA Method 200.7 | 0.006 |
| Cobalt | EPA Method 200.7 | 0.006 |
| Copper | EPA Method 200.7 | 0.0003 |
| Iron | EPA Method 200.7 | 0.02 |
| Lead | EPA Method 200.7 | 0.005 |
| Magnesium | EPA Method 200.7 | 0.50 |
| Manganese | EPA Method 200.7 | 0.002 |
| Mercury | EPA Method 7470 CVAA | 0.0002 |
| Molybdenum | EPA Method 200.7 | 0.008 |
| Nickel | EPA Method 200.7 | 0.01 |
| Potassium | EPA Method 200.7 | 1.0 |
| Selenium | EPA Method 200.8 | 0.02 |
| Silicon | EPA Method 200.7 | 0.08 |
| Silver | EPA Method 200.7 | 0.005 |
| Sodium | EPA Method 200.7 | 0.5 |

| Analytical Parameter | Analysis Method | Lab Detection Limit (mg/L unless noted) |
|---|---|---|
| Thallium | EPA Method 200.7 | 0.01 |
| Titanium | EPA Method 200.7 | 0.005 |
| Uranium | EPA Method 200.8 | 0.01 |
| Vanadium | EPA Method 200.7 | 0.005 |
| Zinc | EPA Method 200.7 | 0.005 |
| **Solids** | | |
| Total Suspended Solids (TSS) | SM 2540D | 1.0 µg/L |
| Total Dissolved Solids (TDS) | SM 2540C | 10 |
| **Alkalinity** | | |
| Alkalinity, total (as $CaCO_3$) | SM 2320B | 20 |
| Carbonate | SM 2320B | 20 |
| Bicarbonate | SM 2320B | 20 |
| **Other** | | |
| pH | 150.1 | 12.45 |
| Specific Conductance | 120.1 | 0.01 µS/cm |
| Cyanide | Kelada-01 | 0.005 |

**Note:** NA = not applicable as sample will not be analyzed for a given parameter.

**Table 9-4**
**Groundwater System Characteristics (from SRK, 1995)**

| Unit | Crystalline Bedrock | Santa Fe Group System | Quaternary Alluvium |
|---|---|---|---|
| Material | Rock | Alluvium | Alluvium |
| $K_h$ (ft/yr) | 10 | 1,000 – 4,000 | ~78,000 |
| $K_v$ (ft/yr) | 10 | 1-40 | ~7 |
| Porosity | 2% | 25% | 25% |
| Storage Coefficient | 1% | 0.1 – 0.001% | 0.1% |
| Depth of Unit | >2,000’ | 0 – 2,000’+ | ~30’ |
| Depth to Water | 0’-50’ | 50’-300’ | ~5’ |
| Notes | Variable, fractured | Higher K to east; heterogeneous | Perched, low communication |

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# 10 Historical and Cultural Properties Survey

Several cultural resources surveys have been conducted at the Copper Flat Mine Permit Area (Site) since 1976. The initial surveys were conducted for the 1977 and 1978 environmental assessments (Glover, 1977; BLM, 1978). A subsequent Class III (100-percent pedestrian coverage) cultural resources survey was conducted by Mariah Associates for Gold Express in 1991 (Evaskovich and Higgins, 1991). In response to comments from the New Mexico State Historic Preservation Officer (SHPO) in August 1995, Alta contracted with Human Systems Research of Las Cruces to resurvey all of the undisturbed portions of the Project not covered by the 1991 survey. The results of this survey were filed with the SHPO in October 1995 (Sechrist and Laumbach, 1995). SHPO representatives have indicated that a new survey of the undisturbed areas may not be needed at this time. Because the most recent survey was conducted more than 10 years ago, the lead federal agency for cultural resource compliance review (Bureau of Land Management [BLM]) and SHPO will review the previous surveys for sufficiency and consistency with current standards for survey investigations. This review will also consider the probability of new sites having become exposed in the interim through processes such as dune formation or movement. If it is determined that a new pedestrian survey is not needed prior to construction, the fieldwork effort for cultural resources likely will be limited to revisiting previously recorded sites to evaluate their current condition and to reassess potential impacts to these resources from the proposed Project.

A number of prehistoric and historic sites eligible for listing in the National Register of Historic Places have been identified at the Site. Where possible, identified sites will be avoided by modifying the design of project components. For sites that might be impacted by the Project, and for which avoidance is not feasible, the New Mexico Copper Corporation (NMCC) will contract with qualified archaeologists to prepare a recovery plan to collect appropriate data and to minimize and mitigate adverse effects to cultural resources resulting from the Project. The recovery plan will be implemented following approval by the BLM and SHPO and prior to construction.

The following subsections assume that a new Class III survey of the undisturbed areas of the Project will be required. They are not applicable if it is determined that no cultural resources survey of the area is necessary at this time.

## 10.1 Introduction and Background

By obtaining knowledge of the local cultural history prior to conducting surveys, cultural resource specialists are better able to identify and interpret findings. Understanding the material and spatial correlates of different culture groups through time ensures that cultural items identified during survey are placed and interpreted in the proper context. The cultural-historical sequence for western Sierra County is generally described in terms of five different time periods:

- Paleoindian (9500 to 6000 B.C.)
- Archaic (6000 B.C. to A.D. 200)
- Formative (A.D. 200 to 1400)
- Protohistoric (A.D. 1400 to 1540)
- Historic (A.D. 1540 to 1960)

Paleoindian sites are poorly represented within the archaeological record for western Sierra County, probably because the basins to the east, north, and south provided better hunting grounds for the mobile hunters of this time period, whose subsistence practices were focused on now-extinct Pleistocene megafauna. However, previous archaeological research in the area has documented evidence of relatively consistent prehistoric occupation during the Archaic and Formative periods (Evaskovich and Higgins, 1991; Laumbach and Kirkpatrick, 1983; Lekson, 1985; Sechrist and Laumbach, 1995).

The most prevalent archaeological sites in the general area are related to historical mining activities. Gold was discovered in the Hillsboro area in 1877 (Harley, 1934) and subsequent historical mining sites include test pits, shafts, stone-walled cabins, dugouts, tent bases, and abandoned settlements (Sechrist and Laumbach, 1995).

An historical Apache occupation in the area is indicated by the identification of a chipped-glass artifact during a previous survey (Bussey and Naylor, 1975) and the presence of gun-ports in a stone cabin at another site (Evaskovich and Higgins, 1991).

Four previous surveys have been conducted within the vicinity of the proposed project area:

- A reconnaissance survey of approximately 6 square miles was conducted by the New Mexico State University Cultural Resources Management Division (CRMD) in 1975 (Bussey and Naylor, 1975).
- A survey of the power line and water line corridors providing utilities to the mine, an access road, and related industrial sites was performed by the CRMD in 1977 (Breathauer and Hoyt, 1977).
- A Class III (100-percent coverage) pedestrian survey of 147 hectares (363.3 acres) on the eastern slope of Animas Peak was conducted by Evaskovich and Higgins in 1991.
- A 229-hectare (565-acre) Class III pedestrian survey of the Copper Flat area was conducted by Human Systems Research, Inc. (HSR) in 1995 (Sechrist and Laumbach, 1995).

This latter survey is of particular interest for the purposes of the current investigation, as 16 archaeological sites and 212 isolated occurrences were documented at that time. Ten of these sites are historical artifact scatters with associated mining and/or habitation features. These include one standing structure, one stone foundation, one tent camp, one mine tunnel, two locations identified as potentially containing graves, and several artifact scatters. The remaining sites consist of 4 flaked-stone artifact scatters, 1 site with evidence of both prehistoric and historic occupations, and 1 prehistoric petroglyph site. The flaked-stone artifact scatters were reported as likely representing Archaic remains based on the presence of diagnostic artifacts and the overall technological attributes of the assemblages (Sechrist and Laumbach, 1995).

NMCC expects that the sites recorded during HSR's 1995 survey will comprise the majority of the cultural resources identified during the current investigation. However, a few new sites may be discovered; these will likely be consistent in type to those previously recorded.

## 10.2 Sampling Objectives

Because the project area includes federally administered land and entails land modification activities, the proposed activity is subject to Section 106 of the National Historic Preservation Act (NHPA, P.L. 89-665, as amended). The NHPA requires consideration of the effects that a proposed undertaking may have on historic properties as defined by this legislation.

The purpose of the cultural resource investigation will be to locate and assess all cultural resources and historic properties within the area of potential effects (APE). The APE—and any potential sampling strategy—will be defined in consultation with the BLM and SHPO. However, surveys conducted for land-modifying undertakings are typically intensive (100-percent pedestrian coverage) and sampling is not a common strategy. That said, standard transect intervals vary between 5 and 15 meters (m) (16 and 49 feet [ft]) and may be considered a limited opportunity to increase or decrease the degree of field review. As with the definition of the APE, the width of the proposed survey intervals will be determined in consultation with the BLM and SHPO. In addition, a large percentage of the project area has been extensively disturbed by previous mining activities and the agencies may consider a less-intensive sampling strategy (e.g., 30-m [98-ft] transects) in these areas, or may eliminate them from the survey entirely.

## 10.3 Sampling Frequency

As stated above, NMCC anticipates conducting an intensive pedestrian survey of the APE that will be limited to a single-episode field investigation and recording effort. Transects may vary, but are likely to be 15 m (49 ft) in width for the entire APE. This technique is the standard for all cultural resource investigations on BLM property and on lands administered by the State of New Mexico.

## 10.4 List of Data to be Collected

Unless otherwise directed by the BLM and SHPO, no artifacts or other cultural materials will be collected during the proposed investigation. All data will be recorded in the field and all cultural materials will be left in place.

The types of properties or data that may be encountered during the survey of the Site include, but are not limited to, archaeological sites, historical cultural properties (historical period buildings, structures, or objects over 50 years old), historical districts, and isolated manifestations (IMs). An assessment will be made for each resource as to its potential eligibility for nomination to the National Register of Historic Places (NRHP).

## 10.5 Methods of Collection

Prior to conducting the survey, cultural resource specialists will complete a pre-field records review of the New Mexico Cultural Resources Information System (NMCRIS) database, to obtain information about previously recorded archaeological sites and surveys in the project area and vicinity. In addition, current listings of the NRHP and the New Mexico State Register of Cultural Properties (NMSRCP) will be consulted to determine the known presence of any listed cultural properties or districts within and in the vicinity of the project area. We will also consult with the BLM Las Cruces Field Office to compare the BLM's records with the findings from the other databases.

Resource locations shown on the Hillsboro, NM (1985) and Skute Stone Arroyo, NM (1961) 7.5-minute U.S. Geological Survey (USGS) quadrangle maps will be obtained through the use of Global Positioning System (GPS) receivers. Universal Transverse Mercator (UTM) coordinates will be obtained using both North American Datum (NAD) 27 and NAD 83 projections on a Trimble GeoXM GPS receiver with a positional accuracy of less than 1 m (3.28 ft). Shapefiles of the project area will be created using a geographic information system (GIS) and uploaded to the Trimble GeoXM for cross-referencing purposes. Using ArcPad software, surveyors will follow project boundaries to ensure adequate coverage of the entire survey area. The survey will be conducted by walking parallel transects spaced 15 m (50 ft) apart throughout the entire survey corridor. The GPS-derived locations for IMs and sites will be verified by reference to landscape features and landmarks shown on the USGS quadrangles. All GPS data will then be differentially corrected for sub-meter accuracy.

### 10.5.1 Site Definition

The definition of a site will follow current BLM guidelines (BLM, 2005), which state that a site is a physical location of past human activities or events, and which further define IMs as sites with fewer than 10 artifacts or a single, undatable feature. Features that may have datable remains, such as deflated thermal features, are also recorded as IMs if they retain little or no integrity and have no associated artifacts.

Following BLM guidelines, sites will be further classified as to whether they are Category 1 or 2, following the current definition in the above-cited guidelines. Category 1 sites are defined as those whose significance lies solely in their potential to yield information under NRHP eligibility Criterion D. These sites are further defined as having small numbers of artifacts (fewer than 15). In addition, they may be classified as containing few or no features (such as soil stains), with no potential for buried cultural deposits (either demonstrated through limited testing or through surface observations—such as when a given site is on bedrock). Category 2 sites are defined as all other sites not falling under the definition of Category 1 sites (BLM Manual Supplement H-8100-1, New Mexico, Oklahoma, and Texas).

### 10.5.2 Site Recording

All sites will be recorded on Laboratory of Anthropology (LA) Site Record forms. Previously recorded sites are updated using the same form. Supplemental analysis forms are used to record prehistoric and historic artifacts, provide adequate descriptive information for each assemblage, and assign cultural/temporal affiliation, if possible.

Cultural and temporal affiliations will be assigned to sites with diagnostic artifacts and/or features on the basis of widely accepted type descriptions. Complete projectile points and point fragments will be sketched in the field for later typological classification, or to confirm in-field classification. Personnel do not, as a general practice, sketch all diagnostic sherds in the field. Because typological classification of these artifacts is based on numerous technological attributes (e.g., paste color and texture, temper type and size, surface smoothing or polish, and use of mineral or carbon paint) that cannot be efficiently represented in a field sketch for later analysis (in contrast to the primarily morphological attributes of projectile point types), we rely instead on professional experience to conduct in-field analysis of ceramics. Our field crews use field manuals that provide ceramic type descriptions and completed ceramic analysis forms that include entries for typological classification and for various technological and design attributes for artifacts that cannot be confidently classified as to type.

To facilitate relocation, each site will be plotted on the appropriate 7.5-minute USGS quadrangle map and labeled with its LA site number. The location of IMs, site datums, and site boundaries are recorded using a Trimble GeoXM GPS receiver and plotted on the appropriate 7.5-minute USGS quadrangle. Roadcuts and other forms of disturbance are recorded with the GPS receiver at all sites that were designated as having either an eligible or undetermined status regarding inclusion in the NRHP. All GPS data are post-field processed for sub-meter accuracy. The GPS-derived locations for IMs and sites are also verified by reference to landscape features and landmarks shown on the quadrangle maps.

A planview map, drawn to scale, will be prepared for each site and include the following information:

- The assigned LA site number
- The site boundaries and datum location
- A north arrow, scale, and legend
- The location of identified features and the distribution of artifacts
- The location of temporally diagnostic artifacts
- The relationship of site boundaries and cultural remains to known project impact areas, such as roads, and to surrounding environmental features
- The location of photograph points
- The APE boundary

In addition to photographing an overview of the Site, photographs will be taken when necessary for Site documentation, such as when features are visible on sites. Photographs will be logged and their locations plotted on Site sketch maps. Drawings of features and individual diagnostic artifacts will also be produced when applicable.

A site marker will be placed at each of the newly discovered sites. The marker on each site will consist of an aluminum cap attached to a 12-inch piece of rebar. Each marker will be placed within close proximity of the site and noted on the Site planview map.

### 10.5.3 Isolated Manifestation Recording

Locations with fewer than 10 artifacts or a single, undatable feature are considered IMs. Features that may have datable remains, such as deflated or poorly defined thermal features, are also recorded as IMs if they retain little or no integrity and have no associated artifacts. IMs are plotted on the appropriate 7.5-minute USGS quadrangle map and verified with a GPS receiver in the same manner as described for site locations. IMs are documented on IM recording forms. Information recorded for IMs include the area (for IMs consisting of more than one artifact), artifact types, measurements, frequencies, and sketches of diagnostic artifacts.

### 10.5.4 Mapping

Mapping of the project area and its resources will be supported by state-of-the-art equipment, including Trimble GPS receivers with submeter accuracy and a Nikon Total Station, along with the newest software including TerraSync and ArcPad 7x. One of the advantages for this technology is that it allows us to produce archaeological site maps that are more accurate and scalable than those created through traditional methods. Using ArcGIS 9x, geo-referenced digital site data can be related to land-use plans and quickly and cost-effectively display how changes or revisions to any undertaking will affect cultural resources. These highly accurate data will be critical in ensuring that the proposed mining activities are in compliance with Section 106 of the NHPA.

At a minimum, the Universal Transverse Mercator coordinates of all IMs, site datums, features, selected artifacts, and site boundaries will be recorded using a handheld Trimble GPS receiver. All spatial data and descriptive information will be stored on the Trimble unit using TerraSync software and data dictionaries produced with Pathfinder Office software. These files are easily copied to desktop computers in the lab where Site maps and Site plans will be generated using ArcGIS 9x. As directed, all data will be provided in applicable GPS-derived shapefiles. All data distribution and management will be in accordance with applicable regulations such as those found in the BLM Manual (2005), Section 304 of the NHPA, Executive Order 13007, and 43 CFR 7.18.

### 10.5.5 Historical Cultural Properties

In-use historical buildings, structures, and objects will be recorded using the New Mexico Historic Cultural Properties Inventory (HCPI) form. Each building or structure will be photographed and its location recorded with the GPS receiver. Form 1 of the HCPI will be completed for all historical buildings. Form 2 will be completed only for historical buildings that are recommended as being eligible to the NRHP. Acequias will be recorded on the Historic Water Delivery System Inventory Form. These resources will be photographed and their locations recorded with the GPS receiver.

The APE will be evaluated for potential districts and/or landscapes before, during, and after fieldwork using standards outlined in the New Mexico Register (Volume XVI, Issue Number 15, August 15, 2005) and the National Park Service (NPS) National Register Bulletin 30 (McClelland et al., 1999). Other materials used to guide the identification of districts and landscapes include NPS Preservation Brief 36 (Birnbaum, 1994) and the Historic Transportation Corridors thematic issue of Cultural Resource Management (Reilly, 1993). These documents, developed primarily by the NPS, define “landscape,” as a site or a district (36 CFR 60.2) in contrast to terms related to eligibility for the NRHP.

As suggested by the NPS in Bulletin 30 (McClelland et al., 1999), researchers define any potential landscape through their choices of historical contexts, period or periods of significance, potential boundaries, and contributing or non-contributing elements. Defined landscapes are more difficult to characterize than buildings or structures with readily definable physical features and boundaries. However, many landscapes do have tangible features and landscape characteristics resulting from human use.

## 10.6 Parameters to be Analyzed

All cultural resources encountered during the investigation will be evaluated in terms of their eligibility for listing in the NRHP, using the implementing regulations provided in 36 CFR Part 60.4. Furthermore, project-specific treatment recommendations will be provided for all NRHP-eligible cultural resources that may be subject to adverse effects from the proposed undertaking. Traditional cultural properties will be evaluated following guidance provided in National Register Bulletin 38 (Parker and King, 1998). Human remains and associated funerary objects will be treated in accordance with the Native American Graves Protection and Repatriation Act. All assessments will be conducted in close consultation with the BLM, SHPO, and other appropriate consulting parties.

In most cases, the treatment recommendations for cultural resources will include the following statement:

*It is recommended that all project-related activities avoid any cultural resources determined to be eligible for inclusion in the NRHP. If total avoidance is feasible, subject to consultation and comment, the proposed undertaking will have no effect on the documented cultural resources. If complete avoidance is not possible, but the undertaking only affects portions of the sites that lack integrity, the proposed undertaking should have no adverse effect on the qualities that qualify the resources for inclusion in the NRHP. However, if avoidance of potentially intact portions of the site areas is not feasible, then one of two actions is recommended to minimize and mitigate potential adverse effects: (1) The project proponent should prepare a testing and data recovery plan per the New Mexico Administrative Code (NMAC) 4.10.8 and to the standards within NMAC 4.10.16, or (2) the project proponent should prepare a monitoring plan prior to construction per NMAC 4.10.17.11. Either plan should be implemented per agency standards, the NMAC, and in consultation with the SHPO and the Cultural Properties Review Committee (if warranted).*

## 10.7 Map Showing Proposed Sampling Locations

Figure 10-1 illustrates the extent of the mine property. All shaded (yellow) areas will be recommended as the APE—and thus the extent of field investigations, should the BLM and SHPO determine that a survey is required.

## 10.8 Laboratory and Field Quality Assurance Plans

Accurate work and timely deliverables will be provided. Reporting will follow the standards in BLM manual H-8100-1, Chapter 1.B.1 and Appendix 2 (2005). In addition, work will be performed in compliance with all aspects of the NMAC, including NMAC 4.10.15.

## 10.9 Discussion in Support of Sampling Proposal

As stated earlier, sampling is not considered a standard strategy for cultural resource investigations in New Mexico. That said, the extent of recent disturbance at the Site may allow for a reduction in the size of the APE defined by the lead and consulting agencies, or a waiver of the requirement to conduct survey. However, within any area that is determined to require survey, NMCC anticipates using a standard 15-m (49-ft) transect interval, which is otherwise defined as an intensive Class III survey. Any modification to the APE, the survey parameters, or the data collection efforts will be the result of consultation with the BLM and the SHPO.

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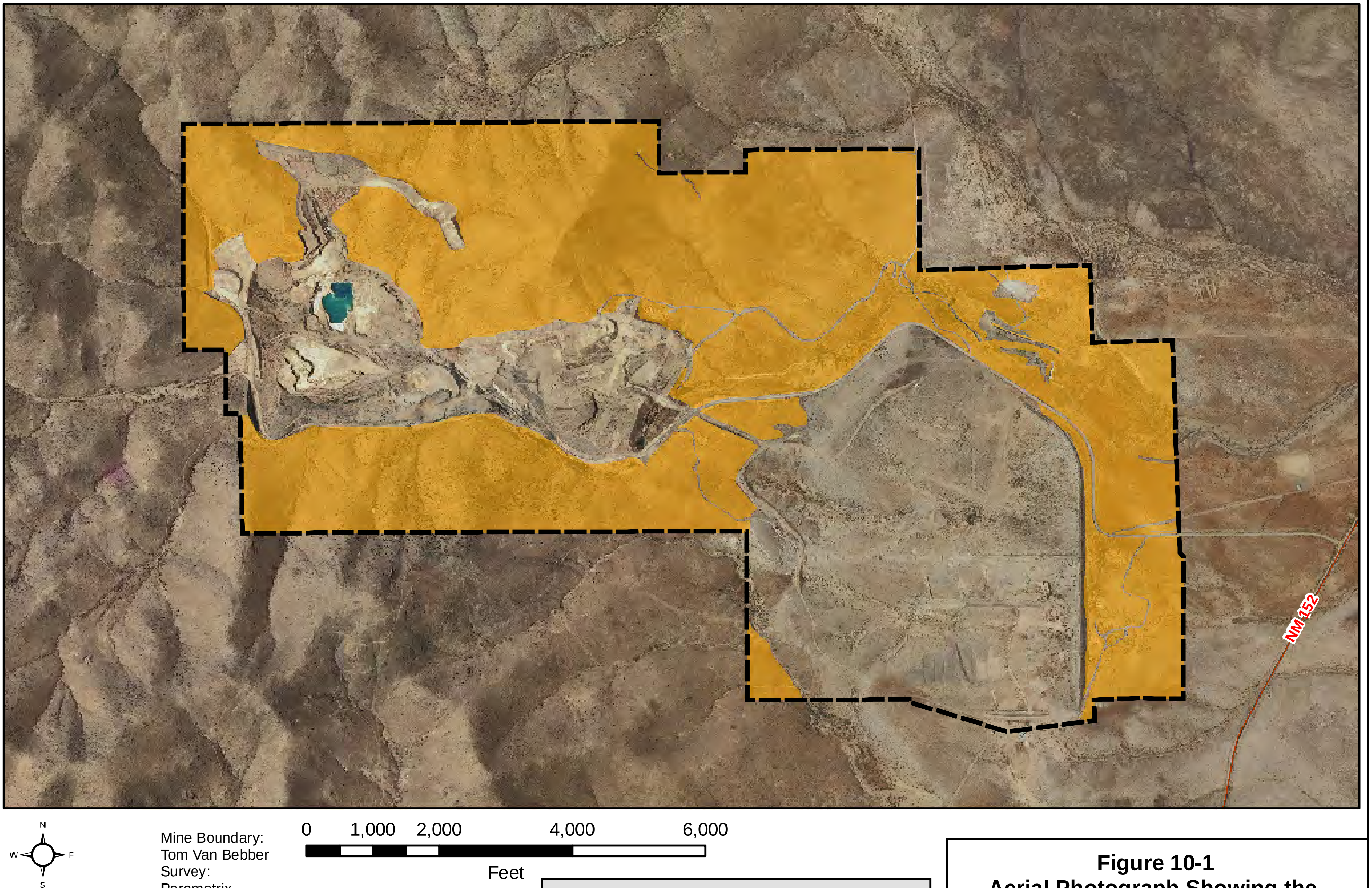
**Figure**




Mine Boundary:
Tom Van Bebber
Survey:
Parametrix
Imagery Information:
-USGS 7.5-Minutes County DOQQ mosaic
Sierra County, 2009
Projection Information:
-New Mexico State Plane West, NAD 1927

**Legend**

Proposed Mine Permit Boundary
Proposed Cultural Resources Survey Area

**Figure 10-1**
**Aerial Photograph Showing the Proposed Survey Area for Cultural Resources Investigation**

**New Mexico Copper Corporation**

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# 11 Present and Historical Land Use

The information in this section is summarized primarily from SRK Consulting (2010) and the U.S. Bureau of Land Management (BLM) (1999). An online review of BLM Master Title Plats and land status on GeoCommunicator, the National Integrated Land System (http://www.geocommunicator.gov/GeoComm/index.shtm) was also performed to check the current status of rights of way (ROW) and other activities on BLM lands.

The Copper Flat Mine Permit Area (Site) and associated noncontiguous mill site claims are located between the communities of Caballo and Hillsboro, north of NM State Highway 152 and south of Animas Peak. It is covered by the Hillsboro 15-minute U.S. Geological Survey (USGS) quadrangle and occupies parts of Sections 30 and 31, Township 15 South, Range 5 West (T15S, R5W); Sections 30 and 31, T15S, R6W; Sections 23 through 27 and 34 through 36, T15S, R7W; Section 6, T16S, R6W; and Section 2, T16S, R7W (all with reference to the New Mexico Principal Meridian). Some of the noncontiguous mill site claims are outside the permit boundary and are associated with water rights and water wells approximately 8 miles east of the Site. The center of the mineralized zone is at approximately latitude 32.970300, longitude −107.533527.

## 11.1 Present Land Use

### 11.1.1 Land Ownership and Status

According to the 2010 property tax schedule of the Sierra County Assessor, Hydro Resources Corporation (Hydro) and Cu Flat, LLC (Cu Flat) own all of the fee lands within the permit area except as follows:

- Edgar E. Greer ("Greer") owns the fee surface estate in the lands within the permit area in Sections 30 and 31, Township 15 South, Range 6 West, and has contracted to sell his fee surface estate to Ryan G. and Wendy M. Fancher (the "Fanchers"). The mineral estate in such lands is owned by the United States and is subject to unpatented mining claims owned by Hydro and GCM, Inc. (GCM).
- Greer owns the fee surface and mineral estates in the Cincinnati, Graf Von Luxenburg, and Prosper patented mining claims in Sections 25 and 36, Township 15 South, Range 7 West, and has contracted to sell such claims to the Fanchers.
- The non-fee lands within the permit area are owned by the United States. All such lands are subject to unpatented mining claims owned by Hydro and GCM.

All of the fee lands and unpatented mining claims within the permit area owned by Hydro, Cu Flat, and GCM are subject to the Option and Purchase Agreement described in Section 1.2.5.

NMCC holds an exclusive option to acquire the Copper Flat properties under an Option and Purchase Agreement effective July 23, 2009 (amended on January 10, 2010; April 1, 2010; May 28, 2010; and August 2, 2010). All option payments to date have been made; an additional payment is due in September 2010, and the final payment is to be made in 2011. The Agreement specifies that after its option is exercised NMCC will pay quarterly royalties to Hydro Resources and GCM. The lands covered by the Agreement are not subject to any other royalties, payment obligations, other agreements or encumbrances, or to any back-in rights. However, NMCC must pay New Mexico property taxes on fee and producing the Copper Flat properties and pay the U.S. fees required to maintain the unpatented mining claims and mill sites.

Figure 11-1 shows the property ownership of the Site as of June 23, 2010. Hydro Resources owns the surface and mineral estates the patented mining claims subject to the Option and Purchase Order Agreement. In addition to the surface and mineral estates shown in Figure 11-1, noncontiguous mill site claims located east of the Site that are owned by Hydro Resources and subject to the Option and Purchase agreement are shown in

Figure 11-2. Cu Flat, another of the optioners, owns the surface and mineral estates in the parcels of other fee land included in the Copper Flat property and the surface estate in three other parcels of other fee land. Hydro Resources has title to the surface rights in 132 unpatented mining claims included in the Copper Flat Property and in nine unpatented mill sites outside the permit boundary. Hydro Resources owns an undivided two-thirds interest in the surface rights as well as in the mining rights in 44 unpatented mining claims included in the Copper Flat Property, and GCM, also a vendor to NMCC, owns an undivided one-third interest in the surface and mining rights in those 44 claims. The United States has retained rights to manage and dispose of plant resources and to manage other non-mineral surface resources on the unpatented mining claims.

State lands would not be directly affected by the operation, although a portion of the mine access road in T15S, R6W, Section 32, passes through State Trust lands. Several sections of State land also exist south of the tailings impoundment dam (T16S, R6W, Section 6) and to the west and east of the existing well field (T15S, R6W, Section 36, and T15S, R5W, Section 32, respectively).

Lands adjacent to the Site include federal, state, and private property. Although there are several nearby placer claims held by rock clubs for recreational collecting, there are no known adjacent properties with mineralization similar to that of the Copper Flat Mine.

### 11.1.2 Land Planning and Regional Land Use

Historically, most of Sierra County has been used for mining, ranching, agriculture, and tourism. The public lands on which the unpatented mining claims and mill sites located at the Copper Flat Site are managed by BLM's Las Cruces Field Office. BLM manages public lands for multiple uses including recreation, range, forestry, mineral extraction and processing, watershed, fish and wildlife habitat, wilderness, and natural, scenic, scientific, and historical values. The current operational land use plan for this region is the 1986 White Sands Resource Management Plan, which covers all BLM-administered lands in Sierra and Otero counties; a new plan, the TriCounty Resource Management Plan, is expected to be approved in early 2011. The White Sands Resource Management Plan identifies the Copper Flat Mine as a mineral resource and recognizes that it could again become a producing mine, although no mining has occurred at the Site since 1982.

The town of Hillsboro, located approximately 5 miles southwest of the Site, has around 100 homes as well as several restaurants, other businesses, and government buildings. Truth or Consequences, approximately 20 miles northeast of the Site, has a population of about 8,000 and is the county seat. Few residences lie within 5 miles of the Copper Flat Mine: the Coalson and Clark ranches are located about 4 miles southeast of the Site and the Golddust Ranch is about 0.1 mile south of the mine and north of Highway 152 (formerly used as Quintana's Site headquarters).

### 11.1.3 Current Land Use and Structures at Site

Livestock grazing is the primary ongoing land use in the area of the Site. BLM grazing allotments 16040 and 10679 cover the Site, and livestock grazing is permitted in areas adjacent to the Site.

Except for a small viewing structure and a sample storage building, no buildings currently exist on the Site. A state and federally approved water diversion channel exists around the Site area. A 370-acre tailings pond exists at the Site along with two decant towers. Three dumps that were used for waste rock during the 1982 operation of the mine are located near the perimeter of the pit.

### 11.1.4 Access, Rights of Way, and Water Rights

The Site is accessed from I-25 by 10 miles of paved highway (NM State Highway 152) and about 3 miles of all-weather gravel road. The mine road is gated near the former mine entrance to discourage vehicular access.

Several other unimproved roads provide access to portions of the Site; however, the tailings area is fenced to limit movement of people and cattle.

Electric power in the area is supplied by Sierra Electric Co-op. An existing 115-kilovolt (kV) transmission line is located in a utility corridor that parallels State Highway 152 from the Caballo switching station to the Site. The original mine operation included a 20-megavolt-ampere (MVA) transformer that stepped the power down to 4.16 kV. A 25-kV power line exists that could be used to carry power from the Site to the water well field previously used for the mine (about 8 miles east of the Site). A 20-inch diameter waterline runs from this well field to the Site. This pipeline has no current ROW agreement, having been abandoned by the former owner, Gold Express Corporation (Gold Express). BLM now owns this line; use rights are currently being negotiated. When Hydro Resources reacquired the Site in 2001, 1,019 acre-feet of water rights were also conveyed. If NMCC exercises its option to acquire the Site, these rights will be transferred to NMCC for use at the mine. Many thousands of acre-feet of additional water rights in the area are owned by third parties; negotiations have been initiated by NMCC to acquire some of these rights (SRK, 2010).

## 11.2 Environmental Liabilities and Permits

The Copper Flat Mine was first permitted by Quintana Minerals (Quintana) during the 1980s. In 1992, a new plan of operations was submitted to BLM and an environmental assessment (EA) was begun by Gold Express, but the operation was never restarted. Alta Gold Company (Alta Gold) acquired the property in the mid-1990s and reinitiated the permitting and approvals process, collecting significant baseline data and submitting applications for all major state and federal permits. Alta Gold declared bankruptcy in early 1999, but not before a draft environmental impact statement (EIS) had been prepared and the associated public comments received; a public hearing had also been held on Alta Gold’s application for a the New Mexico Mining Act Permit and a New Mexico Groundwater Discharge Permit. However, no final permits were issued.

Baseline data collected by Alta Gold, Gold Express, Rio Gold Mining Ltd (Rio Gold), and Quintana is relevant and provides insights for future permitting activity. Five major permits or approvals are needed:

- BLM plan of operation, and subsequent EIS approval
- New Mexico groundwater discharge permit
- New Mexico mining permit
- New Mexico air quality permit
- New Mexico permit for dam construction and operations

These and other permits/approvals are listed in Table 11-1.

## 11.3 Pertinent Historical Land Use

Ore was first discovered in the Hillsboro district in April 1877, and the town of Hillsboro was established that same year. A number of mining claims were patented for the Site between 1892 and the 1940s; these now form most of the private land occupied by the Copper Flat mine.

In 1952, Newmont began exploration in the district for porphyry copper mineralization by drilling nearly 3,599 ft in six angle holes into the Copper Flat Quartz Monzonite (CFQM) (Kuellmer, 1955). Bear Creek drilled another 9,300+ ft in 1958−1959 in 20 widely spaced core holes, hoping to find an enrichment blanket of secondary copper (which was not found). Both the Newmont and Bear Creek drill and assay data is available (Dunn, 1984). Porphyry copper exploration was advanced by Inspiration again in the late 1960s. Inspiration completed 30 core drill holes by 1973, purchased the patented claims, performed metallurgical work, and completed two water wells on the property (Dunn, 1984).

In 1974, Inspiration leased the property to Quintana, which undertook a comprehensive mine development program with metallurgical work, underground drifting, bulk sampling, and drill hole composite testing (all preformed by the Colorado School of Mines Research Center). The program included detailed geologic investigations into the relationship between the breccia pipe and the quartz monzonite host rocks, as well as the relationship between host rocks and mineralization. An EA was initially prepared for state and federal agencies in 1975, but low copper prices caused the project to be shelved from late 1976 until 1979. At that time, processing methods were reviewed and semi-autogenous grinding and copper-molybdenum flotation separation became the basis for subsequent design work. Mineable reserves were estimated at 60 million standard tons (Mst) with 0.42 percent copper and 0.012 percent molybdenum, plus some gold and silver (SRK, 2010).

With Quintana as the overall project manager, the Copper Flat mine began full production in March 1982 at a rated capacity of 15,000 st a day, a waste-to-ore ratio of 1.8:1, and a cut-off grade of 0.25 percent copper. The combination of low copper prices and high interest rates on the financing loan resulted in the mine closing down just 3 months later, at the end of June. During its short operational period, the mine produced 1.48 million standard tons (Mst) of ore containing 7.4 pounds (lbs) of copper, 2,301 ounces (oz) of gold, and 55,955 oz of silver (SRK, 2010). By the end of 1985, the surface facilities equipment had been sold and the site reclaimed as required by state and federal guidelines. However, all structural foundations, power lines, water wells, and in-ground infrastructure were left in place.

Hydro Resources of Albuquerque, New Mexico, acquired the Copper Flat property, including all royalties, from Inspiration in 1989. Rio Gold and Tenneco Minerals (Tenneco) drilled six large-diameter holes in 1990. Gold Express optioned the property in 1993, and then sold it to Alta Gold in 1994 without performing any exploration or development. A preliminary final EIS for the Alta Gold mining project was issued in March 1999, but Alta Gold went bankrupt (due to financial problems with other assets) before any permits were issued. Hydro Resources reacquired all the properties in 2001 along with all royalties. Hydro Resources maintains an archive of information related to the mine, including over 14,000 sample pulps and skeleton core from the Quintana drilling programs (SRK, 2010).

In 2009 and early 2010, NMCC conducted a sample verification program that included pulp reject analysis and drilling, as part of the requirements for a NI43-101 report on the resources at Copper Flat (SRK, 2010). The program was designed to verify different aspects of the mineralization and geology of the deposit, as well as to comply with new reporting requirements. The drill holes were plugged with bentonite and capped with cement, as required by the New Mexico Energy, Minerals and Natural Resources Department (EMNRD) Mining and Minerals Division (MMD). NMCC completed seven drill holes comprising 5,046.5 ft of core. Three of the drill holes terminated prematurely due to bad ground. The drill sites were reclaimed as per MMD requirements (SRK, 2010).

Approximately 60 percent of the proposed Site has been disturbed by previous operations. Remnants of the 1982 mining operation include an open pit and pit lake, a tailings impoundment area, waste rock disposal areas, a number of buried building foundations, and ancillary facilities including decant towers, roads, power transmission lines, and waterlines (Figures 11-3 and 11-4). These features are clearly delineated on BLM geographic information system (GIS) maps and aerial photographs, and have been considered as part of the proposed plan of operations. Although some reclamation was done to the area in 1986, much of the Site remains disturbed (Figure 11-5).

## 11.4 References

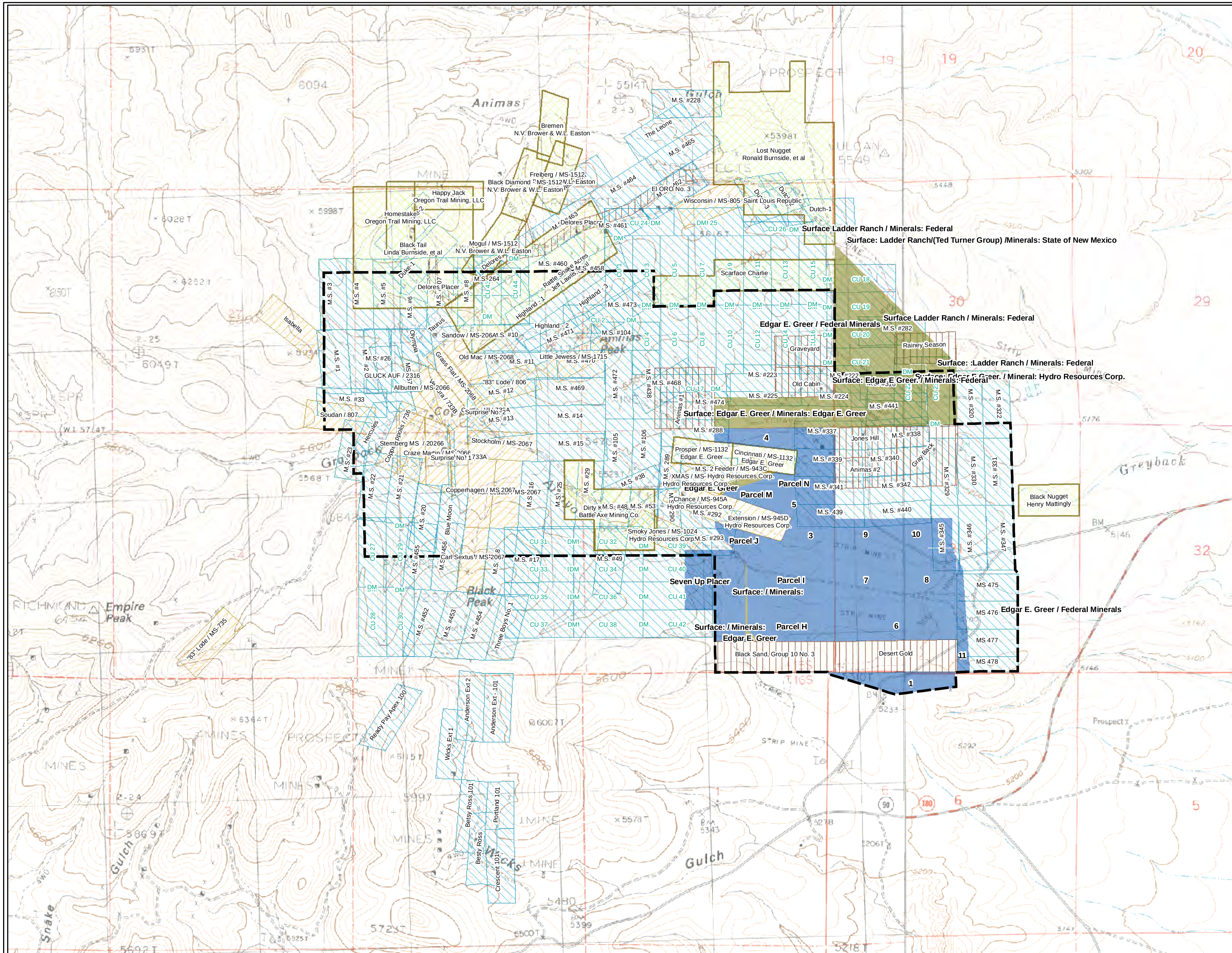
Bureau of Land Management (BLM), 1999, Preliminary final environmental impact statement, Copper Flat project: Las Cruces, N. Mex., U.S. Department of the Interior, 491 p. Prepared by ENSR, Fort Collins, Colo.

Dunn, P., 1984, Geologic studies during the development of the Copper Flat porphyry deposit: Mining Engineering, February, 1984, p. 151.

Kuellmer, F.J., 1955, Geology of a disseminated copper deposit near Hillsboro, Sierra County, New Mexico: New Mexico Bureau of Mines and Mineral Resources Circular 34, 46 p.

SRK Consulting, 2010, NI-43-101 Preliminary assessment, THEMAC Resources Group Limited, Copper Flat project, Sierra County, New Mexico: Lakewood, Colo. Prepared by SRK Consulting for THEMAC Resource Group Limited, June 30, 2010.

# Figures

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S

INTERA

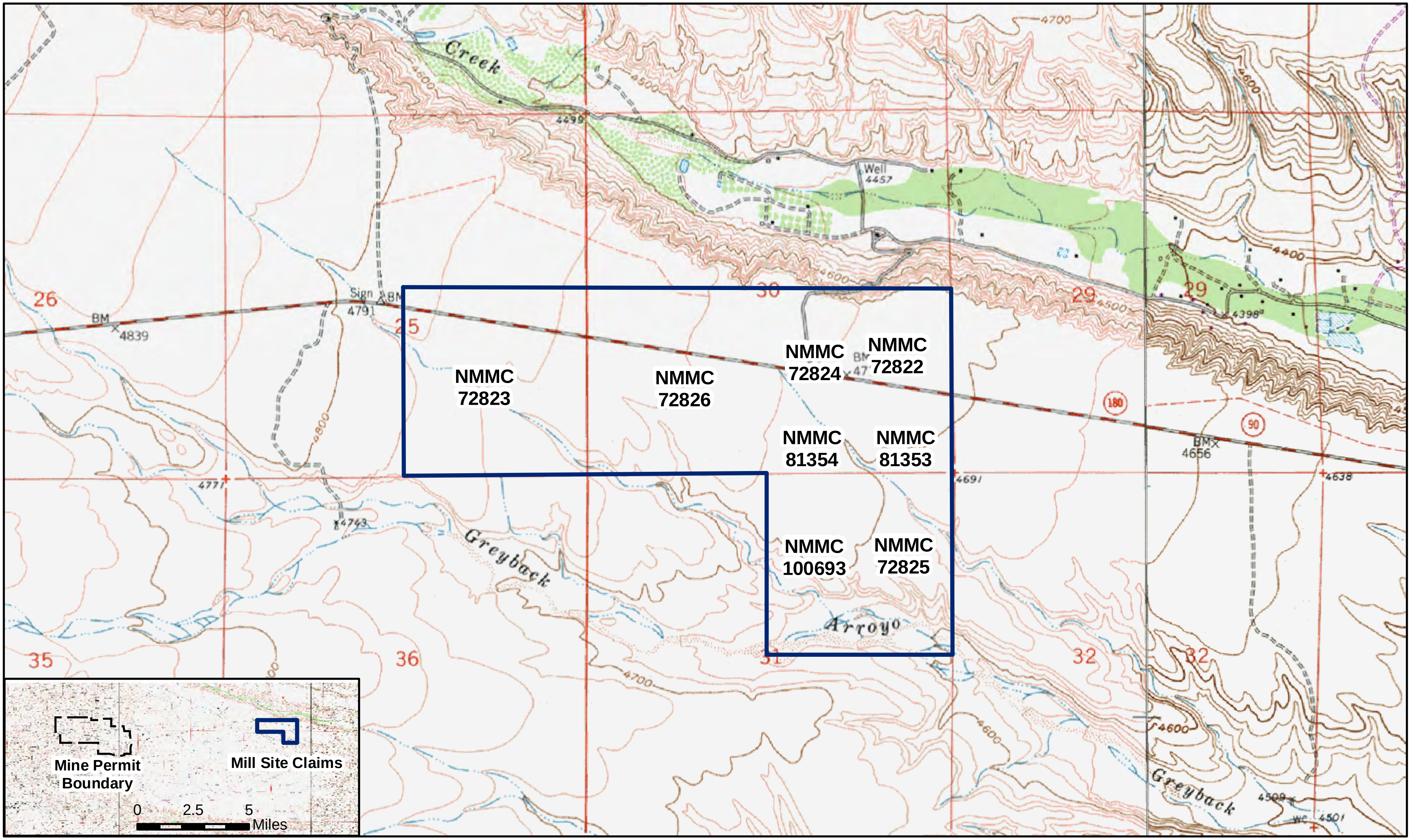
Mine Boundary:
John Reynolds
Claims & Feelands:
Tom Van Bebber
Imagery Information:
-USGS 7.5-Minute Quads; Skute Stone Arroyo & Hillsboro
Projection Information:
-New Mexico State Plane West, NAD 1927

0 1,000 2,000 4,000
Feet

**Legend**

- Mine Permit Boundary
- Fee, Category 3a
- Fee Lands subject to Option Agreement dated July 23, 2009
- Fee Lands NOT subject to Option Agreement dated July 23, 2009

**Figure 11-1**
**Land Ownership Status**
**New Mexico Copper Corporation**

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W E
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0 1,000 2,000 4,000 6,000

Feet

Claim Boundary:
SRK, 2010
Imagery Information:
-USGS 7.5-Minutes Quads; Skute Stone Arroyo & Caballo
Projection Information:
-New Mexico State Plane West, NAD 1927

**Legend**

Mill Site Claims Boundary

**Figure 11-2**
**Noncontiguous Mill Site Claims**
**New Mexico Copper Corporation**

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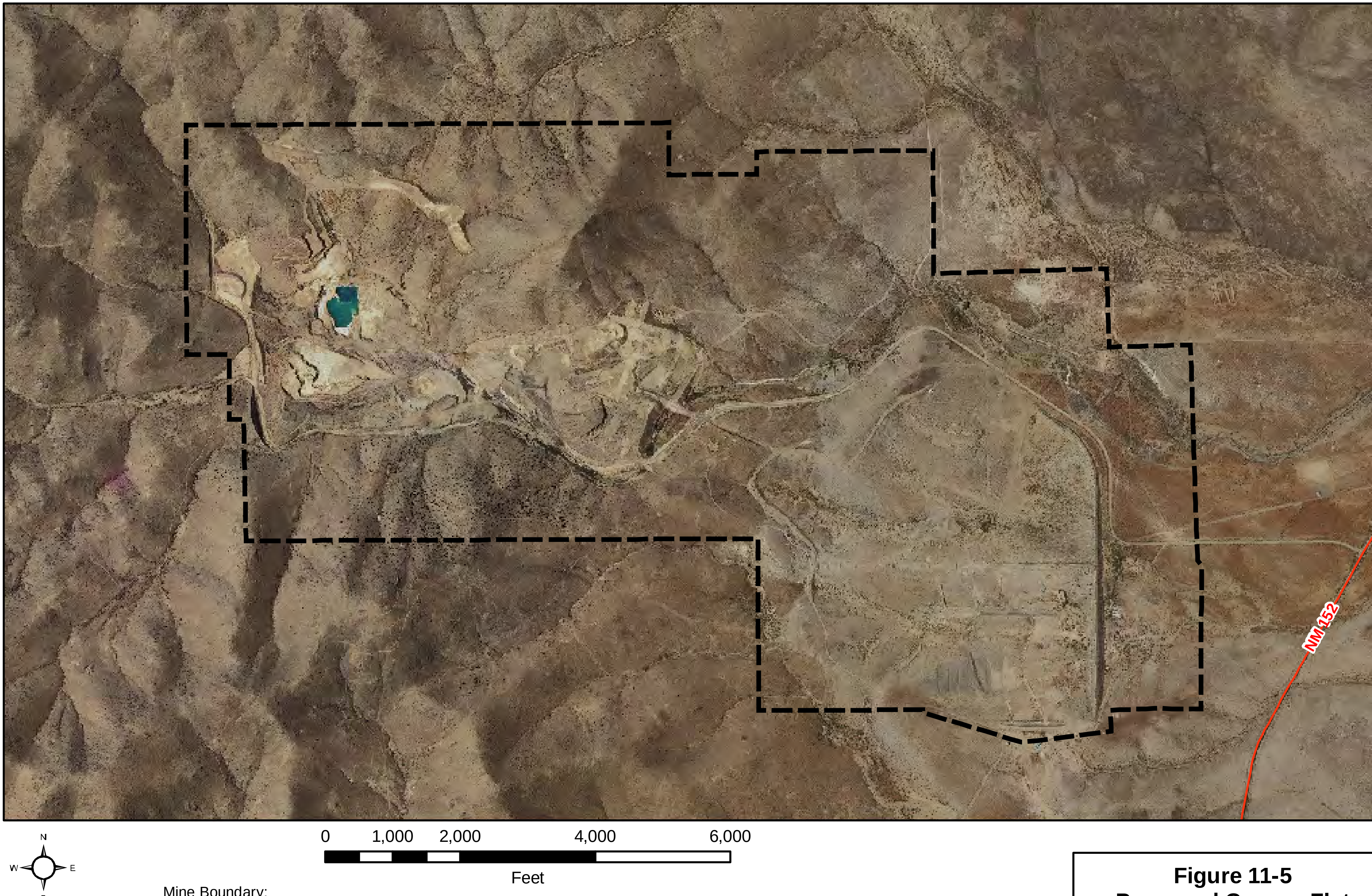
from Hydro Resources, Inc.

**Figure 11-3**
**Aerial View to the West at Copper Flat Mine, 1982**
**New Mexico Copper Corporation**

from Hydro Resources, Inc.

**Figure 11-4**
**Aerial View to the East at Copper Flat Mine, 1982**
**New Mexico Copper Corporation**




Mine Boundary:
Tom Van Bebber
Imagery Information:
-USGS 7.5-Minutes County DOQQ
mosaic Sierra County, 2009
Projection Information:
-New Mexico State Plane West, NAD 1927

**Legend**

Proposed Mine Permit Boundary

**Figure 11-5**
**Proposed Copper Flat Permit Area with Air Photography**

**New Mexico Copper Corporation**

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**Table**

**Table 11-1**

**Permits and Approvals Required for the Copper Flat Mine**

| Permit/Approval | Approving/Granting Agency |
|---|---|
| **Federal** | |
| Plan of Operations | U.S. Bureau of Land Management |
| Nationwide Dredge and Fill Permit (Section 404) | U.S. Army Corps of Engineers |
| FCC License | Federal Communications Commission |
| MSHA Registration | Mining Safety and Health Administration |
| Stormwater Disposal Permit (National Pollutant Discharge Elimination System) | U.S. Environmental Protection Agency |
| **State** | |
| Mining Permit | New Mexico Energy, Mineral and Natural Resources Department-Mining Act Reclamation Bureau |
| Water Pollution Control Permits | New Mexico Energy, Mineral and Natural Resources Department-Mining Act Reclamation Bureau, Environmental Protection Agency |
| Surface Disturbance Permit (Air Quality) | New Mexico Environment Department - Air Quality Bureau |
| Permit to Construct (Air Quality) | New Mexico Environment Department - Air Quality Bureau |
| Permit to Operate (Air Quality) | New Mexico Environment Department - Air Quality Bureau |
| Permit to Appropriate Water | New Mexico State Engineer's Office |
| Permits for Dam Construction and Operations | New Mexico State Engineer's Office |
| Approval to Operate a Sanitary Landfill | New Mexico Environment Department-Solid Waste Bureau |
| Tailings Discharge | New Mexico Environment Department-Groundwater Bureau |
| Cultural Resources Clearance | State Historic Preservation Office |

Source: SRK, 2010, Table 2.5.1.1

# New Mexico Copper Corporation

## Quality Assurance Project Plan

## Copper Flat Mine Site

September 2010

Prepared for:

**New Mexico Copper Corporation**

Submitted to:

**Mining and Minerals Division**

**New Mexico Energy, Minerals and Natural Resources Department**

Prepared by:

INTERA

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# Abbreviations and Acronyms

| | |
|---|---|
| CFR | Code of Federal Regulations |
| COC | chain of custody |
| CPR | cardiopulmonary resuscitation |
| DQA | data quality assessment |
| EPA | United States Environmental Protection Agency |
| ER | equipment rinsate |
| FTL | field team leader |
| ID number | identification number |
| LCS | laboratory control sample |
| MDL | method detection limit |
| MMD | New Mexico Mining and Minerals Division |
| MQO | measurement quality objectives |
| MS | matrix spike |
| NMCC | New Mexico Copper Corporation |
| NMWQCC | New Mexico Water Quality Control Commission |
| OSHA | Occupational Safety and Health Administration |
| PARCC | precision, accuracy, representativeness, completeness, and comparability |
| PM | Project Manager |
| PPE | personal protective equipment |
| PRRL | project-required reporting limits |
| QA | quality assurance |
| QAPP | quality assurance project plan |
| QC | quality control |
| RPD | relative percent difference |
| SAP | sampling and analysis plan |
| Site | Copper Flat Mine Permit Area |
| SQL | sample quantitation limits |

# 1 Project Description and Management

This document establishes the quality standards for products and services that have been established within the industry and through government regulations. New Mexico Copper Corporation (NMCC) and its contractors shall meet or exceed these quality standards throughout the duration of this project.

NMCC is currently initiating permitting activities for the re-opening of the Copper Flat Mine located approximately six miles northeast of Hillsboro, New Mexico, in Sierra County (Site). NMCC and its contractors will assess baseline conditions of for climate, vegetation, wildlife, topsoil, surface water, groundwater, and historical and cultural properties.

The project organizational flow chart for NMCC's geosciences and engineering contractor, INTERA Incorporated (INTERA) of Albuquerque, New Mexico, identifies key personnel and their functions (Figure 1). The INTERA Incorporated (INTERA) Program Manager, Cynthia Ardito, is responsible for project direction and quality assurance (QA) for this project. The Project Manager (PM), Peter Castiglia, is responsible for organizing and implementing field activities, project oversight, data management, and report preparation. Mr. Castiglia is also responsible for ensuring that the Quality Assurance Project Plan (QAPP) and Sampling and Analysis Plan (SAP) are appropriately developed and adhered to. The PM, Dr. John Sigda, is responsible for data analysis and modeling. Dr. Sigda will also provide technical support and will assist in data management and report preparation. INTERA's subcontractors include Class One Technical Services, Inc. of Albuquerque, New Mexico, for air quality services, and Hall Environmental Analysis Laboratories (HEAL) for analytical laboratory services. Subcontractor PMs will be responsible for QA, project oversight, data management, and coordination of field activities.

NMCC has contracted with Parametrix Incorporated of Albuquerque, New Mexico, for ecological and cultural resources services. Parametrix will be responsible for data collection for these resource areas. An organizational chart is included as Figure 2. The Parametrix PM, Mr. Jens Deichmann, is responsible for data collection and data quality. For geologic sampling, NMCC has contracted with SRK Consulting Engineers (SRK). The SRK PM is Mr. Mark Willow. The principal geochemist supporting Mr. Willow and overseeing the geologic sampling program is Dr. Robert Bowell.

## 1.1 Project Definition and Background

A 12-month baseline characterization of pre-mining site conditions must be completed prior to submittal of a Mine Permit Application to the New Mexico Energy, Minerals, and Natural Resources Department Mining and Minerals Division (MMD). As noted previously, this baseline characterization involves sampling, analysis, and assessment of site-specific climatic, vegetation, wildlife, soil, surface water, groundwater, and historical and cultural properties conditions. The MMD requires that a SAP be submitted for agency review. The SAP is a detailed work plan that describes how baseline data will be collected. The SAP must thoroughly describe the proposed sampling methodology and frequency, proposed data sources, and proposed sampling locations to document existing resource conditions within the permit boundary.

## 1.2 Quality Objectives and Criteria

The following sections present the measurement quality objectives (MQO) identified for this project.

### 1.2.1 Measurement Quality Objectives for Analytical Laboratory Data

All analytical results for water samples will be evaluated in accordance with precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters to document the quality of the data and promote data that are of sufficient quality to meet the project objectives. With regard to these PARCC parameters, precision and accuracy method blanks will be prepared at the frequency prescribed in the individual analytical method, or at a rate of 5 percent of the total samples if a frequency is not prescribed in the method. The subsections below describe each of the PARCC parameters and how they will be assessed for this task.

#### 1.2.1.1 Precision

Precision is the degree of mutual agreement between individual measurements of the same property under similar conditions. Usually, combined field and laboratory precision is evaluated by collecting and analyzing field duplicates and then calculating the variance between the samples, typically as a relative percent difference (RPD).

$$RPD = \frac{|A - B|}{(A + B)} \times 100\%$$

where:

| | | |
|---|---|---|
| A | = | First duplicate concentration |
| B | = | Second duplicate concentration |

Field sampling precision is evaluated by analyzing field duplicates. One duplicate groundwater sample will be collected during the initial groundwater sampling event to establish laboratory analytical precision at the onset of the investigation. The duplicate groundwater sample will be collected by completely filling two separate vials by alternating between the primary sample set and the replicate sample set in the order shown below:

- Fill vial #1 - primary sample set
- Fill vial #1 - replicate sample set
- Fill vial #2 - primary sample set
- Fill vial #2 - replicate sample set

Laboratory analytical precision is evaluated by analyzing matrix (laboratory) duplicates. Results for each laboratory duplicate pair will be used to determine the RPD in order to evaluate precision.

#### 1.2.1.2 Accuracy

A program of sample spiking will be conducted to evaluate laboratory accuracy. This program will include analysis of matrix spike (MS), laboratory control samples (LCS) or blank spikes, and method blanks. The results for the spiked samples will be used to calculate the percent recovery for use in evaluating accuracy.

$$\text{Percent Recovery} = \frac{S - C}{T} \times 100\%$$

where:

| | | |
|---|---|---|
| S | = | Measured spike sample concentration |
| C | = | Sample concentration |
| T | = | True or actual concentration of the spike |

Results that fall outside the accuracy goals will be further evaluated on the basis of the results of other quality control (QC) samples.

#### 1.2.1.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent: (1) the characteristics of a population, (2) variations in a parameter at a sampling point, or (3) an environmental condition that they are intended to represent.

Representativeness of data will also be promoted through the consistent application of established field and laboratory procedures. Equipment rinsate (ER) blanks and laboratory blanks will be evaluated for the presence of contaminants to aid in evaluating the representativeness of sample results. Data determined to be non-representative by comparison with existing data will be used only if accompanied by appropriate qualifiers.

#### 1.2.1.4 Completeness

Completeness is a measure of the percentage of project-specific data that are valid. Valid data will be obtained when samples are collected and analyzed in accordance with QC procedures as outlined in this QAPP and when none of the QC criteria that affect data usability are exceeded. When all data evaluation is completed, the percent completeness value will be calculated by dividing the number of useable sample results by the total number of sample results planned for this investigation.

As discussed further in Section 8.0, completeness will also be evaluated as part of the data quality assessment process (EPA, 2000b). This evaluation will help assess whether any limitations are associated with the decisions to be made based on the data collected.

#### 1.2.1.5 Comparability

Comparability expresses the confidence with which one data set can be compared with another. Comparability of data will be achieved by consistently following standard field and laboratory procedures and by using standard measurement units in reporting analytical data.

#### 1.2.1.6 Detection and Quantitation Limits

The method detection limit (MDL) is the minimum concentration of an analyte that can be reliably distinguished from background noise for a specific analytical method. The quantitation limit represents the lowest concentration of an analyte that can be accurately reproduced in a sample matrix. Project-required reporting limits (PRRL) are contractually specified minimum quantitation limits for specific analytical methods and sample matrices, such as soil or water, and are typically several times the MDL to allow for matrix effects. PRRLs, which are established in the project scope of work for subcontract laboratories, are set to establish minimum criteria for laboratory performance. Actual laboratory quantitation limits may be substantially lower.

For this project, analytical methods have been selected so that the PRRL for each target analyte is below the applicable regulatory screening criteria, the New Mexico Water Quality Control Commission (NMWQCC) Standards for groundwater. Also, sample concentrations will be reported as estimated values if concentrations are less than PRRLs but greater than MDLs. The MDL for each analyte will be listed as the detection limit in the laboratory's electronic data deliverable.

### 1.2.2 Measurement Quality Objectives for Meteorological and Air Quality Data

Laboratory and field quality assurance procedures for meteorological and air quality data are described in detail in Section 2 of the Sampling and Analysis Plan (SAP). Please refer to Section 2.8 of this SAP for more information.

### 1.2.3 Measurement Quality Objectives for Ecological Data

A single field crew chief will be assigned to ensure data collection is consistent between crews. This individual will review a sub-set of the field forms following each field day. Formalized data collection training will also be completed prior to field sampling. All field botanists will be familiar with plant systematics and techniques to identify plants using taxonomic keys. Plant species not readily identifiable in the field will be collected and preserved for identification at the University of New Mexico Herbarium.

Vegetation material produced during the previous growing season will be discarded before placing samples into a paper bag. Rocks, soil, and/or litter will not be placed into sample bags. Biomass production will only be calculated as an actual dry-weight sample. No double sampling or estimations will occur.

Field data entered into an electronic format such as MS Excel or Access will be evaluated for integrity, consistency, and completeness before data analysis. Oversights or incorrect entries will be corrected. A sub-set of the field forms will be compared to the electronic version for an accuracy assessment. If significant differences are identified, a thorough re-evaluation of each of the forms will be completed.

For wildlife data, field biologists will have a minimum of a BA/BS in Biology and five to ten years of field experience conducting a wide variety of animal surveys ranging from reptiles and amphibians, to birds, mammals, insects, and other invertebrates. This includes experience in recognizing and identifying signs of wildlife. All findings and results will be reviewed by senior scientists.

### 1.2.4 Measurement Quality Objectives for Cultural Resources Data

Reporting will follow the standards in BLM manual H-8100-1, Chapter 1.B.1 and Appendix 2 (2005). In addition, work will be performed in compliance with all aspects of the NMAC, including NMAC 4.10.15.

## 1.3 Project Organization

Table 1 presents the roles and responsibilities for key personnel who will be involved in the investigation at the Site. In some cases, more than one responsibility has been assigned to one person.

## 1.4 Special Training and Certification

This section outlines the training and certifications required to complete the activities described in this QAPP. The following sections describe the requirements for personnel working on-site.

### 1.4.1 Health and Safety Training

INTERA Personnel who collect water and sediment samples from the Site are required to meet the Occupational Safety and Health Administration (OSHA) training requirements defined in Title 29 of the Code of Federal Regulations (CFR) Part 1910.120(e). These requirements include (1) 40 hours of formal off-site instruction, (2) a minimum of three days of actual on-site field experience under the supervision of a trained and experienced field supervisor, and (3) 8 hours of annual refresher training. Field personnel who directly supervise employees engaged in work at the site shall also receive at least 8 additional hours of specialized supervisor training. The supervisor training covers health and safety program requirements, training requirements, personal protective equipment (PPE) requirements, the spill containment program, and health-hazard monitoring procedures and techniques. Every member of the field team will maintain current certification in the American Red Cross "Multimedia First Aid," and "Cardiopulmonary Resuscitation (CPR) Modular," or equivalent.

Copies of health and safety training records, including course completion certificates for the initial and refresher health and safety training, specialized supervisor training, and first aid and CPR training, are maintained in corporate files.

## 1.5 Documents and Records

Documentation is critical for evaluating the success of any environmental data collection activity. The following sections discuss the requirements for documenting field activities and for preparing laboratory data packages. This section also describes reports that will be generated as a result of this project.

### 1.5.1 Field Documentation

Field personnel will use permanently bound field logbooks with sequentially numbered pages to record and document field activities. The logbooks will list a contract name and number, the project number, the site name, the names of subcontractors, the client, and the PM. At a minimum, the following will be recorded in the field logbook:

- Names and affiliations of all on-site personnel or visitors
- Weather conditions during the field activity
- Summary of daily activities and significant events
- Notes of conversations with coordinating officials
- References to other field logbooks or forms that contain specific information
- Discussions of problems encountered and their resolutions
- Discussions of deviations from the SAP or other governing documents
- Descriptions of all photographs taken

The field team may also use the field forms during certain sampling or data collection activities to document field activities. The same level of detail will be required for all field forms used during this investigation. Copies of the completed field forms will be stored in the project file.

# 2 Data Generation and Acquisition

This section describes the requirements for the following:

- Sampling Design (Section 2.1)
- Field Activities (Section 2.2)
- Sample Handling and Custody (Section 2.3)
- Laboratory Quality Assurance/Quality Control (QA/QC) (Section 2.4)
- Equipment Testing, Inspection, Maintenance, and Calibration (Section 2.5)

## 2.1 Sampling Design

Samples or data will be collected as outlined in the SAP. The SAP for this project is a collection of quarterly or one-time field sampling or data collection events that were prepared by NMCC and its contractors. Field activities will be implemented to optimize the time spent in the field by adhering to established scientific methods and procedures, leading coordinated field schedules, and sharing data with contractors to minimize duplication of data.

Data collected from these field activities will be used in the mine permitting process. This baseline data will also be useful in the design of mine facilities and as a reference during site reclamation activities.

## 2.2 Field Activities

Field activities have been broken into eight separate activities. These activities, which are outlined in the SAP, will be used to establish the baseline conditions at the Site:

- Climatological factors – The purpose of the monitoring program will be to collect baseline climatological data representative of the Site that satisfies the criteria of the New Mexico Surface Mining Act and the U.S. Environmental Protection Agency (EPA) on-site meteorological program guidance for dispersion modeling
- Vegetation survey – The purpose of the survey is to delineate current vegetation stratified according to disturbance history and to describe specific vegetation attributes for plant communities delineated within the Site. In addition, the survey will identify the presence of potential habitat for threatened and endangered species.
- Wildlife survey – Delineate and map current habitat, describe wildlife use of the area, complete a bird species inventory, complete a threatened or endangered species survey by comparing known records and habitat requirements with current field conditions to determine the likelihood of occurrence of all federal and state listed wildlife species, and determine species distribution by habitat and season.
- Soil survey and sampling – To determine the suitability of in-place soils in areas of proposed disturbance for use as a topdressing material during reclamation.
- Surface water sampling – To characterize the volumetric flow and water quality of seeps, springs, streams, and the pit lake.
- Groundwater sampling – To obtain necessary data to evaluate quantity and quality of all aquifers at the Site that could be impacted by mining activities, address data gaps identified during evaluation of the Draft EIS (BLM, 1996), meet the requirements set forth in the regulations in NMAC Title 19, Chapter 10, Part 6, and to meet the guidelines set forth in MMD's draft Guidance Document for Part 6 New Mining Operations Permitting under the New Mexico Mining Act.
- Historical and cultural properties survey – To locate and assess all cultural resources and historic properties within the area of potential effects.

## 2.3 Sample Handling and Custody

The following section describes sample handling procedures, including sample identification and labeling, documentation, chain of custody (COC), and shipping. This section applies to water, sediment, and geologic samples that are submitted to an analytical laboratory. Other sample handling and custody procedures for vegetation and other resources are described, where appropriate, in the SAP.

Each sample collected at the Site will be identified using a unique sample identification (ID) number. The description of the sample type and the point name will be recorded on the COC form, as well as in the field notes. Note that field duplicates and ERs will be given a unique sample ID. The association between primary, duplicate, and ER samples will be noted on the COC form.

A sample label will be affixed to each sample container. The label will be completed with the following information written in indelible ink: project name and location, sample ID number, date and time of collection, preservative used (if applicable), collector's initials, and analysis requested. After labeling, each sample will be refrigerated or placed in a cooler containing ice.

Documentation of sample collection will be completed in permanent black or blue ink in the field logbook. All entries will be legible. The field team leader (FTL) and sampling personnel are responsible for proper documentation of all Site activities.

Standard sample custody procedures will be used to maintain and document sample integrity during collection, transportation, storage, and analysis. COC procedures provide an accurate written record that traces the possession of individual samples from the time of collection in the field to the time of acceptance at the laboratory.

The COC form will be placed in a waterproof plastic bag and taped to the inside of the shipping container used to transport the samples. The laboratory sample custodian will receive all incoming samples, sign the accompanying COC forms, and retain copies of the forms as permanent record. The laboratory sample custodian will record all pertinent information concerning the samples, including the persons delivering the samples, the date and time received, sample condition at the time of receipt (sealed, unsealed, or broken container; temperature; or other relevant remarks).

All samples will be either hand delivered or shipped to an accredited laboratory. Samples may need to be shipped to the laboratory in order to have them analyzed before the expiration of a particular sample's holding time.

## 2.4 Laboratory QA/QC

This section applies to water, sediment, and geologic samples submitted to accredited analytical laboratories. To ensure quality of laboratory analysis, the analytical laboratory will be required to analyze QA/QC samples as specified by the analytical methods. The laboratory will analyze method blanks, MSs, and LCSs.

Method blanks will be prepared at the frequency prescribed in the individual analytical method or at a rate of 5 percent of the total samples if a frequency is not prescribed in the method.

MSs will be analyzed at a frequency of 5 percent for soil and aqueous samples. The percent recoveries will be calculated for each of the spiked analytes and used to evaluate analytical accuracy. The RPD between spiked samples will be calculated to evaluate precision.

LCSs, or blank spikes, will be analyzed at the frequency prescribed in the analytical method or at a rate of 5 percent of the total samples if a frequency is not prescribed in the method. If percent recovery results for the LCS or blank spike are outside of the established goals, laboratory-specific protocols will be followed to gauge the usability of the data.

Sample quantitation limits (SQL), also referred to as practical quantitation limits, are PRRLs adjusted for the characteristics of individual samples. The PRRLs are chemical-specific levels that a laboratory should be able to routinely detect and quantitate in a given sample matrix. The PRRL is defined in the analytical method or in laboratory method documentation, and incorporates precision (reproducibility) assumptions for the analysis. The SQL takes into account changes in the preparation and analytical methodology that may alter the ability to detect an analyte, including changes such as use of a smaller sample aliquot or dilution of the sample extract. Physical characteristics such as sample matrix and percent moisture that may alter the ability to detect the analyte are also considered. The laboratory will calculate and report SQLs for all environmental samples.

The laboratory activities are overseen by a comprehensive quality assurance program to assure that laboratory practices and results adhere to its policies. The laboratory will provide a standard QA/QC report with all reports. This includes surrogate recoveries, spike recoveries, and method blanks.

The laboratory participates in the Wibby Environmental, third party, proficiency testing program. Wibby is accredited by A2LA and NIST/NVLAP. Results of all proficiency results are sent, by Wibby, to both the laboratory and to their accrediting authorities. The laboratory will also perform proficiency testing on a semiannual basis for all accredited tests. Water proficiencies in the water supply and water pollution studies will be performed in addition to soil proficiencies in hazardous waste pollution studies.

Proficiency results are reviewed by the laboratory manager and all personnel involved in reporting the data. Results that are marked as "check for error" and "unacceptable" are thoroughly reviewed and corrective actions are written for "unacceptable" data.

## 2.5 Equipment Testing, Inspection, Maintenance, and Calibration

All equipment used during the investigation will be properly tested, inspected, maintained, and calibrated. Samples collected during this investigation will be analyzed using both field and laboratory equipment. Calibration of the field equipment shall be recorded in the field logbook after each calibration event. The calibration procedure for each piece of field equipment used will be outlined in the final report.

The laboratory's QA plan and written operating procedures describing specific testing, inspection, maintenance, and calibration procedures for equipment will be followed. If required, maintenance procedures and schedules will be performed and documented.

# 3 Inspection and Acceptance of Supplies and Consumables

PMs have primary responsibility for identifying the types and quantities of supplies and consumables needed to complete projects and are responsible for identifying acceptance criteria for these items.

Supplies and consumables can be received either at the contractor's office or at a work site. When supplies are received at an office, the PM or FTL will sort them according to vendor, check packing slips against purchase orders, and inspect the condition of all supplies before they are accepted for use on a project. If an item does not meet the acceptance criteria, deficiencies will be noted on the packing slip and purchase order and the item will then be returned to the vendor for replacement or repair.

Procedures for receiving supplies and consumables in the field are similar. When supplies are received, the PM or FTL will inspect all items against the acceptance criteria. Any deficiencies or problems will be noted in the field logbook and deficient items will be returned for immediate replacement.

Analytical laboratories are required to provide certified clean containers for all analyses. These containers must meet EPA standards as described in *Specifications and Guidance for Obtaining Contaminant-Free Sampling Containers* (EPA, 1992).

# 4 Data Management

All field and analytical data collected during this investigation will be provided to MMD in the Baseline Characterization Report. Field data will be recorded in the logbook and/or field forms and will be included in the appendices. Analytical data will be summarized, tabulated, analyzed, and provided in the body of the final report. The original laboratory data will be provided in an appendix of the final report. Some data may be presented graphically.

# 5 Assessment, Response Actions, and Reports to Management

NMCC and MMD will oversee collection of environmental data using the appropriate assessment and audit activities. Any problems encountered during an assessment of field investigation or laboratory activities will require appropriate corrective action to ensure that the problems are resolved. The corrective actions will be discussed with MMD and will be implemented after approval from MMD is received. NMCC will perform routine audits of their subcontractor's performance. In addition, the subcontractor's project managers will ensure that the work done under their assigned tasks complies with the QAPP and will report non compliance, problems, or other issues to NMCC in a timely manner agreed upon between NMCC and its subcontractors.

Effective management of environmental data collection requires: 1) timely assessment and review of all activities, and 2) open communication, interaction, and feedback among all project participants. NMCC and its contractors will use verbal communication with MMD oversight personnel, electronic communication, and monthly status reports to address any project-specific quality issues and to facilitate timely communication of these issues. NMCC and its contractors will develop a communications protocol to communicate with the MMD and solicit the MMD for concurrence with these communication procedures.

# 6 Data Evaluation and Usability

This section describes the procedures that are planned to review and evaluate field and laboratory data. This section also discusses procedures for verifying that the data are sufficient to meet MQOs for the project.

Review and evaluation of the data generated during field and laboratory activities are essential to obtaining defensible data of acceptable quality. Project team personnel will review field data to identify inconsistencies or anomalous values. Any inconsistencies discovered will be resolved as soon as possible by seeking clarification from field personnel responsible for data collection. All field personnel will be responsible for following the sampling and documentation procedures described in this SAP so that defensible and justifiable data are obtained.

Data values that are significantly different from the population are called "outliers." A systematic effort will be made to identify any outliers or errors before field personnel report the data. Outliers can result from improper sampling or measurement methodology, data transcription errors, calculation errors, or natural causes. Outliers that result from errors found during data verification will be identified and corrected; outliers that cannot be attributed to errors in sampling, measurement, transcription, or calculation will be clearly identified in project reports.

## 6.1 Laboratory Data Verification

Laboratory personnel will verify analytical data at the time of analysis and reporting and through subsequent reviews of the raw data for any nonconformances to the requirements of the analytical method. Laboratory personnel will make a systematic effort to identify any outliers or errors before they report the data. Outliers that result from errors found during data verification will be identified and corrected; outliers that cannot be attributed to errors in analysis, transcription, or calculation will be clearly identified in the case narrative section of the analytical data package.

### 6.2 Laboratory Data Evaluation and Usability

All laboratory data will be evaluated. The data evaluation strategy will not be a full data validation process, but will determine if the analytical results are within the QC limits set for the project. As part of this evaluation, the data usability will be assessed.

# 7 Reconciliation with User Requirements

After environmental data have been reviewed and evaluated in accordance with the procedures described in Section 7.0, the data must be further evaluated to assess whether MQOs have been met.

To the extent possible, EPA's data quality assessment (DQA) process will be followed to verify that the type, quality, and quantity of data collected are appropriate for their intended use. DQA methods and procedures are outlined in EPA's *Guidance for Data Quality Assessment, Practical Methods for Data Analysis* (EPA, 2000b). The DQA process includes five steps: (1) review the sampling objectives and sampling design, (2) conduct a preliminary data review, (3) select a statistical test, (4) verify the assumptions of the statistical test, and (5) draw conclusions from the data. In the case of water, sediment, and geologic samples, no statistical analysis is planned at this time. Statistical analyses planned for ecological and cultural resources data are defined in Sections 4, 5, and 10 of the SAP.

When the five-step DQA process is not completely followed because the sampling objectives are qualitative, data quality and data usability will be systematically assessed. This assessment will include:

- A review of the sampling design and sampling methods to verify that these were implemented as planned and are adequate to support project objectives.
- A review of project-specific data quality indicators for PARCC and project reporting limits to evaluate whether acceptance criteria have been met.
- A review of project-specific sampling objectives to assess whether they have been achieved by the data collected.
- An evaluation of any limitations associated with the decisions to be made based on the data collected (for example, if data completeness is only 90 percent compared to a project-specific completeness objective of 95 percent, the data may still be usable to support a decision, but at a lower level of confidence).

The final report for the project will discuss any potential impacts of these reviews on data usability and will clearly define any limitations associated with the data.

# 8 References

American Society for Testing and Materials (ASTM), 2000, Standard practice for description and identification of soils (visual-manual procedure): ASTM Standard D 2488-00.

Bureau of Land Management (BLM), 1996, Draft environmental impact statement (DEIS), Copper Flat Project: Las Cruces, N. Mex., U.S. Department of the Interior. Prepared by ENSR, Fort Collins, Colo.

Environmental Protection Agency (EPA), 1992, Specifications and guidance for obtaining contaminant-free sampling containers: Washington, DC, Office of Solid Waste and Emergency Response, EPA/A540/R-93/051. December.

———.2000a, Data quality objectives process for hazardous waste site investigations, EPA QA/G-4HW: Washington, DC, Office of Environmental Information, EPA/600/R-00/007. January.

———.2000b, Guidance for data quality assessment, practical methods for data analysis, EPA QA/G-9, QA00 Update: Washington, DC, Office of Environmental Information, EPA/600/R-96/084. July.

———.2000c, Guidance for the data quality objectives process, EPA QA/G-4: Washington, DC, Office of Environmental Information, EPA/600/R-96/055. August.

## Figures

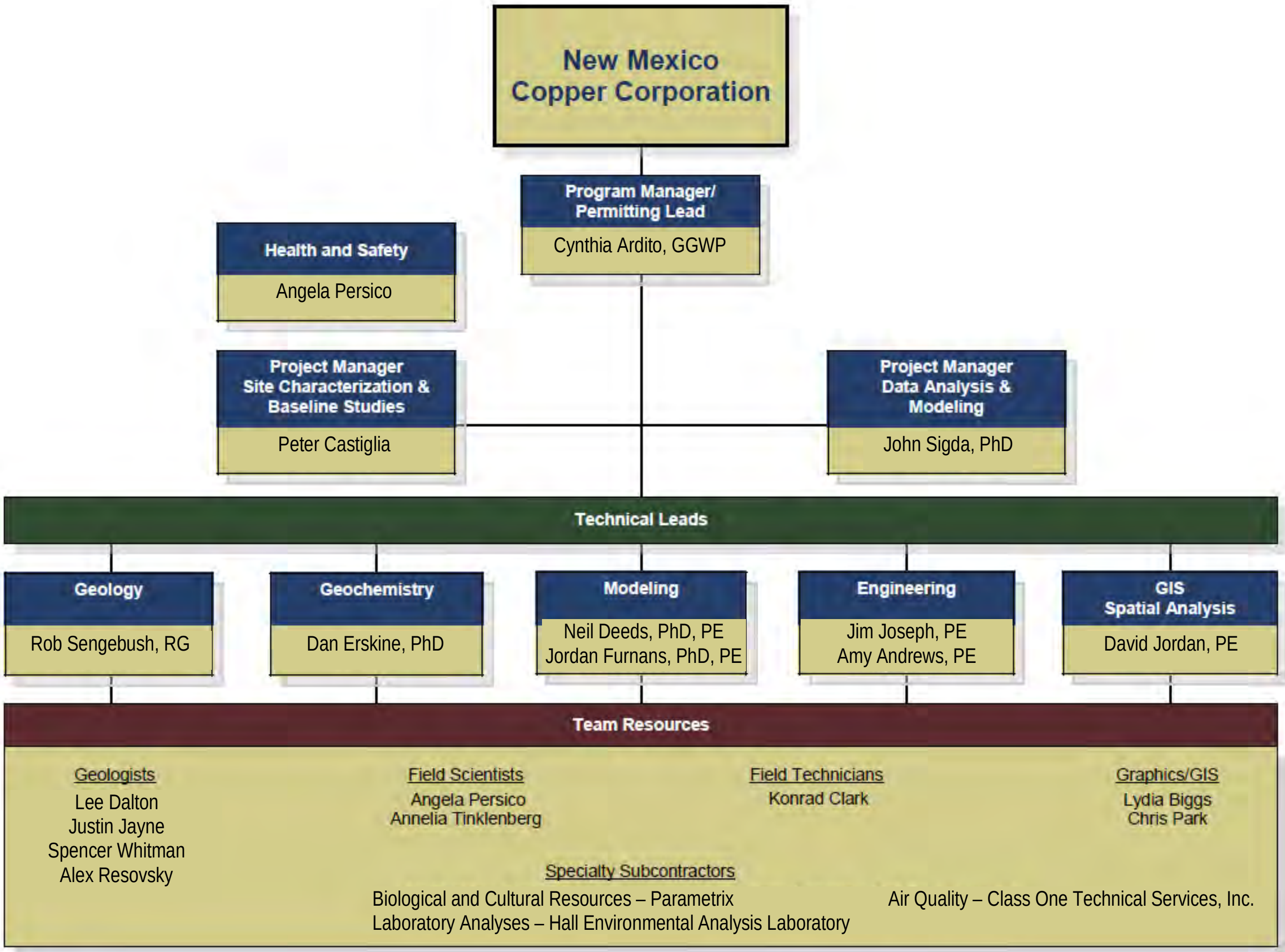


**Figure 1. Project Organization**

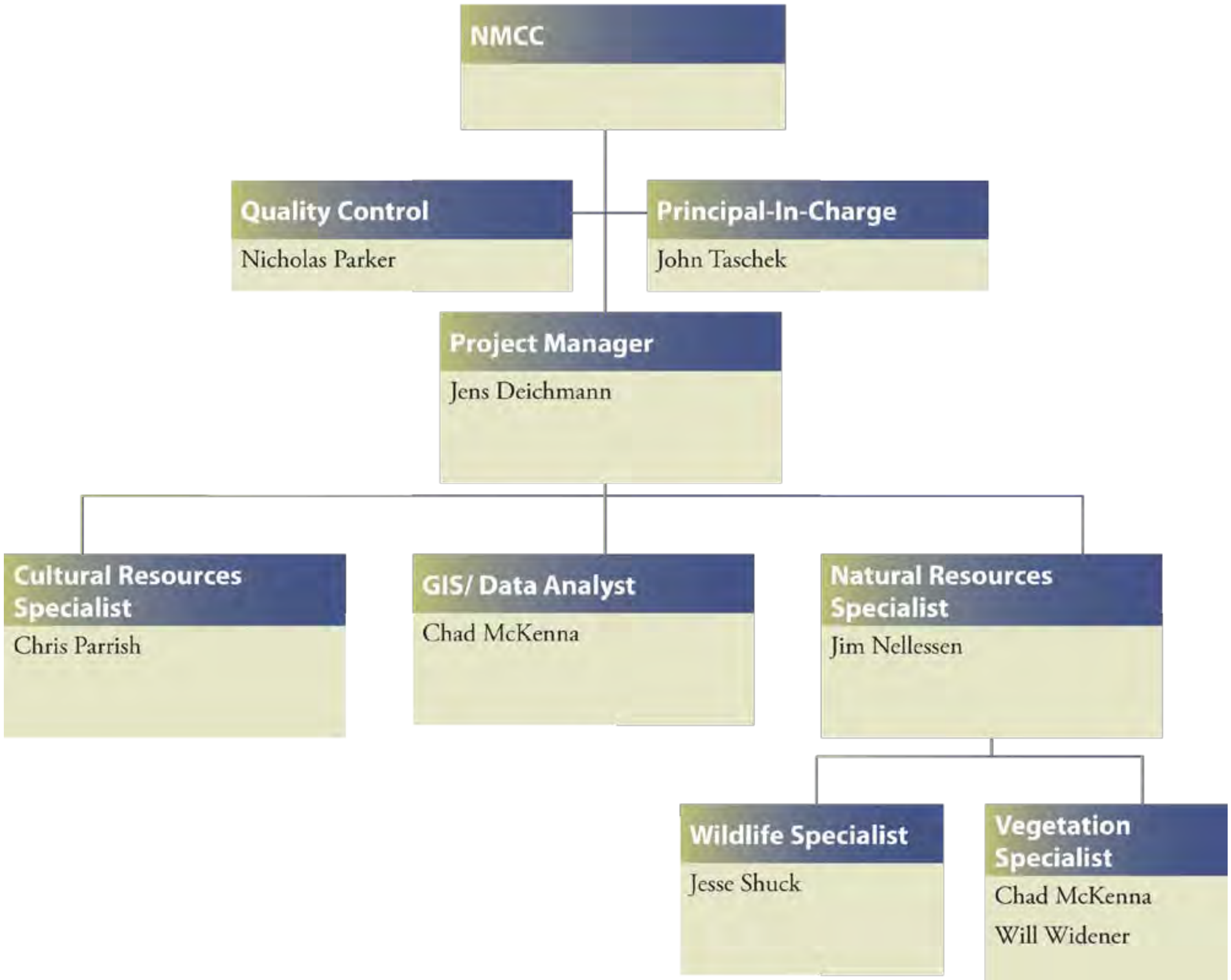


**Figure 2. Parametrix Organizational Chart**

**Table**

## Table 1
## INTERA Key Personnel and Responsibilities

| Name | Organization | Role | Responsibilities | Contact Information |
|---|---|---|---|---|
| Ms. Cindy Ardito | INTERA | Program Quality Assurance (QA) Officer | Participates in development of technical approach.<br>Reviews technical deliverables.<br>Provides technical oversight during data collection | INTERA Inc.<br>6000 Uptown Blvd. NE, Suite 220<br>Albuquerque, NM 87110<br>(505) 246-1600, (505) 246-2600 FAX<br>ext. 1206<br>cardito@intera.com |
| Mr. Peter Castiglia | INTERA | Project Manager/<br>Technical Lead | Responsible for overall project execution and for coordination with regulatory agencies and contractors.<br>Actively participates in Data Quality Objective process.<br>Provides management and technical oversight during data collection. | INTERA Inc.<br>6000 Uptown Blvd. NE, Suite 220<br>Albuquerque, NM 87110<br>(505) 246-1600, (505) 246-2600 FAX<br>ext. 1217<br>pcastiglia@intera.com |
| Mr. Lee Dalton | INTERA | Field Team Leader (FTL) – Groundwater | Responsible for directing day-to-day field activities conducted by INTERA and subcontractor personnel.<br>Verifies that field sampling and measurement procedures follow the Sampling and Analysis Plan.<br>Provides project manager with regular reports on status of field activities. | INTERA Inc.<br>6000 Uptown Blvd. NE, Suite 220<br>Albuquerque, NM 87110<br>(505) 246-1600, (505) 246-2600 FAX<br>ext. 1213<br>ldalton@intera.com |
| Mr. Justin Jayne | INTERA | Field Team Leader (FTL) – Surface Water | Responsible for directing day-to-day field activities conducted by INTERA and subcontractor personnel.<br>Verifies that field sampling and measurement procedures follow the Sampling and Analysis Plan.<br>Provides project manager with regular reports on status of field activities. | INTERA Inc.<br>6000 Uptown Blvd. NE, Suite 220<br>Albuquerque, NM 87110<br>(505) 246-1600, (505) 246-2600 FAX<br>ext. 1220<br>jjayne@intera.com |
| Ms. Angela Persico | INTERA | On-Site Safety Officer | Responsible for implementing health and safety plan for determining appropriate site control measures and personal protection levels.<br>Conducts safety briefings for INTERA and subcontractor personnel and site visitors.<br>Can suspend operations that threaten health and safety. | INTERA Inc.<br>6000 Uptown Blvd. NE, Suite 220<br>Albuquerque, NM 87110<br>(505) 246-1600, (505) 246-2600 FAX<br>ext. 1207<br>apersico@intera.com |
| Ms. Angela Persico<br>Mr. Spencer Whitman<br>Mr. Konrad Clark<br>Ms. Annelia Tinklenberg | INTERA | Field Sampler(s) | Responsible for collecting representative samples and conducting necessary field activities specified in Sampling and Analysis Plan.<br>Works under supervision of field team leader.<br>Ensures proper sampling and handling procedures. | INTERA Inc.<br>6000 Uptown Blvd. NE, Suite 220<br>Albuquerque, NM 87110<br>(505) 246-1600, (505) 246-2600 FAX |

| Name | Organization | Role | Responsibilities | Contact Information |
|---|---|---|---|---|
| Mr. Bob Powell | Class One Technical Services, Inc. | Project Manager | Responsible for overall project execution and for coordination with regulatory agencies and contractors.<br>Actively participates in Data Quality Objective process.<br>Provides management and technical oversight during data collection by Class One Technical Services. | Class One Technical Services, Inc.<br>3500 Comanche Rd. NE Suite G<br>Albuquerque, NM 87107<br>(505) 830-9680 |
| Mr. Jens Deichmann | Parametrix | Project Manager – Ecological and Cultural Resources | Responsible for coordination with regulatory agencies and contractors.<br>Actively participates in Data Quality Objective process.<br>Provides management and technical oversight during data collection by Parametrix. | Parametrix Incorporated<br>8801 Jefferson NE; Bldg. 2<br>Albuquerque, NM 87113<br>(505) 998-5552<br>jdeichmann@parametrix.com |
| Mr. Chris Parrish | Parametrix | FTL - Cultural Resources | Responsible for directing day-to-day field activities conducted for cultural resources by Parametrix and subcontractor personnel.<br>Verifies that field sampling and measurement procedures follow the Sampling and Analysis Plan.<br>Provides project manager with regular reports on status of field activities. | Parametrix Incorporated<br>8801 Jefferson NE; Bldg. 2<br>Albuquerque, NM 87113<br>(505) 821-4700 |
| Mr. Jim Nellessen | Parametrix | FTL – Natural Resources | Responsible for directing day-to-day field activities conducted for natural resources by Parametrix and subcontractor personnel.<br>Verifies that field sampling and measurement procedures follow the Sampling and Analysis Plan.<br>Provides project manager with regular reports on status of field activities. | Parametrix Incorporated<br>8801 Jefferson NE; Bldg. 2<br>Albuquerque, NM 87113<br>(505) 821-4700 |
| Mr. Chad McKenna | Parametrix | Technical Lead – Geographic Information Systems (GIS) | Responsible for directing day-to-day activities conducted for GIS by Parametrix and subcontractor personnel.<br>Verifies that GIS data collection procedures follow the Sampling and Analysis Plan.<br>Provides project manager with regular reports on status of GIS data. | Parametrix Incorporated<br>8801 Jefferson NE; Bldg. 2<br>Albuquerque, NM 87113<br>(505) 821-4700 |
| Mr. Mark Willow | SRK Consulting | Project Manager – Geologic Sampling | Responsible for coordination with regulatory agencies and contractors.<br>Actively participates in Data Quality Objective process.<br>Provides management and technical oversight during data collection by SRK. | SRK Consulting<br>250 Neil Road, Suite 300<br>Reno, Nevada 89502<br>(775) 828-6800<br>mwillow@srk.com |
| Dr. Robert Bowell | SRK Consulting | Technical Lead – Geologic Sampling | Responsible for directing day-to-day activities conducted for geologic by SRK and subcontractor personnel.<br>Verifies that geologic data collection procedures follow the Sampling and Analysis Plan.<br>Provides project manager with regular reports on status of geologic data collection and results. | SRK Consulting (UK) Ltd.<br>5th Floor, Churchill House<br>17 Churchill Way<br>Cardiff, CF10 2HH, UK<br>+44 (0) 29 2034 8150<br>egrbowel@srk.co.uk |