Table of Contents

List of Figures

List of Tables

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

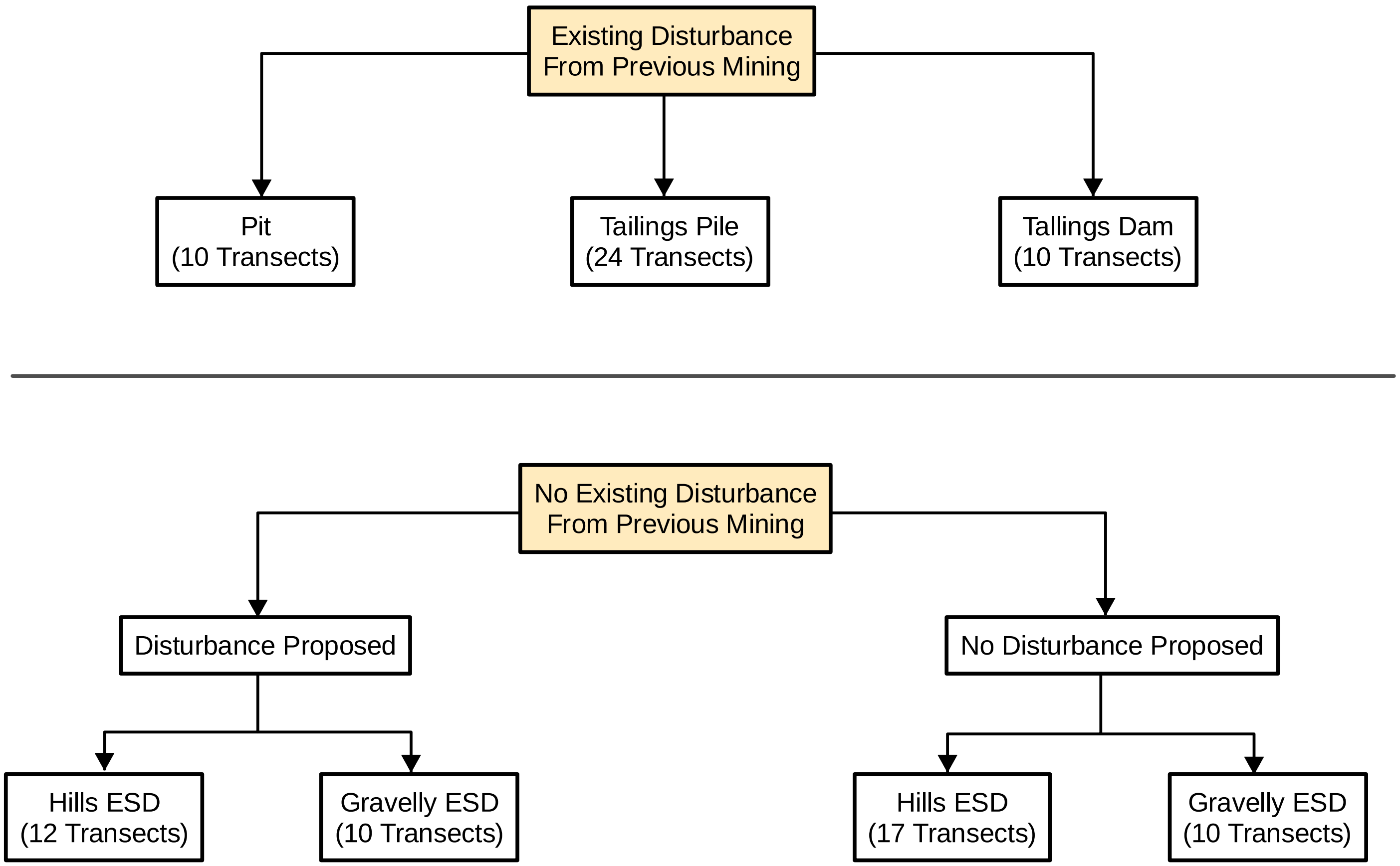
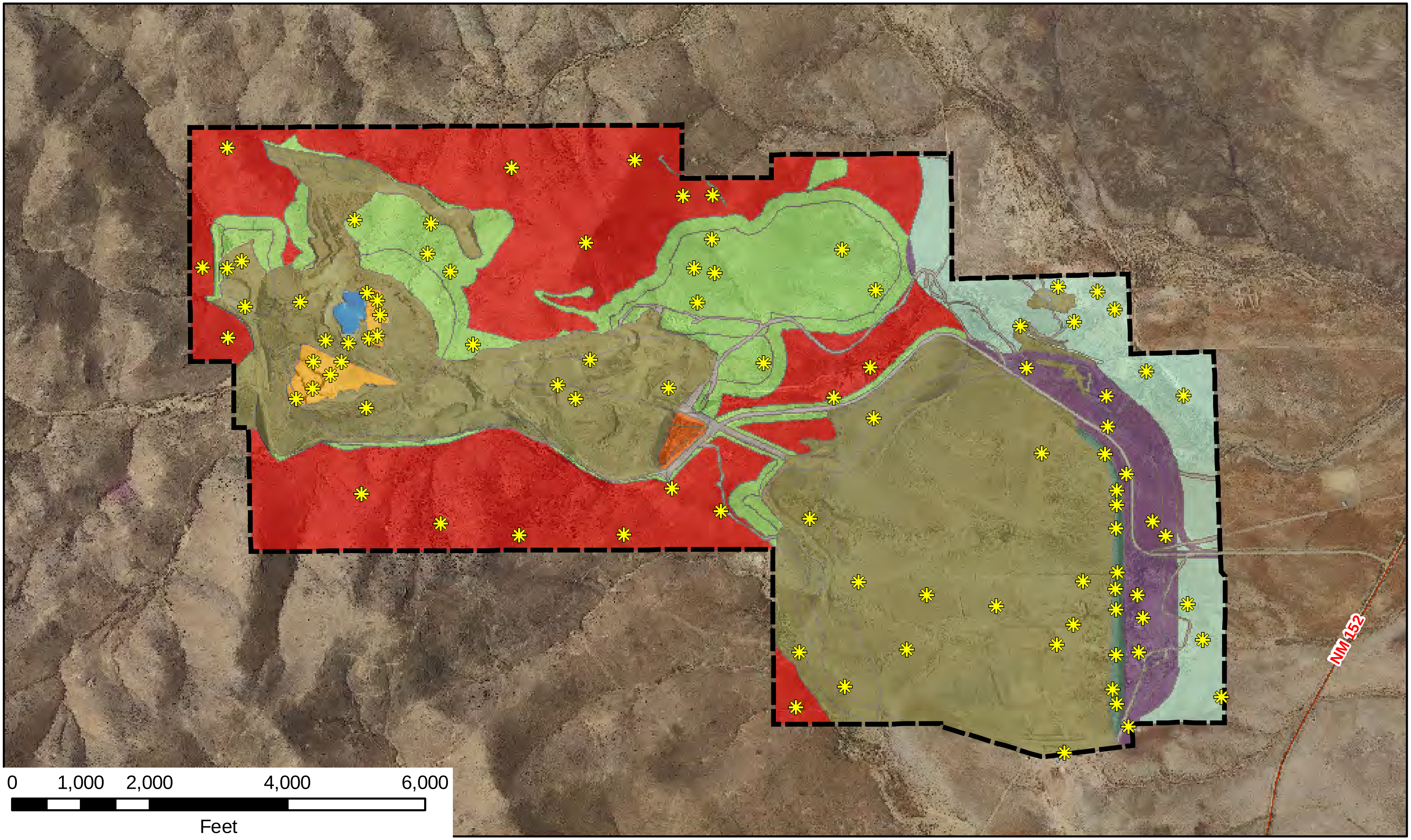


Figure 4-1
Graphical Depiction of the Strata Recommended for Vegetation Sampling and Analysis

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

Legend

- Proposed Mine Permit Boundary
- Preliminary Transect Locations
- Access Road
- Baseline No Proposed Disturbance - Gravelly
- Baseline No Proposed Disturbance - Hills
- Baseline Proposed Disturbance - Gravelly
- Baseline Proposed Disturbance - Hills
- Pit
- Pit Lake
- Saltcedar
- Tailings Dam
- Tailings Pile

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

New Mexico Copper Corporation

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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.