Team 9, a Joint Venture
221 Main Street, Suite 600
San Francisco, CA 94105
Tel: (415) 243-3800
Fax: (415) 882-9261

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Will Duncan, Federal On-Scene Coordinator
United States Environmental Protection Agency
Emergency Response Section
75 Hawthorne Street
San Francisco, California 94105

Subject: Anaconda Mine Radiation Assessment
Letter Report
102 Burch Drive, Yerington, Nevada
Latitude 38° 59' 38.57" N
Longitude 119° 11' 53.64" W

Dear Mr. Duncan:

The Superfund Technical Assessment and Response Team is pleased to provide you with this letter report summarizing the activities that occurred during the Anaconda Mine Radiation Assessment. Should you have any questions, or require additional information, please do not hesitate to contact me or Chad Gibson at 562.989.8494.

Nicole Testa
Staff Scientist

Attachment 1: Figures
Attachment 2: Tables
Attachment 3: Data Validation Reports
Attachment 4: Boring Logs
Attachment 5: Sampling and Analysis Plan
Attachment 6: Occupational Dose Assessment Plan

1.0 INTRODUCTION

The Team 9 Superfund Technical Assessment and Response Team (START) has prepared this radiation assessment summary report for the Anaconda Mine Removal Assessment project conducted at the Anaconda Mine (site), located at 102 Burch Drive, Yerington, Nevada, for the United States Environmental Protection Agency, Emergency Response Section (U.S. EPA ERS) under technical directive document TO1-09-07-02-0001.

Ore material mined at the site contained naturally occurring radioactive materials (NORM). When the ore was processed for its copper content, it produced technologically enhanced, naturally occurring radioactive materials (TENORM), in which radioactive minerals were either concentrated above natural levels or moved from their natural location, causing an increased risk for exposure and off-site migration. TENORM at the site have been documented in previous investigations in an area known as the Process Area. TENORM identified in the Process Area included materials with elevated levels of radium-226 (Ra-226), radium-228 (Ra-228), thorium-230 (Th-230), thorium-232 (Th-232), and uranium-238 (U-238).

START was tasked with characterizing the extent of radiological contamination in the Process Area to determine the threat of release of radioactive materials to the environment, or exposure to on-site workers or local residents. This report documents the U.S. EPA ERS and START activities related to the assessment of radiological contamination in the Process Area. It does not address other assessments, mitigation, or remediation actions conducted at the site.

2.0 SITE BACKGROUND

2.1 Site Location and Description

The site is located at 102 Burch Drive near Yerington, Nevada. The geographic coordinates at the mine office on Burch Drive are latitude 38^{o} 59' 38.57" North and longitude 119^{o} 11' 53.64" West. The site occupies 3,468 acres (about 5.5 square miles) of disturbed land in a rural area approximately 1 mile west of the City of Yerington; see Figure 1 (all figures found in Attachment 1).

The site is bordered to the north by open agricultural fields, to the west by the Singatse Mountain Range, and the town of Weed Heights to the southwest; Bureau of Land Management (BLM) land to the south, and Highway 95A to the east. Highway 95A separates the site from the city of Yerington to the east.

Due to its size, the Process Area was divided into 12 Decision Units (DU; Figure 2). Decision Units were based on areas of concern identified during the previous Process Area soil investigation conducted by Brown and Caldwell in 2005, and designated by similar historical operations and contiguous process elements.

- **DU 1 – Administration and Maintenance Areas.** This area includes the Administration Office, Change House, School House, Assay Lab, Large Warehouse, Small Warehouse, Quonset Hut, Grease Shop Nos. 1 and 2, Filling Station Nos. 1, 2 and 3, and Concrete Pad.

- **DU 2 – Truck Shop and Crushers.** This area includes the Truck Shop, Equipment Garage, Truck Wash/Paint Shop, Equipment Wash, Carpenter Shop, Lead Shop, Fire Engine Storage, Emergency Shed, Sheet Metal Shop, Primary Crusher, Secondary Crusher, and Stacker.

- **DU 3 – Vat Leach Tanks.** This area includes the eight large Vat Leach Tanks and the Sulfide Ore Stockpile area at the northwestern end of the Vat Leach Tanks.

- **DU 4 – Solution Tanks.** This area includes the three Solution Tanks and the associated Solution Tanks Electrical Building and basements.

- **DU 5 – Precipitation Plant.** This area includes the iron launder and precipitation vats (laundry vats) and associated basements and piping in the Precipitation Plant.

- **DU 6 – Sulfide Plant.** This area includes the remaining concrete foundations and thickener tanks associated with the Sulfide Plant and the Sulfide Plant Foremen's Office.

- **DU 7 – Calcine Ditch.** This area includes approximately 2,400 feet of the large ditch area at the northwestern end of the Process Areas known as the Calcine Ditch.

- **DU 8 – North Solution Ditch.** This area includes 1,000 feet of a Solution Ditch of unknown origin or purpose located between the Precipitation Plant and the Sulfide Plant.

- **DU 9 – East Solution Ditch.** This area includes 1,200 feet of a Solution Ditch located northeast of the Precipitation Plant at the base of the vat leach tailings pile.

- **DU 10 – North Low Area.** This area includes the northern half of a topographically low area on the northeastern side of the Process Areas. It also includes an earthen Surge Pond and Concrete Ramps.

- **DU 11 – South Low Area.** This area includes the southern half of the topographically low area in addition to the Upper Truck Sludge Pond, Lower Truck Sludge Pond, and Ditch between Upper and Lower Truck Sludge Ponds.

- **DU 12** – This area covers portions of the Process Area not previously investigated.

2.2 Site History

The site began operation in or about 1918, and was originally known as the Empire Nevada Mine. From 1951 to 1978, the site was occupied by the Anaconda Copper Company. In approximately 1978, Atlantic Richfield Company (Atlantic Richfield) acquired Anaconda, and began operations. In approximately 1982, Atlantic Richfield sold its interests in the private lands within the site to Don Tibbals, a local resident, who conducted minor mining operations at the site. Mr. Tibbals subsequently sold his interests, with the exception of the Weed Heights community, to Arimetco, Inc. (Arimetco), who is the current owner. Arimetco operated a copper recovery operation from existing ore heaps within the site from 1989 to November 1999. Arimetco terminated operations at the site, and is currently managed under the protection of the United States Bankruptcy Court in Tucson, Arizona. The approved bankruptcy plan anticipates a liquidation of Arimetco's operations at the site (Ecology and Environment, 2000). During the 25-year period that Anaconda and Atlantic Richfield operated the site, they removed approximately 360 million tons of ore and debris from the open pit mine, much of which now remains in tailings or leach heap piles. Anaconda and Atlantic

Richfield extracted copper from the mine by two separate copper ore processing methods, depending on the ore type. The mined ore contained copper oxides in the upper portion of the open pit, and copper sulfides in a lower portion of the open pit. During on-site milling operations, a copper precipitate was produced from the oxide ore, and a copper concentrate was produced from the sulfide ore. One processing method involved laying copper oxide ore in leaching vats and leaching out copper with sulfuric acid. The resulting tailings were referred to as vat leach tailings (VLT). The copper subsequently precipitated out after passing the leachate over scrap iron. Beginning in 1965, Anaconda and Atlantic Richfield also began using a second process for the oxide ore in which dilute sulfuric acid was spread over the tops of low-grade oxide ore piles, which leached out the copper. The resulting acidic solution containing copper was collected and the copper recovered by passing the leachate over scrap iron to precipitate the copper. The copper sulfide ore was processed by crushing and concentrated by flocculation. Lime was then added to maintain an alkaline pH, and the resulting copper concentrate was shipped off-site for final processing (NDEP, 1994; Arimetco, 1998).

In another processing method, Arimetco leached the ore successively with a mild acid solution and kerosene in three process vats (approximately 200,000 gallons). A stronger sulfuric acid solution subsequently removed copper from the kerosene solution. A final electro-winning plant plated the copper onto stainless-steel sheets. The operator recirculated the acid solution from the electro-winning vats back into the leach heaps. The leach heaps remain on-site, and are a continuing source of acidic run-off (Ecology and Environment, 2000).

By-products of the milling operation were wet gangue from the sulfide ore, wet tailings, and iron- and sulfate-rich acid brine from the oxide ore. Uranium is also present naturally in virtually all soil and tailings onsite.

The ore material from the Yerington Mine contains naturally occurring radioactive minerals. Processing of that ore produced TENORM, in which the radioactive minerals were concentrated above natural levels in tailings and process solutions (U.S. EPA, 2006).

2.3 Regulatory Involvement

The site has been the subject of numerous regulatory actions by the Nevada Division of Environmental Protection (NDEP), U.S. EPA Remedial Branch, and U.S. EPA ERS since the early 1980s. In 2001, the U.S. EPA proposed placing the site on the National Priorities List (NPL); however, the State of Nevada (the State) objected, because the State was working on the site under a voluntary agreement with ARCO to mitigate hazards. U.S. EPA agreed to defer listing to allow the State to continue the voluntary remediation approach, while reserving the right to reconsider listing on the NPL if efforts did not prove effective. U.S. EPA negotiated a Scope of Work and Memorandum of Understanding with the State and BLM to further address site investigations and cleanup activities, with NDEP retaining lead responsibility, and U.S. EPA providing oversight.

In late 2004, NDEP requested that U.S. EPA take the regulatory lead, due to the increased complexity of contaminants, including radioactive contamination. In early 2005, the U.S. EPA assumed regulatory lead and issued a Unilateral Administrative Order to ARCO. Currently, U.S. EPA and ARCO are drafting a series of work plans addressing site-wide investigations, security, and health and safety.

2.4 Geologic Conditions

The Yerington Mine site is located on the west side of Mason Valley, a structural basin surrounded by uplifted mountain ranges. The area is typical of basin-and-range topography. The mountain blocks are primarily composed of granitic, metamorphic, and volcanic rocks with minor amounts of semi-consolidated to unconsolidated alluvial fan deposits. The Singatse Range has been subject to metals mineralization, as evidenced by the large copper porphyry ore deposit at the Yerington Mine.

The Process Areas of the Yerington Mine site are located on the distal edge of an alluvial fan, between the Singatse Mountain Range and fluvial deposits associated with the Walker River. The source area for the fan is a major drainage feature referred to as The Canyon on the USGS Yerington 7.5-minute quadrangle (1986). The head of The Canyon is shown near Singatse Peak at approximately 6,000 feet above mean sea level (msl) and runs approximately 2 miles south and east to the head of the alluvial fan at approximately 4,800 feet above msl, and the base is between 4,380 and 4,420 feet above msl. The Process Areas are located approximately 1 mile downslope from the head of the fan at an elevation of approximately 4,450 feet above msl. Natural topography in the area has been altered by mining and milling operations (Brown and Caldwell, 2005).

2.5 Previous Investigations

Numerous assessments, investigations, radiological monitoring events, and mitigation actions have been conducted at the site since 2000. The START document *Sampling and Analysis Plan for Radiation Assessment of the Anaconda Mine Site Process Area, Yerington, Nevada*, July 2007 (SAP) provides a more detailed summary of previous investigations (Attachment 5).

In November and December 2005, Brown and Caldwell, contractors for Anaconda, conducted a surface and subsurface investigation at the site. This study obtained monitoring data for gamma radiation, as well as laboratory results for radioisotopes. Surface and subsurface soil samples collected during the investigation documented concentrations of Ra-226 and Ra-228 in multiple areas that exceeded U.S. EPA Preliminary Remediation Goals (PRGs). Additionally, 30 groundwater samples were collected from the process areas of the site. None of the groundwater samples exceeded the U.S. EPA Maximum Contaminant Level (MCL) for Ra-226; however, three groundwater samples exceeded the MCL for Ra-228, and 15 exceeded the MCL for total uranium (Brown and Caldwell, 2005).

3.0 RADIATION ASSESSMENT ACTIVITIES

Based on the presence of TENORM identified in previous investigations at the site, the U.S. EPA ERS tasked START to perform the following preliminary assessment activities to characterize radiological contamination in the Process Area:

- Health and safety assessment to ensure worker health and safety during the radiation assessment.
- Surface radiation assessment throughout the Process Area, which included using a combination of field observations, direct-reading instruments, and surface soil sample collection and analysis.
- Subsurface radiation assessment throughout the Process Area, which included installation of borings, use of direct-reading radiation instruments, and collection and analysis of subsurface soil sample.
- Surface radiation assessment in vats located in the Process Area, which included using a combination of direct-reading instruments, and sample collection and analysis.

The U.S. EPA also tasked the U.S. EPA's Radiation and Indoor Environments National Laboratory (RIENL) with performing surface soil radiation surveys in the Process Area.

All START data collection activities were in accordance with the SAP. RIENL's staff data collection activities were in accordance with RIENL standard operating procedures.

3.1 Radiological Instrumentation

Radiological instrumentation was used in during the assessment to obtain data to meet the project objectives. All instruments were within current calibration and operated in accordance with manufacturer's instructions. Surveys with hand-held direct-reading instruments were performed in accordance with Team 9 Field Operating Procedures (FOPs); see the SAP in Attachment 5.

For following hand-held instruments were used during the investigation:

- Ludlum Model 2221 ratemeter with Ludlum Model 44-20, a three-inch by three-inch (3"x3") sodium iodide (NaI) detector for surface soil surveys
- Ludlum Model 2221 ratemeter with Bicron Model 112, a 3"x3" NaI detector for surface soil surveys
- Ludlum Model 2221 ratemeter with Ludlum Model 43-90, a 126-square centimeter alpha scintillator detector for surface surveys of objects
- Ludlum Model 2360 ratemeter with Ludlum Model 43-93, a 100-square centimeter alpha/beta scintillator detector for surface surveys of objects
- Ludlum Model 2241-3 ratemeter with Ludlum Model 44-62, an ½-inch by one-inch NaI detector for subsurface soil surveys
- Ludlum Model 19, a 1"x1" NaI detector for area exposure rate surveys
- Ludlum Model 192, a 2"x1" NaI detector for area exposure rate surveys
- Ludlum Model 2221 ratemeter with Ludlum Model 43-78 five inch alpha scintillator detector for swipe sample field screening and air filter sample field screening

The 3"x3" NaI detectors were held at six inches above the ground surface and moved in a serpentine pattern at approximately one to two feet per second during surface soil surveys. The detection field of view for these detectors was approximately a three foot diameter area. The alpha and alpha/beta detectors were placed less than one inch from the surface of various objects of interest. Either a scanning survey at a rate of one to two inches per second or a static measurement was performed.

The ½-inch by one-inch NaI detector was used to collect gamma radiation measurements in subsurface soil boreholes. The detector was held at various intervals for approximately 15 seconds to allow the detector to reach full scale before a reading recorded.

A gamma energy window was set to Ra-226, using a 5-microcurie Ra-226 check source, for all 3"x3" NaI detectors. This provided for a lower gamma radiation background and increased sensitivity to Ra-226 and progeny.

Quality control (QC) limits were set for background and a check source to verify all hand-held instruments for operational compliance. The QC limits were checked before the instrument was used each day and at the end of the day. Instruments that failed either QC limit three times during a QC check were taken out of service, repaired, and new QC limits determined before reusing.

Three additional field portable instruments were used to collect radiological data as follows:

- Canberra High-Purity Germanium (HpGe) Model 5030 detector with ISOCS data processing software for surface soil gamma spectroscopy

- General Electric Reuter-Stokes Model RSS-131 high-pressure ion chamber (HPIC) for surface soil integrated exposure rate measurements

- Environmental Radiation Ground Scanner (ERGS); detailed description provided below

The HpGE detector was set at a height of 30 centimeters above the ground surface and a gamma spectrum collected for approximately five minutes. The spectrum was post-processed using ISOCS data processing software to estimate the concentration of radionuclides in the surface soil.

The HPIC was set at a height of one meter above the ground surface and data logged an exposure rate measurement every second for approximately six minutes. The detection field of view was approximately a 10 foot diameter area. The data set was post-processed to calculate the average exposure rate in milliroentgen per hour (mR/hr). The HPIC detector takes approximately 90 seconds to stabilize, so the first 90 seconds of data were not used to calculate the average exposure rate. The remaining data was averaged to calculate the exposure rate; a minimum of 180 data points were averaged.

The ERGS system consists of an array of eight sodium iodide (NaI) detectors for scanning ground surfaces. The detectors are four inches by four inches by 16 inches in size and the array is collimated with ½ inch lead and ¼ inch steel on all sides and the top. The window faces the ground surface at a height of 18 inches with a detection field of view of approximately 6 feet by 6 feet. The detector array is mounted on an all-terrain vehicle and operated at a scanning rate of approximately four feet per second. Gamma radiation measurements are collected once per second with a global positioning system (GPS) coordinate. Data is stored on an onboard computer system and post-processed based on project objectives.

3.2 Background Determination

In the beginning of the project, an area located in the northeast section of DU 1 was surveyed by the ERGS as a potential background location. This area was a storage yard that was suspected as not impacted by site activities. The ERGS surveyed an area of approximately 50 feet by 200 feet to determine a background measurement. Three randomly selected locations within the storage yard were selected for the background determination for the 3"x3" NaI detectors. A one minute static count was collected for each 3"x3" NaI detector at each of the three locations and the average background measurement calculated. Daily background determinations were performed during the assessment.

At the end of the assessment, EPA selected the background air sampling station located southwest of the site as an area representative of background. The ERGS surveyed a 50 foot by 200 foot area to re-determine background; this measurement was used for post-processing the ERGS data. The background for the 3"x3" NaI detectors was not re-determined as the hand-held surveys had been completed and areas delineated based on the storage yard background data.

Five background locations (SS-01, SS-02, SS-03, SS-51, and SS-52) were selected as representative of naturally occurring radiation levels (Figure7). These locations were sampled for surface soil and radiation measurements were collected with the HpGe, ERGS, and HPIC. Locations SS-51 and SS-52 were located adjacent to the background air sampling station located southwest of the site as representative of the site background. Locations SS-01, SS-02, and SS-03 were located in DU 12 in an area believed to have not been impacted by operations and were proposed as potentially representative of background for the Process Area. However, the EPA selected the area adjacent to the background air sampling station as the project background location.

3.3 Health and Safety Assessment

Prior to assessment activities, START performed a health and safety assessment to ensure worker safety during the investigation in accordance with the Occupational Dose Assessment Plan (ODAP, TPC 2007). From July 24 to July 27, 2007, twenty-four air samples were collected and field screened for alpha radiation. Each day, five air samples were collected downwind of the Process Area, with one sample collected at the Anaconda Mine off-site background air sampling station. Air monitoring locations are illustrated in Figure 3. Air filter samples were field-screened with a Ludlum Model 2200 ratemeter with a Ludlum Model 43-78 alpha detector soon after collection. The air samples were again field-screened periodically over the next week.

The highest activity of alpha particles (corrected for background) for each day was used to estimate worker ambient particulate inhalation dose. In addition, external gamma radiation doses were based on real-time dosimeters worn by the field team performing activities during the four day assessment. Finally, a conservative estimate of internal dose from radon gas was estimated based on sampling and analysis of field-based radon samplers.

These dose estimates were summed and evaluated to determine if workers could exceed regulatory limits in accordance with the Occupational Dose Assessment Plan (Attachment 6). The conservative total estimated dose did not exceed occupational regulatory limits.

3.4 Surface Assessment

To identify and delineate potential areas of concern, a gamma radiation surface assessment of the Process Area was completed from July 31 through August 9, 2007. The surface assessment covered a majority of the Process Area DUs, except for areas that were not accessible due to steep slopes, structures, and debris and around the buildings on the southeastern portion where contamination was not expected. In addition, budget constraints did not allow for additional field surveys in low priority areas like the southeastern portion of the Process Area, so a very cursory survey was performed with the ERGS. Based on the results of the surface assessment, 48 locations within the Process Area were selected for additional radiological assessment.

3.4.1 Radiation Surface Survey

To identify and delineate potential areas of surface radiation contamination, a gamma survey of a majority of the accessible surface within the Process Area was completed using the ERGS and hand-held 3”x3” NaI detectors. The total area surveyed with both the ERGS and 3”x3” NaI detectors is illustrated on Figure 6.

An investigation level of two times the detector background was established for the 3”x3” NaI detectors to identify potentially contaminated areas. The background for the detectors was approximately 16,000 counts per minute (cpm). Areas above five times the background were also delineated to identify potential higher priority contaminated areas. START members performed the surface soil scanning surveys in accordance with the SAP. Areas that exceeded the investigation level were delineated and marked. A Trimble Global Positioning System (GPS) was used to map the boundaries of marked areas with sub-meter accuracy. Figure 5 illustrates the results of the hand-held surveys. The yellow and red colors depict areas of contamination above twice background for gamma radiation and represent areas of potential contamination. Note that due to the resolution of the figure areas above five times background are not visible although several areas were delineated. These areas can be determined by close examination of the geographic information system (GIS) data generated to produce this figure.

The ERGS did not have a pre-selected investigation level; instead, data were logged with collocated GPS coordinates, and post-processed. Results are discussed in Section 4.

Throughout the site, remains of piping, piping debris, and pipe scale were visible on the surface ground, particularly south of the Laundry Vats within DU 4 and DU 5. Hand-held instruments and the ERGS were used to scan these areas whenever possible. Piping materials were notably high in gamma radiation activity, in some cases exceeding the upper range of the field instruments. No attempt was made to differentiate high activity pipe scale from soil contamination.

Results of the surface radiation surveys were reviewed by U.S. EPA ERS, RIENL, and START members. Based on professional judgment, 47 locations within the Process Area were selected to for additional assessment (Figure 7). Locations were selected based on gamma radiation measurements that exceeded the investigation level. In addition to the 47 judgmental sampling locations, the five background locations (SS-01, SS-02, SS-03, SS-50, and SS-51) were selected.

At these locations HpGe and HPIC measurements were obtained and surface soil samples were collected for laboratory analysis as discussed in Section 3.3.2. The HpGe data was collected between August 1 and 5, 2007 and the HPIC data was collected between September 26 and 27, 2007. Screening data results for each location are summarized in Table 1 (all tables are located in Attachment 2). These data were analyzed to determine if a correlation existed between the ERGS, HpGe, and HPIC. Qualitative correlation was observed between the data sets.

3.4.2 Surface Soil Sampling

During the August field event, grab and composite surface soil samples were collected from 53 sample locations in accordance with the SAP (Figure 8). Composite soil samples were identified with the letter "C" as a suffix for the sample number. For example, the grab sample collected at location 1 was numbered SS-01, whereas the composite sample collected at that location was numbered SS-01-C. Duplicate samples were designated with a "DUP" suffix; e.g. SS-02-DUP is a duplicate of SS-02.

The surface soil samples were collected from the ground surface to a maximum of four inches below ground surface. A grab sample at each location was collected except at 10 locations where a five point composite sample was collected from a three-foot diameter circle. The circle was divided into four equal sections with an "X" and an aliquot collected from the center and from the four points of the "X" near the outer edge of the circle. All five aliquots were combined to form a single sample. The composite samples were collected to determine if contamination was homogenous within a three-foot diameter area at select locations. Almost all grab and composite sample result pairs indicated homogeneity for Ra-226.

All samples were submitted for laboratory analysis by the U.S. EPA National Air and Radiation Environmental Laboratory (NAREL) by Method GAM-01, Gamma Spectroscopy. Forty of the 53 samples were submitted for analysis by General Engineering Laboratory (GEL) by Method HASL 300, 4.5.2.3 (EPA Method 903.1) for Ra-226; this method has greater accuracy for Ra-226 than Method GAM-01. The remaining 13 samples were not submitted to GEL as insufficient sample volume was available after the analysis by Method GAM-01. All analytical results were reviewed and validated by a START chemist in accordance with *Quality Assurance/Quality Control Guidance, Sampling QA/QC Plan Validation Procedures*, *OSWER Directive 9360.4-1, April 1990*. Surface soil sample analytical results are summarized in Table 2. Data validation reports, including the laboratory analytical data sheets, are provided in Attachment 3.

3.5 Subsurface Assessment

To investigate the potential vertical extent of radiological contamination, 16 of the 52 surface soil sampling locations were selected for subsurface investigation (Figure 9). The subsurface investigation occurred from October 25 through November 1, 2007.

Selection of boring locations was based on accessibility and the professional judgment of U.S EPA and START, using the radiation results collected during this investigation to bias locations with elevated activity surface radiation measurements. At each of the 16 selected locations, soil borings were advance to approximately 30 feet below ground surface (bgs) using a sonic drilling system. The geologic nature of the borings was logged and recorded on field boring logs (Attachment 4).

Continuous cores were collected from the borings and placed into bags. Samples were collected from each core in 5-foot intervals over the total length of the core. In addition, field screening of each core was conducted using a hand-held NaI detector. If a measurement of a specific location on the core exceeded the investigation level, then a sample was collected. A subset of samples was submitted to NAREL and GEL for analysis by GAM-01 and HASL 300, 4.5.2.3 (EPA Method 903.1), respectively. All analytical results were reviewed and validated by a START chemist in accordance with *Quality Assurance/Quality Control Guidance, Sampling QA/QC Plan Validation Procedures*, *OSWER Directive 9360.4-1, April 1990*. Selected laboratory analytical data are summarized in Table 3. Data validation reports, including the laboratory analytical data sheets, are provided in Attachment 3.

Following the removal of the core from the boring, a temporary 1-inch-diameter Schedule 40 polyvinyl chloride pipe was inserted into the boring to prevent collapse. A Ludlum Model 2221 ratemeter with Ludlum Model 44-62 detector was lowered into the boring. Total activity measurements were collected at 6-inch intervals from ground surface to the bottom of the boring and recorded on field boring logs. These measurements represent a qualitative determination of potential subsurface contamination based on locations within the borehole that exceeded twice background (background was 2,500 cpm). Measurements are summarized in Table 4 and the field logs are provided in Attachment 4.

All boreholes were backfilled in accordance with Nevada State guidelines.

3.6 Vat Assessment

3.6.1 Laundry Vats

Within DU 5 there are 42 “laundry vats.” Each vat is approximately 12 feet wide and 60 feet long with a wall thickness of approximately one foot. The depth of each vat varies. At the request of the U.S. EPA ERS, START and U.S. EPA’s Environmental Response Team (ERT) performed radiation scanning surveys of six of the 42 laundry vats (LV-41, LV-38, LV-35, LV-32, LV-25, and LV-17 on August 2 and 3, 2007. Not all vats were surveyed because of restricted accessibility and time constraints. Each vat was surveyed for gamma radiation using a Ludlum Model 19 or Model 192 ratemeter and select wall locations were surveyed for alpha radiation with a Ludlum Model 2241-2 with Ludlum Model 43-90 alpha scintillator. Wipe samples for removable particulate were collected along the vat walls and field-screened with an alpha particle counter (Ludlum Model 2221 with a Ludlum Model 43-78).

In general, gamma radiation in the laundry vats exceeded the investigation level of two times background, with some areas exceeding ten times background. Alpha radiation averaged 75 to 80 cpm on vat walls. The highest measurement collected was in LV-17 along the southeastern corner wall. The alpha radiation detected in this location was approximately 400 cpm. Alpha contamination was not detected on the swipes indicating that the contamination was fixed.

3.6.2 Leaching Vats

Eight large leaching vats are located within DU 3. According to ARCO representatives, these vats were historically used to impregnate a leaching solution from the ores mined on site. ARCO has proposed to use these vats as a repository for on-site disposal of radioactive wastes. The U.S. EPA ERS considered these vats as a potential waste repository and directed START to perform an exterior and interior radiation assessment on the leaching vats. The assessment was conducted to determine if radiological contamination was present in the vats. For the purpose of this assessment, vats were numbered from south to north, VAT 1 though VAT 8 (Figure 5). Based on the professional judgment of Team 9's Health and Safety Officer, the leaching vats met the requirements of a permit-required confined space in accordance with Occupational Safety and Health Administration's regulations.

On October 29, 2007, prior to vat entry, START and a representative from EPA's Emergency Rapid Response Services (ERRS) contractor assessed the integrity of the vats. Based on this assessment, the vats were found structurally sound for entry.

Between October 30 and 31, 2007, START performed permit-required confined space entries into Vats 1, 2, 5, and 6. Access to the vats was achieved through the use of an aerial lift, ladders, and fall protection equipment. START performed air monitoring for oxygen, toxic gases, flammable vapors, and gamma radiation prior to entry. Results of air monitoring and radiation measurements were noted on the confined space permit. Upon entering each vat, START performed a 100 percent ground surface scanning survey of the interior material using hand-held NaI detectors. The surface soil scan was performed in accordance with Team 9 FOPs.

START field members noted that the interior material was distributed along the bottom of the leaching vats in a "wave-like" pattern. "Waves" were typically evenly spaced and approximately one to two feet high. Timbers along the bottom of the vats were exposed. In general, the tops of the waves showed much less radioactivity than material at the level of the exposed timbers. Nearly all areas of the surveyed vats exhibited a minimum of twice background gamma radiation, with many areas above five and ten times background (Figure 5).

Samples of the interior material were collected throughout the vats. Each sample was a composite of materials at the top and bottom of the "waves." All analytical results were reviewed and validated by a START chemist in accordance with *Quality Assurance/Quality Control Guidance, Sampling QA/QC Plan Validation Procedures*, *OSWER Directive 9360.4-1, April 1990*. Vat soil sample results are presented in Table 4.

3.7 Pipe Scale Assessment

A cursory assessment of two pipes located in a vault in DU 4 was conducted to determine the level of contamination of pipe scale. A Ludlum Model 2360 ratemeter with Ludlum Model 43-93 detector was place inside the pipes within less than one inch of the interior surface. Results for alpha and beta radiation were over 33,000 and 692,000 cpm, respectively, indicating high activity contamination.

4.0 DISCUSSION OF RESULTS AND RECOMMENDATIONS

Surface and subsurface radiation surveys and sample analytical results indicated areas of radiological contamination throughout the Process Area. The following sections present a discussion of action levels used to determine specific areas for a potential removal action.

4.1 Action Level Determination

The U.S. EPA selected a site-specific action level for soil as background plus the EPA PRG for an outdoor worker of 2.58 picocuries per gram (pCi/g) for Ra-226 plus daughters.

An average off-site background soil concentration of 1.21 pCi/g for Ra-226 was determined by this assessment. This value was determined from surface soil samples SS-51 and SS-52 by EML HASL 300, 4.5.2.3 analysis. This value is similar to the Brown and Caldwell average background concentration of 1.26 pCi/g for Ra-226, as noted in the draft report *Background Soils Data Summary Report* (Brown and Caldwell, 2008). The Ra-226 site-specific action level is the sum of 2.58 pCi/g (PRG) plus 1.21 pCi/g (average background concentration), or 3.79 pCi/g.

4.2 Radiation Survey Results

Radiation survey results indicated contamination above the project action level of 3.79 pCi/g Ra-226. Survey results did not provide a definitive delineation of areas above the action level due to the nature of the contamination. The distribution and concentration of radionuclides, such as radium and thorium, was not homogenous. In addition, geometric effects of nearby objects, like debris and structures, skewed measurements. Finally, high activity pipe scale skewed measurements for surface soil in some locations. If the scale was removed, radiation levels in the immediate area may decrease below the action level; i.e. the influence of high activity scale may give the appearance that surface soil is contaminated when it is not.

Due to the complexity of the contamination distribution, ERGS data did not quantitatively correlate with laboratory, HPIC, or HpGe results. A qualitative data analysis was conducted by comparing ERGS data to soil sample results and HpGe data to determine an ERGS measurement that was equivalent to the action level.

The equivalent ERGS measurement was established based on background data. The ERGS surveyed a 50 foot by 200 foot off-site background location, the area adjacent to the background air station. All collected measurements were averaged and the standard deviation calculated. The average was 13,020 counts per second (cps) with a 244 cps standard deviation. The upper confidence level for background was determined as the average plus two times the standard deviation, which equals 13,508 cps.

Analysis of the ERGS measurements compared to soil sample results and HpGe detector measurements indicated that ERGS values of the background upper confidence level (13,508 cps) plus 30 times the standard deviation (7,320 cps) which equals 20,828 cps is approximately equivalent to the site specific cleanup goal of 3.79 picocuries per gram (pCi/g) for radium-226. Figure 4 illustrates the areas above 20,828 cps in red color that represents the estimated area exceeding the cleanup goal.

The yellow color depicted in Figure 4 represents areas above the average upper confidence level (13,508 cps) plus 20 times the standard deviation (4,880 cps), which equals 18,388 cps. This threshold (18,388 cps) represents the potential lower boundary of contamination that could be above the cleanup level.

Figure 5 illustrates hand-held 3”x3” NaI survey results. The hand-held surveys found only very small elevated areas of potential contamination except in the Leaching Vats in DU 3, which, as shown, have large areas of contamination. The correlation between hand survey results and the cleanup goal was not determined. Therefore, these data are used to qualitatively indicate areas of potential contamination.

4.3 Recommendations

ERGS measurements above 20,828 cps represent potential areas of surface contamination above the site-specific action level of 3.79 pCi/g Ra-226. These areas warrant removal of contamination for proper disposal. Surface and subsurface soil locations above the action level are presented in Figure 10. In addition, hand-held instrument data results above twice background warrant further investigation and potential removal for disposal.

All debris that has been identified to contain radioactive materials should be properly disposed; in particular, the piping south of the Laundry Vats within DU 4 and DU 5. Pipes and other debris within this area were found in excess of fifteen times background for gamma radiation. Other pipe or pipe scale materials visible within the Process Area should be collected and properly disposed.

A complete assessment of each of the laundry vats should be completed. Each vat should be surveyed for alpha and gamma radiation. Any materials exceeding site-specific action levels should be disposed.

Following any removal actions, confirmation surveys and sampling and analysis should be completed in accordance with the *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM; EPA, 2001).

5.0 CONCLUSION

The U.S. EPA tasked START to assess the extent of radiological contamination within the Process Area of the Anaconda Mine site. From July through October, 2007, START conducted a site investigation in accordance with the U.S. EPA-approved SAP. The assessment consisted of a health and safety air sampling assessment for worker safety; surface survey for gamma radiation of a majority of the Process Area; surface and subsurface sampling and analysis; and alpha and gamma radiation surveying inside six laundry vats, four leaching large vats, and inside two pipes in a vault. Definitive and screening-level radiation data were generated by this assessment.

Site specific action levels were developed based on data collected during the assessment and professional judgment of U.S. EPA. The site-specific action levels were used to identify areas that the U.S. EPA recommends the removal and disposal of contaminated soil and debris.

6.0 REFERENCES

Brown and Caldwell, 2005. *Data Summary for Process Areas Soil Characterization*, November 1.

Bureau of Land Management, 2004. *Technical Resources Group, "Review of Yerington Mine Characterization Activities*, December.

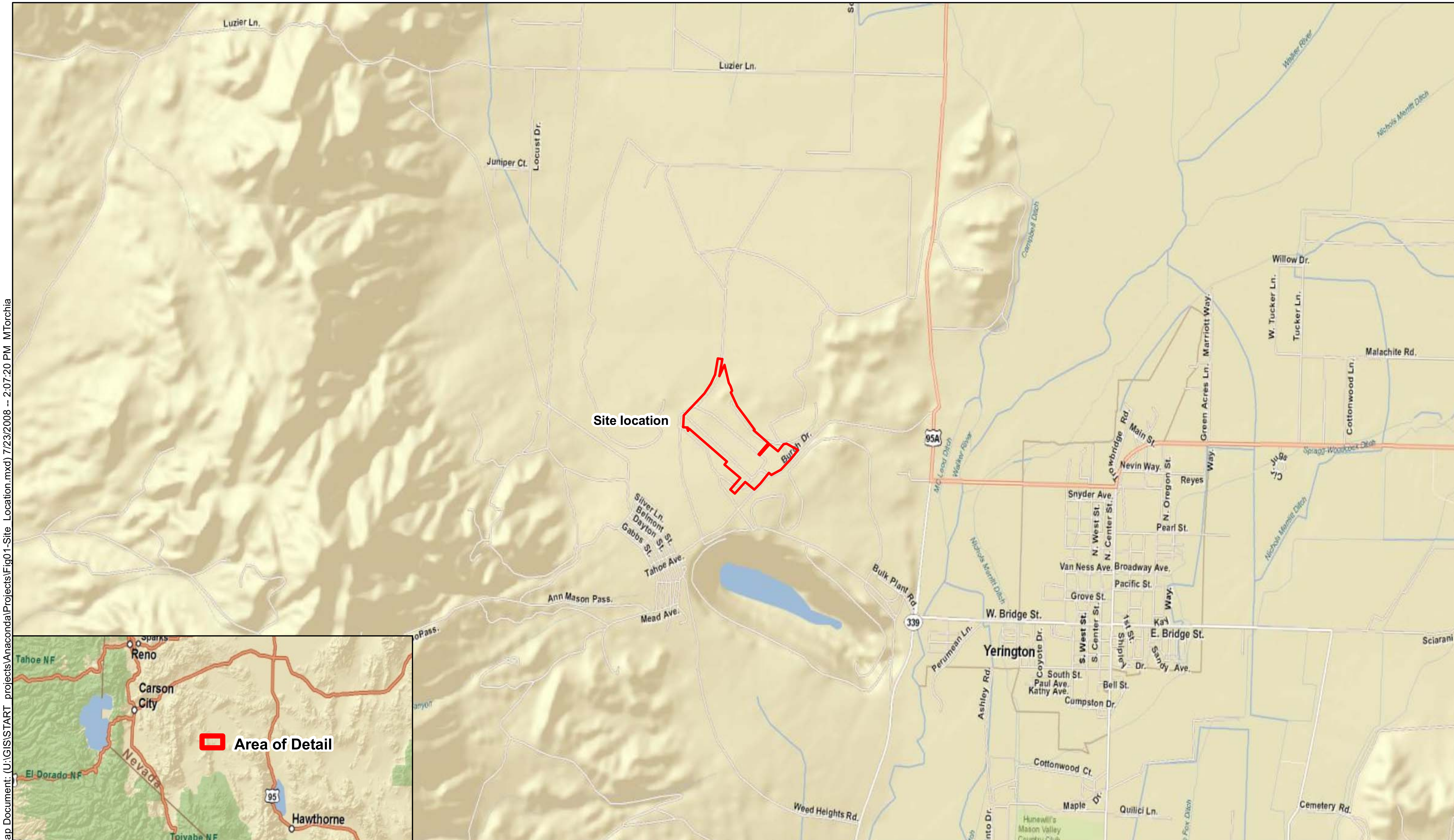
Ecology & Environment, Inc. 2000. Superfund Technical Assessment and Response Team (START), *Expanded Site Inspection, Anaconda Copper Company, Yerington Mine*, December.

Team 9, 2007. *Sampling and Analysis Plan, Radiation Assessment Anaconda Mine Site Process Area, Yerington, Nevada*, July.

U.S. EPA, 2001. Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM).

Attachment 1: Figures

Map Document: (U:\GIS\START_projects\Anaconda\Projects\Fig01-Site_Location.mxd) 7/23/2008 -- 2:07:20 PM MTorchia



N

0.5 0 0.5 Miles

START T9 REGION 9	Anaconda Mine Removal Assessment	Site Location	*Figure 1*
	28067219		*August 2007*

Map Document: (U:\GIS\START_projects\Anaconda\Projects\Fig02-Decision_units.mxd) 7/23/2008 -- 2:24:14 PM MTorchia

LEGEND

Decision Unit

START T9 REGION 9	Anaconda Mine Removal Assessment	Process Area - Decision Units	*Figure 2*
	28067219		*August 2007*

Map Document: (U:\GIS\START_projects\AnacondaProjects\Fig03-Air_monitoring.mxd) 7/23/2008 -- 2:43:19 PM MTorchia

LEGEND

Air sampling location number

400 0 400 Feet

1 inch equals 400 feet

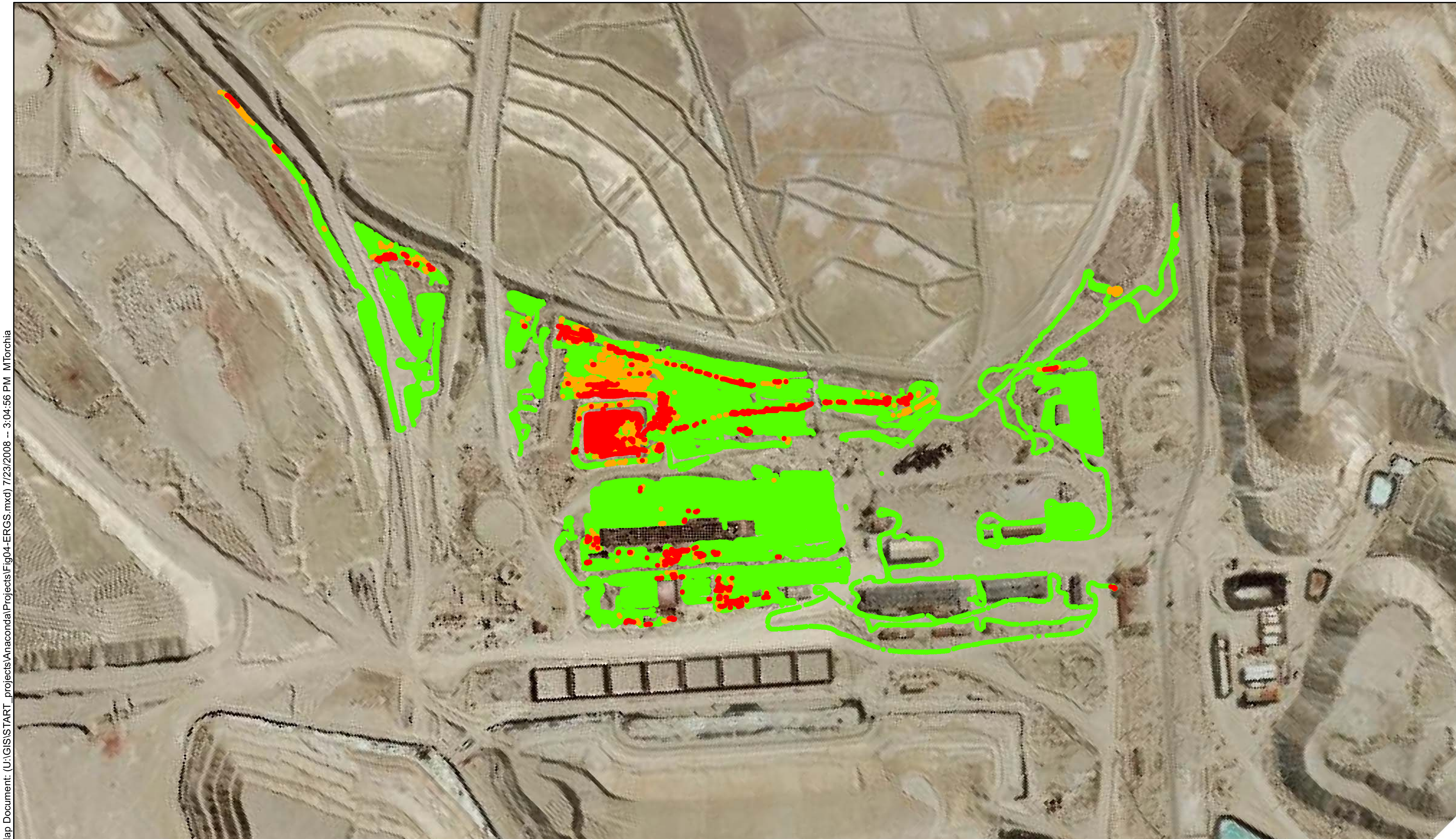
Anaconda Mine Removal Assessment

28067219

Process Area - Air Sampling Locations

Figure 3

August 2007



LEGEND

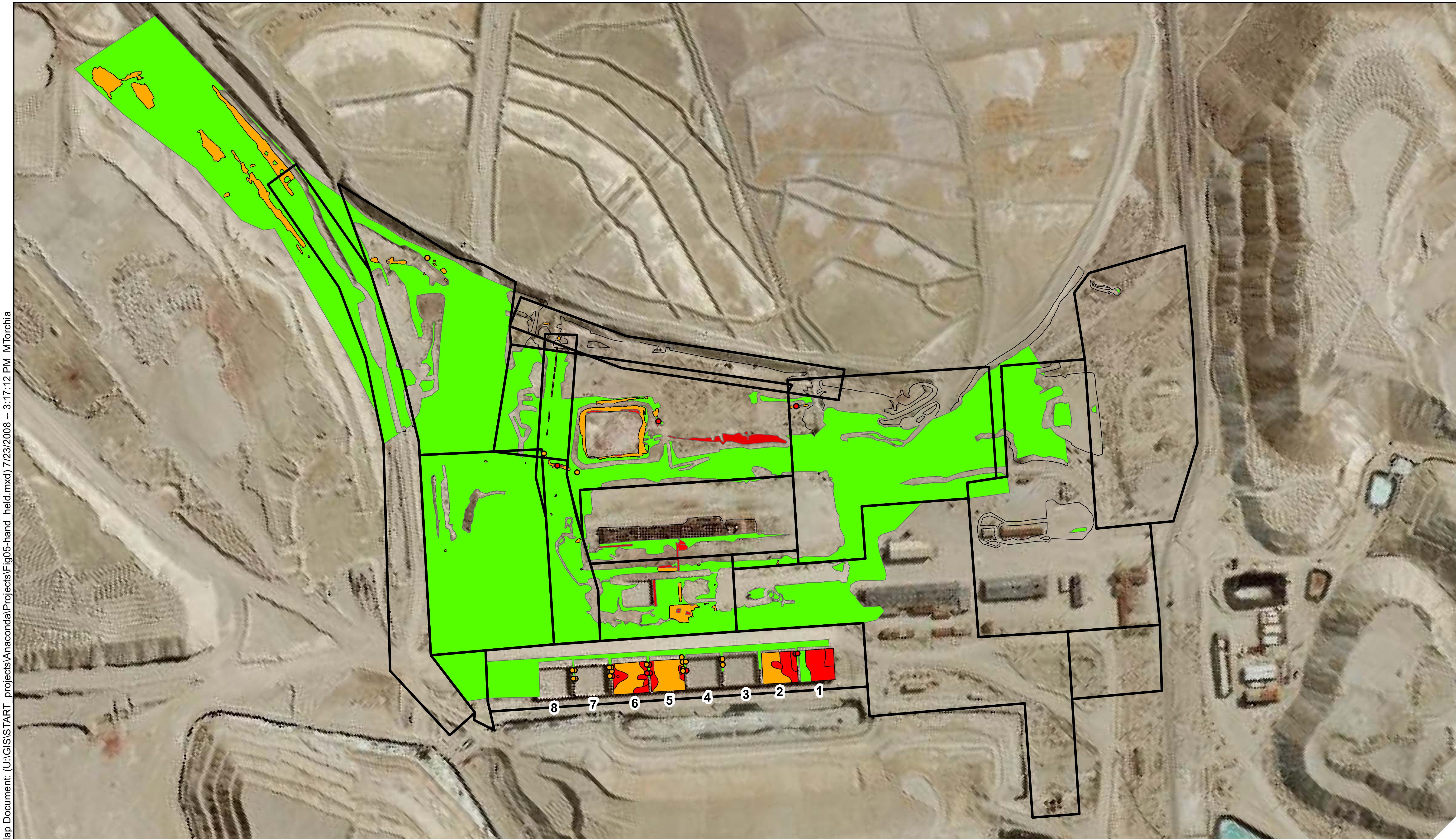
ERGS (Gamma counts per second)

- 0 - 18,388
- 18,389 - 20,828
- 20,829 - 48,375

ERGS: Environmental Radiation Ground Scanner

350 0 350 Feet

START T9 REGION 9	Anaconda Mine Removal Assessment	Process Area ERGS Gamma Survey Results Average Plus 30 Times Standard Deviation	*Figure 4*
	28067219		*August 2007*



LEGEND

Hand Held Gamma Survey - Times Above Background

- 0 - 2
- 2 - 5
- >5

- 0 - 2
- 2 - 5
- >5

350 0 350 Feet

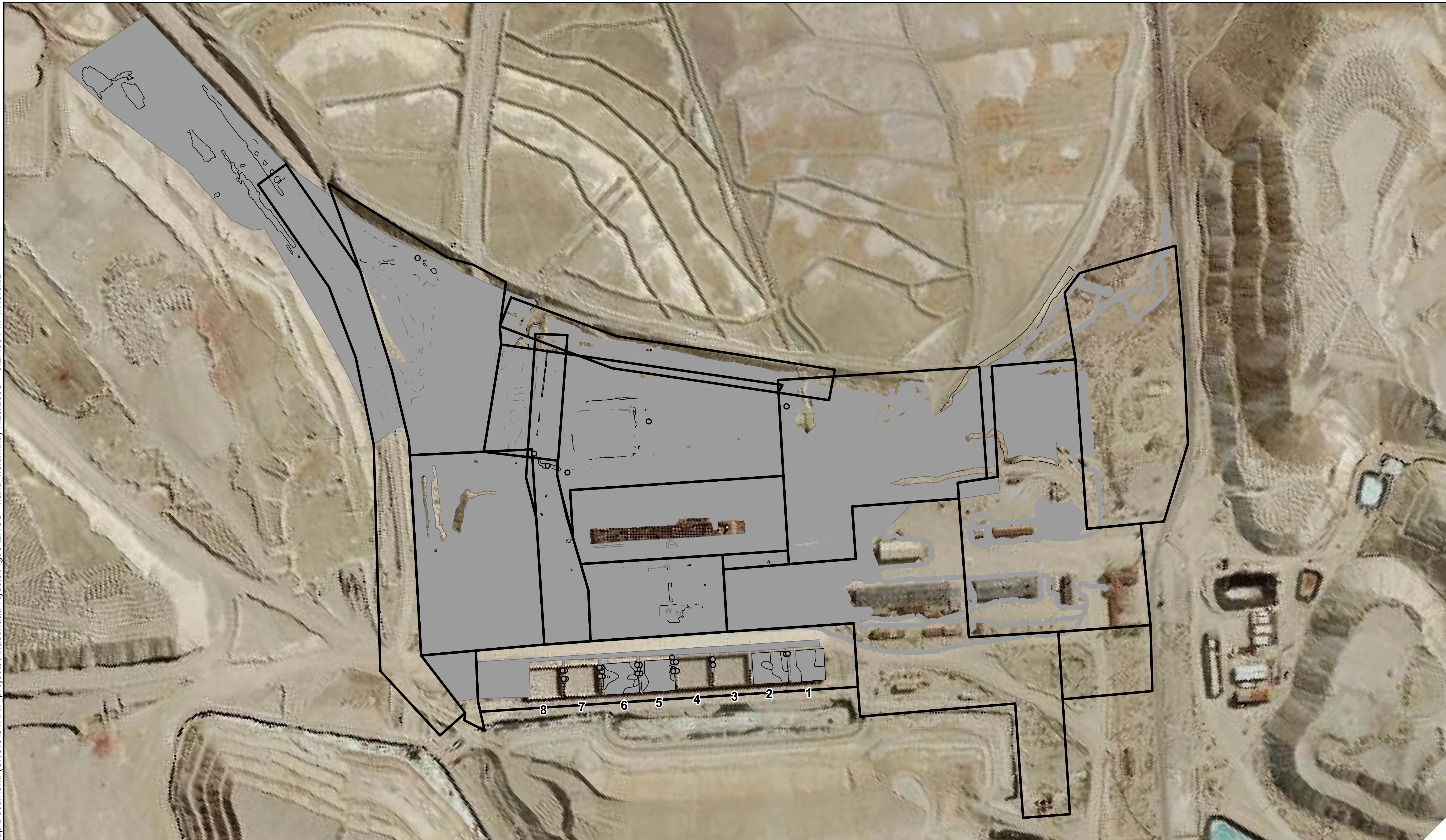
Anaconda Mine Removal Assessment

28067219

Process Area - Hand Held Gamma Results

Figure 5

August 2007



Map Document: (U:\GIS\START_projects\Anaconda\Projects\Fig06-ERGS+hand_held.mxd) 7/23/2008 -- 3:27:55 PM MTorchia

LEGEND

Surveyed area

Surveyed area

350 0 350

Feet

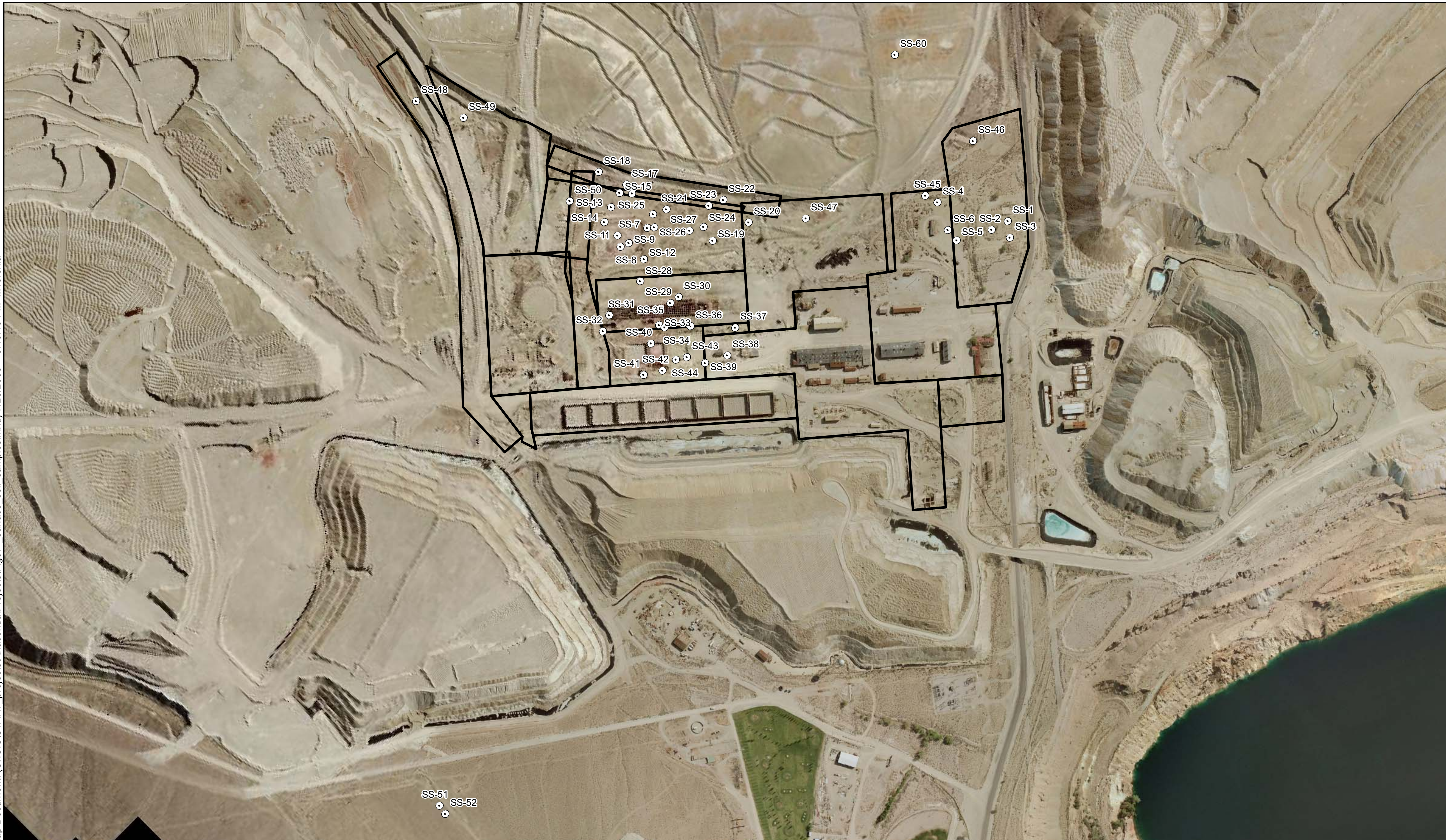
Anaconda Mine Removal Assessment

28067219

Process Area -
Surface Area Surveyed

Figure 6

August 2007



Map Document: (U:\GIS\START_projects\Anaconda\Projects\Fig07 - surface_soil_samples.mxd) 7/23/2008 -- 3:40:10 PM MTorchia

LEGEND

⊙ Sample location

350 0 350

Feet

START T9 REGION 9	Anaconda Mine Removal Assessment	Process Area - Surface Sample Locations	***Figure 7***
	28067219		***August 2007***

LEGEND

☉ Sample location

350 0 350 Feet

Anaconda Mine Removal Assessment

28067219

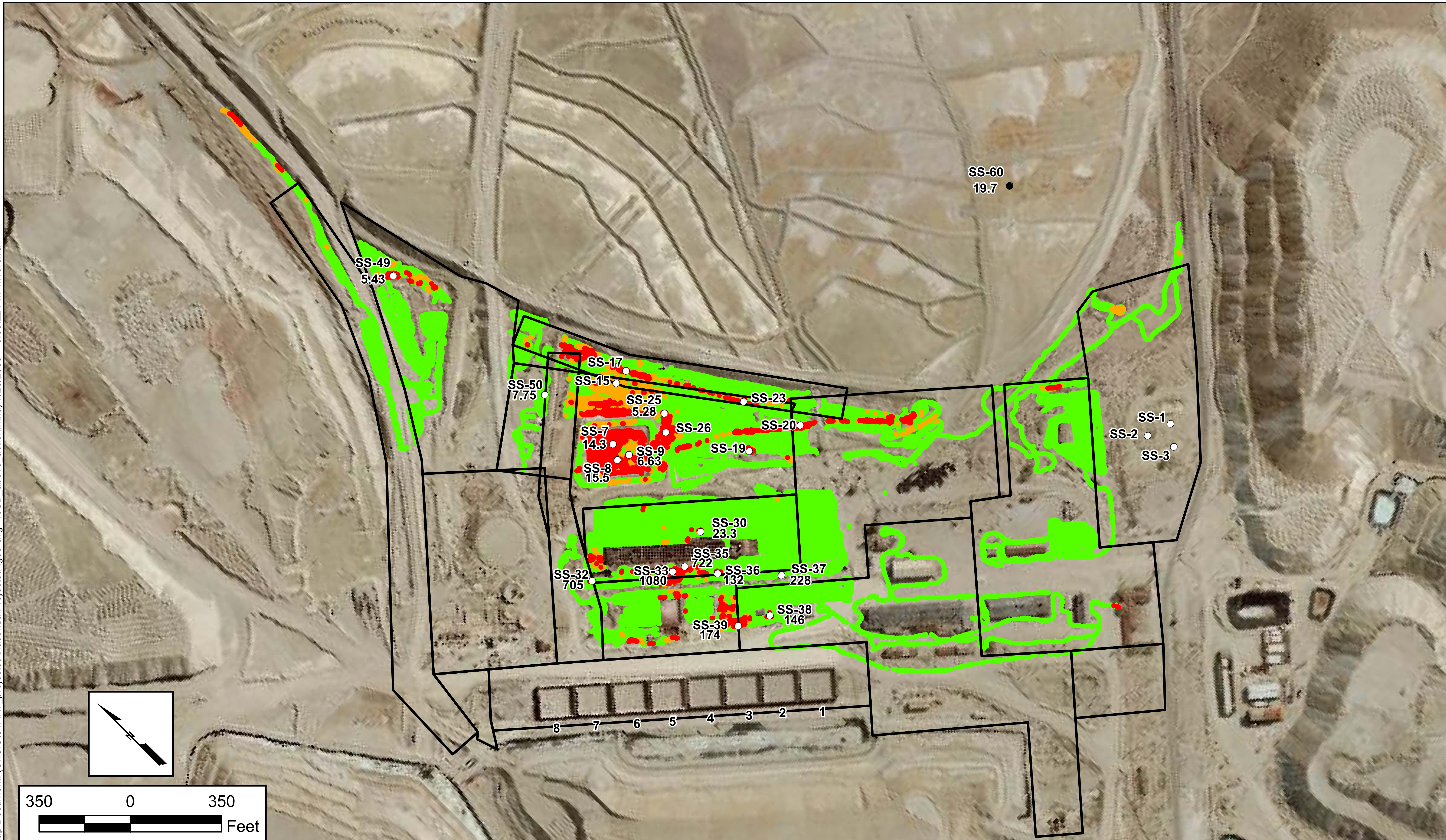
Process Area
Surface Soil Sample Locations

Figure 8

August 2007

Map Document: (U:\GIS\START_projects\Anaconda\Projects\Fig08-soil_samples.mxd) 7/23/2008 -- 3:46:26 PM MTorchia

Map Document: (U:\GIS\START_projects\Anaconda\Projects\Fig09-avg+40SD_above_action.mxd) 7/23/2008 -- 3:53:22 PM MTorchia



LEGEND

ERGS Gamma (Average plus 30 times Standard Deviation in counts per second)

- 0 - 18,388
- 18,389 - 20,828
- 20,829 - 48,375

- Surface Soil sample location
- Surface Soil sample location above action level (Ra-226 Results in pCi/g)

START REGION 9	Anaconda Mine Removal Assessment	Process Area ERGS Locations and Ra-226 Results Above Action Level	***Figure 9***
	28067219		***August 2007***

Map Document: (U:\GIS\START_projects\Anaconda\Projects\Fig10-boring_locations.mxd) 7/23/2008 -- 4:03:12 PM MTorchia

LEGEND

⊙ Boring location

350 0 350 Feet

START T9 REGION 9	Anaconda Mine Removal Assessment	Process Area - Boring Locations	*Figure 10*
	28067219		*August 2007*

Attachment 2: Tables

Table 1
Anaconda Mine Radiation Assessment
Surface Survey Gamma Data Summary
August 2007

Sample Number	HpGe						ERGS (cps)	HPIC Average Dose Rate (mR/hr)	Number of HPIC Data Points (1 per second)
	K-40	± 1 SD	Bi-214	± 1 SD	Ac-228	± 1 SD			
	(pCi/g)		(pCi/g)		(pCi/g)				
SS-01	18.3	0.7	1.1	0.1	1.0	0.1	11876	0.0169	250
SS-02	19.1	0.7	1.2	0.3	1.1	0.7	11767	0.0168	273
SS-03	16.1	0.7	1.4	0.1	0.7	0.1	11866	0.0167	266
SS-04	13.8	0.7	2.1	0.1	0.6	0.1	13738	0.0173	252
SS-05	15.1	0.7	1.8	0.1	0.7	0.1	12337	0.0162	205
SS-06	12.8	0.7	1.2	0.8	0.9	0.1	10711	0.0152	244
SS-07	9.3	1.0	5.6	0.4	52.8	1.7	46041	0.1263	272
SS-08	14.9	0.9	7.5	0.4	3.6	0.3	22717	0.0346	274
SS-09	15.8	0.2	4.9	0.2	2.4	0.2	16941	0.0269	244
SS-10	17.4	1.0	1.7	0.1	1.8	0.2	14302	0.0248	298
SS-11	16.1	1.0	2.5	0.1	4.9	0.3	20335	0.0340	321
SS-12	19.1	1.0	3.4	0.2	1.6	0.2	17110	0.0242	248
SS-13	13.7	0.9	3.2	0.2	13.2	0.5	27803	0.0328	237
SS-14	16.7	1.0	3.2	0.2	3.5	1.2	17401	0.0238	227
SS-15	13.8	0.8	2.9	0.2	4.2	0.3	18430	0.0248	238
SS-16	16.3	1.0	2.2	0.2	7.5	0.4	22206	0.0261	246
SS-17	15.3	1.0	2.9	0.2	16.5	0.7	32617	0.0331	202
SS-18	16.8	1.0	3.2	0.2	5.0	0.3	21327	0.0276	244
SS-19	7.2	1.3	154.0	6.4	0.8	0.4	saturated	0.1103	308
SS-20	15.3	1.0	2.9	0.2	16.5	0.7	42407	0.0422	267
SS-21	17.3	1.0	1.5	0.1	1.6	0.2	13241	0.0187	225
SS-22	18.3	1.0	2.2	0.2	1.4	0.2	13713	0.0191	250
SS-23	16.9	1.0	1.8	0.1	4.1	0.3	26798	0.0283	257
SS-24	13.9	1.0	2.4	0.2	10.9	0.5	36290	0.0376	274
SS-25	16.9	1.0	3.3	0.2	5.9	0.4	22232	0.0272	243
SS-26	11.0	1.0	3.1	0.3	22.3	0.8	43523	0.0833	241
SS-27	16.2	1.0	1.6	0.1	2.7	0.2	21914	0.0222	291
SS-28	9.5	0.9	64.7	2.5	0.9	0.3	38970	0.0291	284
SS-29	11.9	0.8	7.1	0.3	5.8	0.3	37690	0.0269	224
SS-30	10.0	0.8	21.9	0.9	7.1	0.4	36154	0.0276	253
SS-31	18.2	1.0	2.2	0.2	1.4	0.2	34000	0.0322	259
SS-32	11.0	2.8	125.7	4.9	3.2	1.3	46495	0.0576	253
SS-33	0.6	2.1	232.1	8.9	2.2	0.6	saturated	0.0890	294
SS-34	15.3	1.0	169.0	6.6	2.7	0.5	saturated	0.0874	215
SS-35	DNC	DNC	DNC	DNC	DNC	DNC	saturated	0.6035	233
SS-36	15.8	1.0	30.0	1.2	1.2	0.2	saturated	0.0309	257
SS-37	10.8	1.2	113.6	4.4	2.1	0.5	47944	0.0656	253
SS-38	16.8	1.0	5.1	0.3	4.2	0.3	21715	0.0202	251
SS-39	13.6	1.3	95.1	3.7	ND	ND	47135	0.1127	222
SS-40	15.9	1.0	13.8	0.6	1.2	0.2	27835	0.0298	287
SS-41	20.9	1.0	4.2	0.2	3.6	0.3	25495	0.0243	240
SS-42	13.0	0.4	13.5	0.6	5.6	0.3	33458	0.0364	237
SS-43	14.6	0.9	4.1	0.2	1.1	0.2	21280	0.0182	238
SS-44	14.5	0.9	5.8	0.3	3.3	0.4	22931	0.0247	245
SS-45	17.0	1.0	1.7	0.1	5.8	0.3	24836	0.0221	248
SS-46	12.5	1.0	4.4	0.2	0.9	0.2	497	0.0238	194
SS-47	18.1	0.8	3.0	0.1	3.3	0.4	33392	0.0359	248
SS-48	18.1	1.0	2.0	0.1	4.2	0.3	17200	0.0216	240
SS-49	16.8	1.0	4.1	0.3	12.9	0.5	36100	0.0449	258
SS-50	14.6	0.9	4.9	0.2	1.0	0.2	17269	0.0205	216
SS-51	19.5	0.9	1.3	0.1	1.2	0.1	13687	0.0183	281
SS-52	18.9	0.8	1.4	0.1	1.2	0.1	12947	0.0183	244

Legend
K-40 = potassium-40
AC-228 = Actinium-228
Bi-214 = bismuth-214
cps = counts per second
DNC = Data not collected
ERGS = Environmental Radiation Ground Scanner
HpGe = High Purity Germanium
HPIC = High Pressurized Ion Chamber
mR/hr = milliRoentgen per hour
ND = not detected
pCi/g = picoCuries per gram
saturated = measurement exceeded the upper limit of detector
SD = standard deviation

Table 2
Anaconda Mine Radiation Assessment
Surface Soil Analytical Sample Results
(pCi/g)
August 2007

Sample ID	Date	Matrix	Am241	Ba133	Ba140	Be7	Bi212	Bi214	Co57	Co58	Co60	Cs134	Cs137	Eu152	Ir192	I131	K40	Mn54	Pa231	Pa234m	Pb210	Pb211	Pb212	Pb214	Sample ID	Date	Matrix	Ra223	Ra224
			NAREL GAM-01	NAREL GAM-01	NAREL GAM-01	NAREL GAM-01	NAREL GAM-01	NAREL GAM-01	NAREL GAM-01	NAREL GAM-01	NAREL GAM-01	NAREL GAM-01	NAREL GAM-01	NAREL GAM-01	NAREL GAM-01	NAREL GAM-01	NAREL GAM-01	NAREL GAM-01	NAREL GAM-01	NAREL GAM-01	NAREL GAM-01	NAREL GAM-01	NAREL GAM-01	NAREL GAM-01				NAREL GAM-01	NAREL GAM-01
SS-01	8/7/2007	soil	ND	ND	<0.21	ND	1.19	1.06 J	ND	ND	<0.021	ND	<2.3e-02	ND	ND	<1.1e-01	22.3	ND	ND	ND	ND	ND	1.11	1.13J	SS-01	8/7/2007	soil	ND	0.866
SS-01-C	8/8/2007	soil	ND	ND	<0.44	ND	1.24	1.12J	ND	ND	<0.024	ND	0.0131	ND	ND	<3.9e-01	23.9	ND	ND	ND	ND	ND	1.16	1.19J	SS-01-C	8/8/2007	soil	ND	0.847
SS-1001	8/9/2007	soil	ND	ND	<0.24	ND	1.14	1.02 J	ND	ND	<0.019	ND	<0.022	ND	ND	<0.14	24.4	ND	ND	ND	ND	ND	1.07	1.09 J	SS-1001	8/9/2007	soil	0.297 J	0.835
SS-1001-C	8/10/2007	soil	ND	ND	<0.16	ND	1.41	1.06 J	ND	ND	<0.017	ND	0.0142	ND	ND	<0.087	22.1	ND	ND	ND	ND	ND	1.14	1.14 J	SS-1001-C	8/10/2007	soil	0.286 J	0.454
SS-02	8/11/2007	soil	ND	ND	<0.21	ND	1.13	0.969J	ND	ND	<0.02	ND	0.0572	ND	ND	<1.2e-01	25.6	ND	ND	ND	ND	ND	1.05	1.01J	SS-02	8/11/2007	soil	0.258J	0.729
SS-02-C	8/12/2007	soil	ND	ND	<0.2	ND	1.11	0.979 J	ND	ND	<0.018	ND	0.04	ND	ND	<0.11	23.90	ND	ND	ND	ND	ND	0.99	1.05 J	SS-02-C	8/12/2007	soil	0.262 J	0.70
SS-02-Dup	8/13/2007	soil	ND	ND	<0.2	ND	1.09	1.01 J	ND	ND	<0.019	ND	0.04	ND	ND	<0.12	22.90	ND	ND	ND	ND	ND	1.04	1.05 J	SS-02-Dup	8/13/2007	soil	ND	0.58
SS-03	8/14/2007	soil	ND	ND	<0.2	ND	0.909	1.17J	ND	ND	<0.017	ND	0.0177	ND	ND	<1.2e-01	19.2	ND	ND	ND	ND	ND	0.818	1.25J	SS-03	8/14/2007	soil	0.198J	0.517
SS-03-C	8/15/2007	soil	ND	ND	<0.22	ND	0.905	1.26J	ND	ND	<0.018	ND	0.0244	ND	ND	<1.3e-01	19.6	ND	ND	ND	ND	ND	0.81	1.35J	SS-03-C	8/15/2007	soil	0.308J	0.665
SS-07	8/16/2007	soil	ND	ND	<1.5	3.38	184	12.6J	ND	ND	<0.13	ND	<1.7e-01	ND	ND	<7.6e-01	20.9	ND	ND	ND	ND	25.6	176	14.3J	SS-07	8/16/2007	soil	40.1J	170
SS-08	8/17/2007	soil	ND	ND	<0.89	ND	3.37	15.1J	ND	ND	<0.051	ND	<5.3e-02	ND	ND	<7.2e-01	17.9	ND	ND	ND	ND	4.83	ND	16.6J	SS-08	8/17/2007	soil	ND	ND
SS-08-C	8/18/2007	soil	ND	ND	<0.53	ND	4.11	6.12J	ND	ND	<0.026	ND	0.0196	ND	ND	<4.2e-01	18.1	ND	2.08	ND	ND	2.2	3.65	6.87J	SS-08-C	8/18/2007	soil	2.53	1.7
SS-09	8/19/2007	soil	ND	ND	<0.49	ND	2.28	7.16J	ND	ND	<0.051	ND	<5.7e-02	ND	ND	<2.7e-01	17.5	5.63	ND	ND	ND	2.64	2.48	8.44J	SS-09	8/19/2007	soil	3.21	ND
SS-09-C	8/20/2007	soil	ND	ND	<0.67	ND	ND	6.5 J	ND	ND	<0.037	ND	<0.041	ND	ND	<0.55	18.6	ND	ND	ND	ND	1.15	0.199	7.04 J	SS-09-C	8/20/2007	soil	ND	ND
SS-1009	8/21/2007	soil	ND	ND	<0.35	ND	2.23	6.42 J	ND	ND	<0.037	ND	<0.041	ND	ND	<0.17	17.1	ND	2.65	ND	ND	2.07	2.31	7.56 J	SS-1009	8/21/2007	soil	2.67 J	ND
SS-1009-C	8/22/2007	soil	<0.069	ND	<0.63	ND	2.59	6.97 J	ND	ND	<0.033	ND	<0.038	ND	ND	<0.52	19	ND	0.621	ND	1 J	1.76	ND	7.62 J	SS-1009-C	8/22/2007	soil	ND	ND
SS-15	8/23/2007	soil	ND	ND	<0.35	ND	5.81	2.4 J	ND	ND	<0.024	ND	0.0302	ND	ND	<0.2	15	ND	ND	ND	ND	ND	5.09	2.62 J	SS-15	8/23/2007	soil	ND	3.93
SS-15-C	8/24/2007	soil	ND	ND	<0.39	ND	6.42	2.66 J	ND	ND	<0.026	ND	0.0396	ND	ND	<0.23	16.1	ND	ND	ND	ND	ND	6.01	2.9 J	SS-15-C	8/24/2007	soil	1.63 J	4.93
SS-17	8/25/2007	soil	ND	ND	<1	0.764	39.5	4.65 J	ND	ND	<0.062	ND	0.0613	ND	ND	<0.6	19.8	ND	2.42	ND	ND	ND	37.4	5.22 J	SS-17	8/25/2007	soil	8.48 J	40.1
SS-19	8/26/2007	soil	ND	ND	<78	ND	ND	3300 J	ND	ND	<9.2	ND	<8.3	ND	ND	<43	<98	ND	ND	ND	ND	ND	27.2 J	3360 J	SS-19	8/26/2007	soil	45.2 J	380 J
SS-20	8/27/2007	soil	ND	ND	<0.18	ND	1.74	1.78 J	ND	ND	<.025	ND	0.0474	ND	ND	<0.079	24.6	ND	ND	ND	ND	ND	1.75	1.94J	SS-20	8/27/2007	soil	0.383J	1.07
SS-23	8/28/2007	soil	ND	ND	<0.17	ND	2.59	1.36 J	ND	ND	<0.023	ND	0.0584	ND	ND	<0.076	23.7	ND	ND	ND	ND	ND	2.41	1.44J	SS-23	8/28/2007	soil	0.525J	1.97
SS-25	8/29/2007	soil	ND	ND	<0.3	ND	10.7	4.32 J	ND	ND	<0.035	ND	0.0811	ND	ND	<0.14	22.6	ND	ND	ND	ND	ND	9.65	4.78J	SS-25	8/29/2007	soil	2.42J	10.6
SS-25-C	8/30/2007	soil	ND	ND	<0.44	ND	10.7	4.03 J	ND	ND	<0.02	ND	0.0756	ND	ND	<0.23	22	ND	ND	ND	ND	ND	9.69	4.37J	SS-25-C	8/30/2007	soil	2.38J	8.1
SS-26	8/31/2007	soil	ND	ND	<0.35	ND	17.8	2.5 J	ND	ND	<0.033	ND	<0.05	ND	ND	<16	21.2	ND	0.713	ND	ND	ND	15.8	2.85J	SS-26	8/31/2007	soil	3.75J	15.4
SS-30	9/1/2007	soil	ND	ND	<0.48	ND	12	22.8 J	ND	ND	<0.053	ND	<0.08	ND	ND	<0.22	11.1	ND	1.43	ND	ND	3.21	10.5	24.9J	SS-30	9/1/2007	soil	4.55J	6.63
SS-32	9/2/2007	soil	ND	<0.72	<1.5	ND	12.6	817 J	<0.17	<0.2	<0.24	<0.21	<29	<1.7	<0.6	ND	24.7	<0.27	ND	ND	294 J	ND	ND	868J	SS-32	9/2/2007	soil	ND	ND
SS-33	9/3/2007	soil	ND	ND	ND	ND	33.1	1340 J	ND	ND	<1.6	ND	<0.564	ND	ND	ND	11.2	ND	ND	ND	ND	16.7	17.2	1150J	SS-33	9/3/2007	soil	17.5	ND
SS-35	9/4/2007	soil	ND	ND	<1.3+02	ND	ND	6650 J	ND	ND	<19	ND	<19	ND	ND	<68	<210	ND	ND	ND	ND	ND	58.6J	6780J	SS-35	9/4/2007	soil	ND	451
SS-36	9/5/2007	soil	ND	ND	ND	ND	3.09	115 J	ND	ND	<0.075	ND	0.0198	ND	ND	<0.26	18.8	ND	ND	ND	ND	1.62	2.9	121J	SS-36	9/5/2007	soil	3.67J	9.56
SS-37	9/6/2007	soil	ND	ND	ND	ND	6.2	285 J	ND	ND	<0.12	ND	0.14	ND	ND	<0.37	7.44	ND	ND	ND	ND	3.99	3.31	225J	SS-37	9/6/2007	soil	2.3J	ND
SS-37-DUP	9/7/2007	soil	ND	ND	ND	ND	5.89	301 J	ND	ND	<0.16	ND	<0.19	ND	ND	<0.58	7.48	ND	ND	ND	ND	ND	3.75	240J	SS-37-DUP	9/7/2007	soil	ND	ND
SS-38	9/8/2007	soil	ND	ND	<1	1.72	87.8	84.8 J	ND	ND	<0.11	ND	<0.15	ND	ND	<0.48	21	ND	7.85	ND	ND	24.2	69.4	86.4J	SS-38	9/8/2007	soil	ND	44.4
SS-39	9/9/2007	soil	ND	ND	ND	ND	5.31	655 J	ND	ND	<0.41	ND	0.285	ND	ND	<1.4	19.7	ND	ND	ND	ND	ND	5.92	646J	SS-39	9/9/2007	soil	7.64J	41.6
SS-49	9/10/2007	soil	ND	ND	<0.87	ND	16.2	5.03 J	ND	ND	<0.041	ND	0.0498	ND	ND	<0.65	26.4	ND	ND	ND	ND	ND	14.6	5.52J	SS-49	9/10/2007	soil	3.39J	15.5
SS-50	9/11/2007	soil	ND	ND	<0.34	ND	1.89	6.89 J	ND	ND	<0.072	ND	<0.065	ND	ND	<0.12	18.5	ND	ND	ND	ND	ND	1.67	7.22J	SS-50	9/11/2007	soil	0.503J	1.6
SS-50-C	9/12/2007	soil	ND	ND	<0.18	ND	1.94	7.87 J	ND	ND	<0.032	ND	<3.6e-02	ND	ND		22.1	ND	ND	ND	ND	ND	1.78	8.43J	SS-50-C	9/12/2007	soil	0.71J	1.78
SS-51	9/13/2007	soil	ND	ND	<0.36	ND	1.48	1.33 J	ND	ND	<0.023	ND	0.223	ND	ND	<2.5e-01	28.3	ND	ND	ND	ND	ND	1.37	1.42J	SS-51	9/13/2007	soil	0.369J	0.851
SS-51-C	9/14/2007	soil	ND	ND	<0.35	ND	1.43	1.23 J	ND	ND	<0.023	ND	0.369	ND	ND	<2.6e-01	25.9	ND	ND	ND	ND	ND	1.18	1.31J	SS-51-C	9/14/2007	soil	0.337J	0.758
SS-52	9/15/2007	soil	ND	ND	<0.39	ND	1.44	1.33 J	ND	ND	<0.026	ND	0.23	ND	ND	<2.9e-01	28.9	ND	ND	ND	ND	ND	1.3	1.46J	SS-52	9/15/2007	soil	0.343J	1.02
SS-52-C	9/16/2007	soil	ND	ND	<0.23	ND	1.34	1.28 J	ND	ND	<0.022	ND	0.31	ND	ND	<1.1e-01	27.4	ND	ND	ND	ND	ND	1.3	1.36J	SS-52-C	9/16/2007	soil	0.348J	0.907
SS-60	8/7/2007	soil	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	SS-60	8/7/2007	soil	NA	NA
SS-60-C	8/7/2007	soil	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	SS-60-C	8/7/2007	soil	NA	NA

Table 2
Anaconda Mine Radiation Assessment
Surface Soil Analytical Sample Results
(pCi/g)
August 2007

Ra226	Ra226	Ra228	Rn219	Rn220	Th227	Th228	Th234	Tl208	U235	Zn65	U234	U235	U238	Th227	Th228	Th230	Th232
NAREL GAM-01	EML HASL 300, 4.5.2.3	NAREL GAM-01	NAREL GAM-01	NAREL GAM-01	NAREL GAM-01	NAREL GAM-01	NAREL GAM-01	NAREL GAM-01	NAREL GAM-01	NAREL GAM-01	NAREL U-EICHROM	NAREL U-EICHROM	NAREL U-EICHROM	NAREL TH-EICHROM	NAREL TH-EICHROM	NAREL TH-EICHROM	NAREL TH EICHROM
2.07J	1.06	1.14	ND	ND	ND	ND	ND	0.358	0.13J	ND	0.995	0.0868	0.989	ND	ND	ND	ND
2.46J	1.01	1.21	ND	ND	ND	ND	ND	0.387	0.155J	ND	1.23	0.0369	1.31	ND	ND	ND	ND
2.26 J	NA	1.17	ND	ND	ND	ND	0.919 J	0.346	0.142 J	ND	1.13	0.088	1.17	0.111	0.427	0.924	0.94
2.33 J	NA	1.17	ND	ND	ND	ND	0.594 J	0.365	0.147 J	ND	1.12	0.0448	1.15	0.0727	0.919	1.14	0.96
1.97J	0.922	1.16	ND	ND	ND	ND	ND	0.442J	0.325	ND	1.15	0.0911	1.13	ND	ND	ND	ND
2.07 J	NA	1.09	ND	ND	ND	ND	0.639 J	0.32	0.129 J	ND	0.96	0.04	1.22	0.18	0.95	1.11	0.91
1.84 J	NA	1.05	0.33	0.115 J	ND	ND	ND	ND	ND	ND	1.14	0.04	1.17	0.09	1.01	1.21	0.94
2.27J	1.77	0.899	ND	ND	ND	ND	0.401J	0.256	0.143J	ND	1.04	0.104	0.921	ND	ND	ND	ND
2.19J	1.74	0.885	ND	ND	ND	ND	0.69J	0.258	ND	ND	1.21	0.133	1.03	ND	ND	ND	ND
32.5J	**14.3**	174	5.61	161	ND	214	8.99J	57.3	2.2J	ND	8.75	4.37	14.6	ND	ND	ND	ND
21.4J	**15.5**	3.18	2.69	1.03	1.37J	ND	ND	ND	ND	ND	6.42	0.335	3.44	ND	ND	ND	ND
9.98J	**7.14**	3.67	2	ND	1.49	ND	4.04J	1.17	0.63J	ND	5.08	0.369	4.57	ND	ND	ND	ND
13.2J	**6.63**	2.02	2.35	ND	1.79	ND	7.32J	0.677	0.833J	ND	11.7	0.199	4.37	ND	ND	ND	ND
10.9 J	NA	2.27	0.767	1.63 J	0.756	0.693 J	ND	ND	ND	ND	5.05	0.263	2.92	2.09	2.44	5.26	1.47
11.5 J	NA	2.1	2.26	ND	1.83	ND	4.04 J	0.708	0.731J	ND	7.54	0.319	3.73	2.76	2.05	5.17	1.42
12.5 J	NA	2.4	1.03	ND	ND	ND	3.19 J	0.81	0.801 J	ND	7.34	0.253	5.28	1.82	2.48	6.82	2.32
4.59 J	NA	5.62	ND	ND	ND	5.53	0.927 J	1.66	0.286 J	ND	4.68	0.147	3.77	0.68	9.64	29.9	8.44
5.59 J	NA	6.63	ND	ND	ND	ND	2.03 J	1.91	0.348 J	ND	5.32	0.279	3.7	0.986	9.55	33.8	10.3
13.3 J	NA	39.5	1.01	35.1	ND	37.5	6.5 J	11.9	0.869 J	ND	1.65	0.29	1.3	0.354	5.35	18.9	4.89
3420 J	NA	<56	ND	ND	25 J	6.08 J	ND	ND	ND	ND	1.65	1.37	2.15	1.95	4.78	2.67	0.809
4.21J	2.03	1.84		2.51	ND	ND	1.15J	0.565	0.262J	ND	2.51	0.131	2.04	0.156	1.47	5.31	1.72
3.59J	1.39	2.7	0.143	2.9	ND	ND	2.35J	0.782	0.224J	ND	2.9	0.172	2.5	0.0694	2.28	10.4	2.31
10.4J	**5.28**	10.5	0.66	9.98	ND	7.14	4.31J	3.05	0.649J	ND	9.98	0.703	6.82	0.939	12.5	40.6	12.1
9.13J	**5.58**	10.4	0.735	8.25	0.595	11.1	7.58J	3.07	0.569J	ND	8.25	0.638	6.63	1.42	12	39.3	11.8
12.3J	3.14	17.3	0.554	13.2	ND	16.5	8.75J	5.04	0.781J	ND	13.2	1.34	9.77	1.05	11.9	44.8	13.7
33.8J	**23.3**	11.3	2.32	134	1.73	ND	43.4J	3.2	2.79J	ND	134	4.62	104	2.79	12.3	60.6	13.7
926J	**705**	12.9	2.69	9.36	ND	ND	ND	2.7	53.1J	ND	9.36	2.3	3.36	14	21.9	33.8	6.05
771J	**1080**	26.5	7.53	63.3	6.14	ND	ND	7.76	48.1J	ND	63.3	6.12	49.1	13.2	42.1	119	21.8
6670J	**722**	<110	ND	12.3	70.4J	ND	ND	11.4J	ND	ND	12.3	1.18	7.13	8.28	10.5	35.8	4.82
129J	**132**	2.76	ND	5.55	1.61	ND	ND	0.869	7.61J	ND	5.55	1.24	4.26	2.78	8.66	9.71	4.26
132J	**228**	4.97	2.09	4.63	1.03	ND	ND	1.76	ND	ND	4.63	0.467	3.46	2.36	6.89	9.48	4.12
138J	NA	5.49	2.39	3.36	1.45	ND	ND	1.84	<0.85	ND	3.36	0.173	3.22	3.17	6.24	13.4	2.51
85.9J	**146**	82.9	12.8	146	8.9	ND	ND	25.4	2.3J	ND	146	7.7	108	2.16	85.6	478	76.8
662J	**174**	6.78	5.25	6.29	3.84	ND	ND	1.82	35.3J	ND	6.29	0.697	5.12	4.21	63.4	225	58.2
6.03J	**5.43**	16	0.729	34.2	ND	13.5	19.5J	4.72	1.31J	ND	34.2	3.22	27.4	1.17	6.12	2.85	0.534
12.6J	**7.75**	1.57	0.436	5.17	0.257	ND	3.78J	0.544	0.736J	ND	5.17	0.438	4.34	0.289	1.57	3.28	1.19
12.1J	**6.24**	1.68	0.336	6.08	0.19	ND	4.93J	0.545	0.187J	ND	6.08	0.319	4.78	0.25	1.57	3.32	1.36
2.62J	1.22	1.47	ND	1.13	ND	ND	0.781J	0.42	0.165J	ND	1.13	0.0805	1.11	0.0148	1.45	1.28	1.31
2.46J	1.18	1.32	ND	1.25	ND	ND	1.02J	0.388	0.154J	ND	1.25	0.056	1.18	0.151	1.01	1.21	1
2.51J	1.20	1.46	ND	1.06	ND	ND	0.544J	0.43	0.157J	ND	1.06	0.0649	1.02	0.0336	1.05	1.25	1.04
2.55J	1.20	1.39	ND	ND	ND	ND	0.519J	0.407	0.161J	ND	1.23	0.0815	1.09	ND	ND	ND	ND
NA	**19.7**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	**22.0**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

LEGEND

Am241 = Americium-241
Ba133 = Barium-133
Ba140 = Barium 140
Be7 = Beryllium-7
Bi212 = Bismuth-212
Bi214 =Bismuth-214
Co57 = Cobolt-57
Co58 = Cobolt-58
Co60 = Cobolt-60
Cs134 = Cesium-134
Cs137 = Cesium-137
Eu152 = Europium-152
I131 = Iodine-131
Ir192 = Iridium-192
K40 = Potassium-40
Mn54 = Manganese-54
Pa231 = Protactinium-231
Pa234 = Protactinium-234
Pb210 = Lead-210
Pb211 = Lead-211
Pb212 = Lead-212
Pb214 = Lead-214
Ra223 = Radium-223
Ra224 =Radium-224
Ra226 = Radium-226
Ra228 = Radium-228
Rn219 = Radon-219
Rn220 = Radon-220
Th227 = Thorium-227
Th228 = Thorium-228
Th230 = Thorium-230
Th232 = Thorium-232
Th234 = Thorium-234
Tl208 = Thallium-208
U234 = Uranium-234
U235 = Uranium-235
U235 = Uranium-235
U238 = Uranium-238
Zn65 = Zinc-65

pCi/g = picocuries per gram dry
bgs = below ground surface
NA = not analyzed
ND = sample result not detected above the minimum detectable acti
NA = data not available
J = result is estimated
< = less than the value
DUP = duplicate sample
C = composite sample
BOLD = result above site specific action level of 3.79 pCi/g Ra-226

Table 3
Anaconda Mine Radiation Assessment
Subsurface Soil Analytical Results
October - November 2007

Sample Number	Depth (feet bgs)	Ra-226 (pCi/g)	Th-228 (pCi/g)	Th-230 (pCi/g)	Th-232 (pCi/g)	Total Uranium (pCi/g)	Ur-233/234 (pCi/g)	Ur-235/236 (pCi/g)	Ur-238 (pCi/g)
BH-7-2	2	2.50	9.73	44.0	7.18	26.0	9.76	0.750	8.63
BH-7-5	5	**4.08**	38.7	NA	NA	NA	NA	NA	NA
BH-7-28	28	1.72	3.16	NA	NA	NA	NA	NA	NA
BH-7-15	15	1.14	0.720	NA	NA	NA	NA	NA	NA
BH-17-2	2	2.5	9.73	NA	NA	NA	NA	NA	NA
BH-7-1005	5	**3.88**	NA	NA	NA	NA	NA	NA	NA
BH-19-1001-1001.5	1 - 1.5	3.38	1.78	1.45	0.989	2.95	1.19	0.0346	0.985
BH-19-1-1.5	1 - 1.5	3.25	1.82	2.37	1.30	4.66	1.44	0.165	1.54
BH-20-.5-1.5	0.5 - 1.5	**4.49**	37.6	178	32.3	62.5	22.3	1.32	20.8
BH-24-1.5-2.0	1.5 - 2	2.70	17.6	84.3	13.6	62.3	22.9	1.63	20.7
BH-28-2-3	2 - 3	1.42	3.14	2.36	1.31	5.29	1.80	0.370	1.72
BH-28-16	16	1.13	0.876	1.48	1.33	3.21	1.25	0.127	1.06
BH-28-29	29	1.31	2.58	2.46	1.79	4.78	1.44	0.109	1.59
BH-28-1002	2	1.38	2.07	0.842	1.17	5.01	1.51	0.348	1.63
BH-28-1016	16	1.06	1.90	2.64	1.91	5.00	1.05	0.256	1.64
BH-28-1029	29	1.41	2.19	2.42	1.51	4.01	1.48	0.185	1.32
BH-30-16	16	1.13	2.10	0.608	0.539	3.91	1.54	0.101	1.30
BH-51-15	15	0.853	0.717	1.00	0.952	3.08	0.705	0.109	1.02
BH-51-2	2	1.16	1.75	1.25	1.87	3.29	1.75	0.113	1.09
BH-51-30	30	1.51	3.65	1.88	1.67	8.20	2.28	0.0496	2.75
BH-52-15	15	1.00	1.84	1.18	1.00	4.39	1.62	0.222	1.44
BH-52-2	2	1.14	1.51	1.38	1.29	4.02	1.36	0.00	1.35
BH-52-30	30	1.58	1.59	NA	NA	NA	NA	NA	NA

Legend

Ra-226 = Radium-226
Th-228 = Thorium-228
Th-230 = Thorium-230
Th-232 = Thorium-232
U-233/234 = Uranium-233/234
U-235/236 = Uranium-235/236
U-238 = Uranium-238

Results by EML HASL 300, 4.5.2.3
pCi/g = picocuries per gram dry
bgs = below ground surface
bold: Sample result above action level
NA = data not available

Table 4
Anaconda Mine Radiation Assessment
Subsurface Soil Gamma Survey Results
(kcpm)
October - November 2007

Feet bgs	BH-7	BH-10	BH-13	BH-17	BH-19	BH-20	BH-22	BH-24	BH-25	BH-28	BH-30	BH-36	BH-37	BH-49	BH-51	BH-52
0	**14.5**	2.1	4.2	0.7	**30**	**9.3**	1.1	**5**	2.2	**5**	**8**	2	1.7	2	1.7	1.8
0.5	**16**	2.3	2.8	**7.5**	**45**	**17**	1.9	**13.5**	1.9	3.3	**9**	2	1.7	2.25	2.6	2.3
1	**20**	2.3	2.3	**5.7**	**44**	**19.5**	2	**15**	1.8	2.7	**5**	1.7	1.7	3.4	2.4	2.5
1.5	**19**	2.4	2.2	**5.7**	**18**	**17.5**	2	**11**	2	2.6	3.7	1.7	1.7	**5.6**	2.6	2.6
2	**12.5**	2.6	1.9	4.3	**9.5**	**13**	2	**8**	2.2	2.3	3.4	1.7	1.8	**9.5**	2.6	2.5
2.5	**5.5**	2.4	1.9	3.6	3.9	**9.5**	2	**6**	2.2	2.3	2.8	1.6	1.9	**10.5**	2.7	2.4
3	3.6	2.3	1.9	3.4	2.8	**8.5**	2	4.6	2.1	2.2	2.4	1.8	1.8	**11**	2.7	2.5
3.5	3.4	2.4	2.1	3	2.2	**8.3**	2.1	4.1	1.9	2.4	2.6	1.9	2.1	**8.6**	2.5	2.6
4	2.6	2.7	1.8	2.8	1.9	**8.5**	2..3	3.75	2	2.6	3.3	2	2	**6.3**	2.6	2.7
4.5	2.9	2.7	1.9	2.8	2	**6.5**	2.3	3.5	2	2.4	2.9	1.9	1.9	**5.2**	2.6	2.7
5	4.6	2.8	1.9	2.9	2	**5.7**	2.2	3.3	2	2.3	2.7	2	2	3.9	2.6	2.8
5.5	3.3	2.5	2	2.7	2.2	**5**	2.4	3.1	2	2.4	2.5	1.9	1.9	2.8	2.4	2.7
6	3.4	2.8	2	2.7	1.95	3.8	2.3	2.8	1.9	2.5	2.5	2	1.9	2.8	2.3	2.5
6.5	3.5	2.3	2	2.6	2.2	3.5	2.3	2.9	2.1	2.4	2.5	1.8	1.9	2.7	2.3	2.4
7	3.1	2.4	1.9	2.3	2	3.1	2.1	2.6	1.9	2.3	2.4	1.9	2	2.7	2.4	2.4
7.5	2.9	2.2	1.9	2.3	2	3.2	2.1	2.7	1.8	2.4	2.2	2	2	2.5	2.8	2.6
8	2.6	2.4	1.9	2.9	2.1	3.4	2.1	2.6	2	2.1	2	1.9	2	2.3	2.4	2.5
8.5	2.4	2.5	2	1.1	2	3.4	2	2.3	2.2	2	1.85	1.8	2.2	2.1	2.5	2.4
9	2.3	2.3	2	1.9	1.9	2	2.2	2.6	2.2	2	1.95	2	2.5	2.1	2.4	2.5
9.5	2.1	2.2	2.1	1.8	1.9	2.75	2.2	2.6	2.2	2	1.8	1.9	2.3	2.4	2.5	2.4
10	2	2.1	2.1	1.7	1.9	2.7	2.2	2.3	2.2	2	1.8	2	2.3	2.5	2.6	2.4
10.5	2	2.1	1.9	1.8	1.9	2.6	2.1	2.5	2	2.1	1.9	2	2.3	2.6	2.4	2.3
11	2	2	1.9	1.7	2.2	2.3	2.2	2.1	1.9	2.2	2.1	2	2.4	2.3	2.2	2.2
11.5	1.8	1.9	1.9	1.7	1.9	2.6	2.3	2.2	2	1.9	2.1	2.1	2.3	2.1	2.2	2.3
12	1.8	2	2	1.8	2	2.8	2.1	2.4	2	1.8	1	2.3	2.4	2.1	2.3	2.3
12.5	1.8	1.9	2	1.8	2.1	2.8	2.1	2.4	2	2	1.9	2.2	2.6	2.3	2.5	2.5
13	1.8	1.9	1.9	1.8	2.3	3	2.2	2.2	2.1	2.1	1.8	2.1	2.8	2.3	2.5	2.2
13.5	2.1	2	1.9	2	2.2	3.1	2.2	2.2	2.1	2	1.9	2.3	2.7	2.4	2.5	2.3
14	2.2	2.1	2	2.1	2.2	3	2.4	2.2	2	1.9	1.8	2.5	2.4	2.5	2.3	2.3
14.5	2.3	2.1	1.9	2.1	2.4	3	2.3	2.25	2.2	2	1.8	2.3	2.6	2.9	2.3	2.3
15	2.5	2.1	1.9	1.9	2.1	2.8	2.4	2.25	2.2	1.9	1.9	2.3	2.6	2.5	2.6	2.2
15.5	2.4	1.9	1.9	1.9	2	2.8	2.7	2.3	2.3	2	1.9	2.3	2.5	2.7	2.9	2.2
16	2.3	2	2.6	2	2.1	2.9	2.3	2.8	2.2	2	2.2	2	2.8	2.5	2.4	2.2
16.5	2.1	2.1	1.9	2.2	2.1	2.9	2.3	2.6	2.3	1.8	2.3	2	2.6	2.6	2.6	2.3
17	2	2.2	2	2.2	2.2	2.9	2.6	2.5	2.3	1.9	2.1	2.1	2.7	2.3	2.5	2.4
17.5	2.1	1.9	2.2	1.9	2.3	2.7	2.6	2.6	2.3	1.9	2	2.2	2.5	1.9	2.7	2.4
18	2.2	2.1	2.4	2.2	2.2	2.7	2.7	2.4	2.4	1.9	2.1	2.3	2.7	2	2.6	2.3
18.5	2.2	2	2.3	2.1	2.3	2.6	2.75	2.6	2.1	2	2.2	2.7	2.5	2.1	2.5	2.5
19	2.3	1.9	2.3	2.2	2.3	2.8	2.45	2.25	2.2	2	2	2.5	2.6	2.1	2.7	2.6
19.5	2.3	1.8	2.3	2.1	2.5	2.6	2.3	2.4	2.3	2.1	2.1	2.5	2.6	2.2	2.6	2.4
20	2.5	1.8	2.2	2.1	2.4	2.7	2.4	2.7	2.3	2.1	2.1	2.4	2.6	2.2	2.6	2.4
20.5	2.8	1.7	2.3	2.2	2.6	2.5	2.3	2.4	2.2	2.1	2.1	2.6	2.9	2.4	2.5	2.2
21	2.5	1.8	2.2	2.2	2.8	2.5	2.7	2.5	2.3	2.3	2.1	2.5	2.7	2.6	2.8	2.5
21.5	2.8	2.1	2.4	2.2	2.8	2.4	2.5	2.5	2.3	2.3	2.1	2.5	2.5	2.6	2.6	2.3
22	2.9	2.1	2.4	2.1	2.7	2.5	2.3	2.6	2.5	2.1	2.3	2.6	2.5	2.8	2.5	2.5
22.5	2.9	2.2	2.4	2.3	2.8	2.4	2.5	2.7	2.5	2.5	2.3	2.6	2.4	2.9	2.7	2.7
23	2.4	2.2	2.4	2.3	2.7	2.5	2.5	2.6	2.7	2.2	2.4	2.5	2.3	3	2.7	2.5
23.5	2.5	2.1	2.4	2.4	2.7	2.4	2.7	2.5	2.8	2.3	2.3	2.6	2.4	3	2.9	2.6
24	2.5	2.1	2.4	2.5	2.3	2.6	2.8	2.6	2.9	2.3	2.3	2.4	2.1	3.1	2.7	2.6
24.5	2.6	2.1	2.6	2.5	2.5	2.7	2.8	2.7	2.7	2.4	2.3	2.5	2.3	2.8	2.9	2.5
25	2.6	2	2.8	2.6	2.9	2.8	2.9	2.6	2.7	2.4	2.3	2.6	2.1	2.75	2.8	2.7
25.5	2.6	2.1	3.1	2.4	3	2.9	2.9	2.5	2.7	2.3	2.5	2.5	2.3	2.7	2.9	2.6
26	2.6	2	3	2.3	2.7	2.9	2.8	2.6	2.5	2.3	2.4	2.5	2.3	2.1	2.8	2.7
26.5	2.6	2	3.2	2.6	3	3.3	2.8	2.4	2.7	2.5	2.2	2.5	2.4	2.5	2.7	2.7
27	2.7	2.4	2.9	3	3	3	2.7	2.5	2.5	**7**	2.5	2.5	2.3	2.6	2.8	2.8
27.5	3.6	2.3	3.1	2.8		2.5	2.7	2.8	2.7	**8**	2.5	2.4	2.4	2.3		3.25
28	3.1	2.5	2.9	2		2.5	2.4	2.8	2.6	3.5	3	2.1	2.4	2.6		2.8
28.5	3.4	2.5		3		2.7	2.2	2.8			3.3	2.3	2.6	2.5		2.8
29	5.1	2.15		3.1		3.9		2.7			3.3		2.3			2.8
29.5	4.95			2.9		4.5		2.5			3		2.4			
30	4.6					3.75										
	4.4															

Notes:
bgs = below ground surface
Instrument Background = 2.5 kcpm
Bold = Value greater than twice background
kcpm = kilo counts per minute

Attachment 3: Data Validation Reports (on CD)

Attachment 4: Boring Logs

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BOREHOLE LOG

START T9 REGION 9

Project Name: ANACONDA

Address:

Borehole Number: BH-17

Date: 10/31/07

Logged By: MG/PA

DEPTH	% REC	BLOWS	SAMPLE I.D.	Alpha (CPM)	Gamma (CPM)	DTW First	DTW Static	USCS SYMBOL	SOIL DESCRIPTION	Well Construction
0' +10			8.7						BKG 25	
			7.5							
			5.7							
			5.7							
			4.3							
			3.6						Sample @ ~8	
			3.4							
			3.0							
			2.8							
			2.8							
5'			2.9							
			2.7							
			2.7							
			2.6							
			2.3							
			2.3							
			7.9							
			1.9							
			1.8							
			1.7							
10'			1.75							
			1.7							
			1.85							
			1.8							
			1.8							
			2.0							
			2.1							
15'			2.1							
			1.9						Sample @ ~15	
			1.9							
			2.0							
			2.15							
			2.2							
			1.9							
			2.15							
			2.1							
20'			2.3							
			2.1							
			2.1							
			2.2							
			2.2							
			2.15							
			2.1							
			2.3							
			2.3							
			2.35							
25'			2.5							
			2.5							
			2.6							
			2.4							
			2.3							
			2.6							
			3.8							
			2.8							
			3.0							
			3.0							
30'			3.1						Sample @ ~30	
			2.9							

Driller / Drilling Co.: Ed

Equipment: Ludlum 2241-3

BOREHOLE LOG

Project Name:	Anaconda
Address:	
Borehole Number:	BH-7
Date:	10-31-07
Logged By:	PA / HE

DEPTH	% REC	BLOWS	SAMPLE I.D.	Alpha (CPM)	Gamma (CPM)	DTW First	DTW Static	USCS SYMBOL	SOIL DESCRIPTION	Well Construction
+6 / 0'			14.5							
			16 / 20							
1			19 / 12.5							
2			5.5 / 3.6							
3			3.4 / 2.6							
4			2.9 / 4.6							
5' / 5			3.3 / 3.4							
6			3.5 / 3.1							
7			2.9 / 2.6							
8			2.4 / 2.3							
9			2.1 / 2.1							
10'			2.0 / 2.0							
11			2.0 / 1.8							
12			1.8 / 1.8							
13			1.8 / 1.8							
			2.1 / 2.2							
15'			2.3 / 2.25							
16			2.5 / 2.4							
17			2.3 / 2.1							
18			2.0 / 2.1							
19			2.2 / 2.2							
20'			2.3 / 2.3							
21			2.5 / 2.8							
22			2.9 / 2.9							
23			2.4 / 2.5							
24			2.5 / 2.6							
25'			2.6 / 2.6							
26			2.6 / 2.75							
27			3.6 / 3.1							
28			3.4 / ~~4.0~~	5.1						
29			4.95 / 4.6							
30'			4.4							

Driller / Drilling Co.:

Equipment:

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BOREHOLE LOG

Borehole Number: BH-19

Project Name: Anaconda

Address:

Date: 10/31/07

Logged By: MG/PA

DEPTH	% REC	BLOWS	SAMPLE I.D.	Alpha (CPM)	Gamma (CPM)	DTW First	DTW Static	USCS SYMBOL	SOIL DESCRIPTION	Well Construction
0' +6			30.0							
			45.0							
			44.0	(BH-19-1-1.5)					(BH-19-[illegible]:5)	
			18.0							
			9.5							
			3.9							
			2.8							
			2.2							
			1.9							
			2.0							
5'			2.0							
			2.2						sample @ 2	
			1.95							
			2.15							
			2.0							
			1.95							
			2.1							
			2.0							
			1.9							
			1.9							
10'			1.95							
			1.9							
			1.9							
			1.9							
			2.0							
			1.9							
			1.9							
			1.9							
			2.2							
			1.85							
15'			2.0	BH-19-15					sample @ 15	
			2.1							
			2.3							
			2.2							
			2.2							
			2.4							
			2.1							
			2.0							
			2.1							
			2.05							
20'			2.15							
			2.25							
			2.20							
			2.25							
			2.25							
			2.5							
			2.4							
			2.6							
			2.8							
			2.8							
25'			2.7							
			2.75							
			2.7							
			2.7							
			2.25							
			2.5							
			2.9							
			3.0							
			2.7							
			3.0							
30'			3.0	BH-19-30					sample @ 30	

Driller / Drilling Co.:

Equipment: Ludlum 2241-3

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BOREHOLE LOG

Project Name: ANACONDA	Borehole Number: BH-20
Address:	Date: 10/31/07
	Logged By: MG/PA

DEPTH	% REC	BLOWS	SAMPLE I.D.	~~Alpha~~ Gamma (CPM)	Gamma (CPM)	DTW First	DTW Static	USCS SYMBOL	SOIL DESCRIPTION	Well Construction
0' +6		8	9.25, 17.0, 19.5, 17.5, 13.0, 9.5, 8.5, 8.3, 8.5, 6.5	⊠					BKG 2.5 BH-20-.5-1.5	
5'			5.7, 5.0, 3.8, 3.5, 3.05, 3.2, 3.4, 3.4, 3.0, 2.75							
10'			2.70, 2.60, 2.30, 2.60, 2.75, 2.75, 3.0, 3.1, 3.0, 3.0	⊠					BH-20-15 ~~[illegible]~~ BH-20-~~[illegible]~~ 1015	
15'			2.75, 2.8, 2.9, 2.9, 2.9, 2.7, 2.7, 2.6, 2.8, 2.6							
20'			2.7, 2.5, 2.5, 2.4, 2.5, 2.4, 2.5, 2.4, 2.6, 2.7							
25'			2.8, 2.9, 2.9, 2.8, 3.0, 2.5, 2.5, 2.65, 3.9, 4.5, 3.75	⊠					BH-20-30	
30'										

Driller / Drilling Co.:

Equipment: Ludlum

BOREHOLE LOG

START T9 REGION 9

Project Name: Anaconda

Address:

Borehole Number: BH-24

Date: 10/3/07

Logged By: MG/PA

DEPTH	% REC	BLOWS	SAMPLE I.D.	Alpha (CPM)	Gamma (CPM)	DTW First	DTW Static	USCS SYMBOL	SOIL DESCRIPTION	Well Construction
0'			5.7						BKG 2.5	
			5.0							
			13.5							
			15.0 BH-24-1.5-2							
			11.0							
			8.0							
			6.0							
			4.6							
			4.1							
			3.75							
			3.5							
5'			3.25						- sample @ 5	
			3.1							
			2.8							
			2.85							
			2.6							
			2.65							
			2.55							
			2.3							
			2.55							
10'			2.6							
			2.25							
			2.5							
			2.1							
			2.2							
			2.4							
			2.4							
			2.2							
			2.15							
			2.25							
			2.25							
15'			2.3 BH-24-15						- sample @ 15	
			2.8							
			2.6							
			2.5							
			2.6							
			2.4							
			2.6							
			2.75							
			2.4							
			2.7							
20'			2.7							
			2.4							
			2.5							
			2.5							
			2.6							
			2.7							
			2.6							
			2.5							
			2.6							
25'			2.7							
			2.6							
			2.5							
			2.6							
			2.4							
			2.5							
			2.75							
			2.8							
			2.8							
			2.05						- sample @ 30	
30'			2.5 BH-24-30							

Driller / Drilling Co.:

Equipment: Ludlum 2241-3

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BOREHOLE LOG

START T9 REGION 9	Project Name: Anaconda	Borehole Number: BH-28
	Address:	Date: 10/31/07
		Logged By: MC/PA

DEPTH	% REC	BLOWS	~~SAMPLE~~ GAMMA I.D.	Alpha (CPM)	Gamma (CPM)	DTW First	DTW Static	USCS SYMBOL	SOIL DESCRIPTION	Well Construction
0' +6			7.0, 5.0, 3.3, 2.7, 2.6, 2.3, 2.3, 2.2, 2.4, 2.6						BKG - ~~2.~~5 silt w/ ~10% ~~poorly~~ fine sand poorly graded. Brown. Dry. No apparent odor. 3½': silt with few ~~of~~ small to large gravels (20%) & few cobbles. Light yellowish brown. Dry. No odor. 4½: Same as above but brown. 7': color change to reddish brown	
5' (BH-~~28~~30-5-6)			2.4, 2.3, 2.4, 2.5, 2.4, 2.3, 2.4, 2.1, 2.0, 2.0						* SOIL DESCRIPTION FOR BH-30	
10'			2.0, 2.0, 2.1, 2.2, 1.85, 1.9, 2.0, 2.1, 2.0, 1.9							
15' (BH-~~28~~30-15-16)			2.0, 1.9, 2.0, 2.0, 1.75, 1.9, 1.9, 1.9, 1.9, 1.85							
20'			2.0, 2.0, 2.1, 2.1, 2.1, 2.25, 2.3, 2.1, 2.5, 2.2							
25'			2.25, 2.3, 2.4, 2.35, 2.30, 2.25, 2.5, 7.03							
30' (BH-~~28~~30-29-30)			8.0, 3.5							

Driller / Drilling Co.: ~~Earth~~

Equipment: Ludlum 2241-3

BOREHOLE LOG

START T9 REGION 9

Borehole Number: BH-30

Project Name: Anaconda

Address:

Date: 10/31/07

Logged By: MG/BA

DEPTH	% REC	BLOWS	GAMMA I.D.	Alpha (CPM)	Gamma (CPM)	DTW First	DTW Static	USCS SYMBOL	SOIL DESCRIPTION	Well Construction
0' (BH30-2-3)			+6 6.0, 8.0, 9.0, 5.0, 3.7, 3.4, 2.8, 2.4, 2.6, 3.3						BKG 5 Silt w/ some fine grain poorly graded sand. light yellowish brown. Dry No apparent odor. 2': Same as above but w/ 50% sm. to lg gravels	
5'			2.9, 2.7, 2.5, 2.5, 2.5, 2.4, 2.2, 2.0, 1.85, 1.95						Sample @ 5	
10'			1.8, 1.8, 1.9, 2.1, 2.1, 1.0, 1.9, 1.8, 1.9, 1.8						8-9': Silt w/ ~75% gravels to med cobbles. ~~Dry~~ gray. to dark gray 9': Same as 2' 10': color change to brown. 12': color change to reddish brown	
15' BH30-10			1.8, 1.85, 1.85, 2.2, 2.25, 2.1, 2.0, 2.1, 2.2, 2.0						~~Sample @ 10(NT)~~	
20'			2.1, 2.1, 2.1, 2.1, 2.1, 2.3, 2.3, 2.01, 2.3, 2.3						23': Silt w/ small to large gravels (~50%) & ~10% sm. cobbles. ~~Dry~~ Slightly moist. Reddish brown. No apparent odor.	
25'			2.3, 2.3, 2.5, 2.4, 2.2, 2.5, 2.5, 3.0, 3.3, 3.3						27': Same as above but mostly (~75%) med to lg. cobbles.	
30' BH30-29-30			3.0						Sample @ 30	

Driller / Drilling Co.:

Equipment: Ludlum 2241-3

* D to 2, 15, 30

BOREHOLE LOG

START T9 REGION 9

Project Name: Anaconda Mine	Borehole Number: BH-51
Address:	Date: 10/31
	Logged By: PA/MG

DEPTH	% REC	BLOWS	GAMMA ~~4.0~~	Alpha (CPM)	Gamma (CPM)	DTW First	DTW Static	USCS SYMBOL	SOIL DESCRIPTION	Well Construction
0'	FG		1.4, 1.7, 2.6, 2.4, 2.6, 2.6, 2.65, 2.7, 2.5, 2.6						(Kc/m) Background - 2.5 Kc/m silts with some gravels throughout. very light brown. Dry. No apparent odor 3': color Δ to reddish brown.	
5' (BH-51 (BH51-5-6) (0915))			2.6, 2.6, 2.35, 2.3, 2.3, 2.4, 2.84, 2.4, 2.5, 2.4, 2.5						silt w/ few gravels (~20%) to small cobbles. light reddish brown. Dry. No apparent odor.	
10'			2.6, 2.4, 2.2, 2.2, 2.3, 2.5, 2.5, 2.5, 2.3, 2.3							
15' (B52-15-16 (0920))			2.6, 2.85, 2.4, 2.6, 2.5, 2.7, 2.55, 2.5, 2.7, 2.6						silt w/ ~ 50% small to lg gravels. light reddish brown. Dry. No apparent odor.	
20'			2.6, 2.5, 2.6, 2.75, 2.6, 2.5, 2.65, 2.7, 2.9						Same as above but mostly gravels & small cobbles w/ ~20% Fines.	
25'			2.7, 2.9, 2.8, 2.9, 2.8, 2.7, 2.8							
B52-29-30 (0925) 30'										

★ WRONG SHEET!

~~BORING~~ SOIL LOGS for B-52

Driller / Drilling Co.: Boart Long year

Equipment: Ludlum Model 2241-3, DET 1 PANCAKE, GAMMA

BOREHOLE LOG

Borehole Number: BH-52

Project Name: Anaconda Mine

Address:

Date: 10/31/07

Logged By: MK/RA

DEPTH	% REC	BLOWS	~~SAMPLE~~ GAMMA I.D.	Alpha (CPM)	Gamma (CPM)	DTW First	DTW Static	USCS SYMBOL	SOIL DESCRIPTION	Well Construction
0' +6			1.7, 1.8, 2.3, 2.5, 2.6, 2.5, 2.4, 2.5, 2.6, 2.65, 2.65						(Units K¢/M) BKG 2.5 K¢/M silts w/ some small gravels throughout. light brown. Dry No apparent odor 3': color Δ to light reddish brown. 5': silt w/ few small gravels to small cobbles (~20%). light reddish brown. Dry. No apparent odor	
5' BH51-5-6 (0930)			2.8, 2.65, 2.5, 2.4, 2.4, 2.6, 2.5, 2.4, 2.45, 2.4							
10'			2.4, 2.3, 2.2, 2.3, 2.3, 2.45, 2.2, 2.3, 2.3, 2.3							
15' B51-15-16 (0935)			2.2, 2.2, 2.2, 2.3, 2.35, 2.35, 2.3, 2.5, 2.6, 2.35						same as above	
20'			2.35, 2.2, 2.5, 2.25, 2.5, 2.7, 2.5, 2.6, 2.6, 2.5							
25'			2.7, 2.7, 2.6, 2.65, 2.7, 2.8, * 3.25, 2.8, 2.8, 2.8						same as above	
30' B51-29-30 (0940										

WRONG SHEET!!!

Driller / Drilling Co.:

Equipment: Ludlum Model 2241-3, DET 1 Pancake, Gamma

BOREHOLE LOG

START T9 REGION 9

Project Name: Anaconda	Borehole Number: BH-37
Address:	Date: 10/31/07
	Logged By: MK/PA

DEPTH	% REC	BLOWS	~~SAMPLE I.D.~~ GAMMA	Alpha (CPM)	Gamma (CPM)	DTW First	DTW Static	USCS SYMBOL	SOIL DESCRIPTION	Well Construction
0'			2.1						BKG 2.5	
			1.7						silt w/ ~10% Fine sand poorly graded few gravels throughout. BROWN. DRY. No apparent odor	
			1.7							
			1.7							
			1.7							
			1.8							
			1.9							
			1.8							
			2.1							
			2.0							
5'			1.9						sample @ 5: same as above but w/ sm. to med. cobbles.	
			2.0							
			1.9							
BH37-5-6			1.9							
			1.9							
			2.0							
			2.0							
			2.0							
			2.2							
			2.5							
10'			2.3							
			2.3							
			2.3							
			2.4							
			2.3							
			2.4							
			2.6							
			2.8							
			2.7							
			2.4							
15'			2.6						sample @ 15	
			2.6							
BH37-15-16			2.5							
			2.8							
			2.6						17': Silt w/ mostly med to large cobbles (~75% cobbles). BROWN. DRY. No apparent odor.	
			2.7							
			2.5							
			2.7							
			2.5							
			2.6							
20'			2.6							
			2.6							
			2.9							
			2.7							
			2.5							
			2.5							
			2.4							
			2.3							
			2.4							
			2.1							
25'			2.3							
			2.1							
			2.3						26': Same as 5'.	
			2.3							
			2.4							
			2.3							
			2.4							
			2.4							
			2.6							
			2.3						Sample @ 30	
30'			2.4							

Driller / Drilling Co.:

Equipment: Ludlum 2241-3

BOREHOLE LOG

START Region 9

Project Name: Anaconda

Address:

Borehole Number: BH-36

Date: 10/31/07

Logged By: MG/PA

DEPTH	% REC	BLOWS	~~SAMPLE~~ GAM I.D.	Alpha (CPM)	Gamma (CPM)	DTW First	DTW Static	USCS SYMBOL	SOIL DESCRIPTION	Well Construction
0' – 30'			+6 / 1.9, 1.95, 1.95, 1.7, 1.65, 1.7, 1.55, 1.75, 1.85, 2.0, 1.85, 2.0, 1.9, 2.0, 1.8, 1.9, 2.0, 1.9, 1.8, 2.0, 1.9, 2.0, 2.0, 2.0, 2.1, 2.3, 2.2, 2.1, 2.3, 2.5, 2.3, 2.3, 2.3, 2.0, 2.0, 2.1, 2.2, 2.3, 2.7, 2.5, 2.5, 2.4, 2.6, 2.5, 2.5, 2.5, 2.6, 2.6, 2.5, 2.6, 2.4, 2.5, 2.6, 2.5, 2.5, 2.5, 2.5, 2.4, 2.1, 2.3	NA						

MK/K BK6 - 2.5

Silt w/ ~10% Fine sand poorly graded. Few gravels throughout. light yellowish BROWN. Dry. No apparent odor.

#1/2': color Δ to ~~light yellowish~~ brown

4 1/2': Same as above w/ small to med cobbles.

Sample @ 5

Sample @ 15

SAME.

Sample @ 30

SOIL DESCRIPTION FOR BH-28

Driller / Drilling Co.:

Equipment: Ludlum 2241-3

BOREHOLE LOG

START T9 REGION 9

Project Name: Anaconda

Address:

Borehole Number: ~~BH-E~~ BH-50

Date: 10/31/07

Logged By: MC/PA

DEPTH	% REC	BLOWS	~~SAMPLE~~ GAMMA I.D.	Alpha (CPM)	Gamma (CPM)	DTW First	DTW Static	USCS SYMBOL	SOIL DESCRIPTION	Well Construction
0' 6			2.4						Bkg 2.5	
			2.4							
			2.0							
			1.75							
			1.65							
			1.5							
			1.2						- sample @ 2	
			1.1							
			1.1							
			1.1							
5'			1.15							
			1.4							
			1.4							
			1.4							
			1.65							
			1.8							
			1.7							
			1.8							
			1.8							
			1.9							
10'			1.85							
			1.9							
			1.8							
			2.0							
			2.0							
			2.15							
			2.0							
			2.0							
			2.15							
			2.0							
15'			1.8						- sample @ 15	
			1.85							
			2.0							
			1.9							
			2.1							
			1.8							
			1.8							
			2.0							
			1.9							
			1.9							
20'			2.1							
			2.0							
			2.0							
			2.3							
			2.35							
			2.2							
			2.1							
			2.1							
			2.3							
			2.2							
25'			2.4							
			2.75							
			2.6							
			2.5							
			2.35							
			2.8							
			2.7							
			2.45							
			2.5							
			2.5					- Sample @ 30	
30'			2.5							

Driller / Drilling Co.:

Equipment:

BOREHOLE LOG

Project Name:	Anaconda
Address:	
Borehole Number:	BH -10
Date:	10/31/07
Logged By:	MG/PA

DEPTH	% REC	BLOWS	SAMPLE I.D.	Alpha (CPM)	Gamma (CPM)	DTW First	DTW Static	USCS SYMBOL	SOIL DESCRIPTION	Well Construction
0' +0			2.0, 2.1, 2.25, 2.25, 2.4, 2.6, 2.4, 2.3, 2.4, 2.7						BKG 2.5	
5'			2.7, 2.75, 2.5, 2.75, 2.25, 2.40, 2.2, 2.4, 2.5, 2.3						- sample @ 5	
10'			2.2, 2.1, 2.1, 2.0, 1.85, 2.0, 1.9, 1.9, 2.0, 2.1						- sample @ 15	
15'			2.1, 2.1, 1.9, 2.0, 2.1, 2.2, 1.9, 2.1, 2.0, 1.9							
20'			1.8, 1.75, 1.7, 1.8, 2.1, 2.1, 2.15, 2.15, 2.1, 2.1							
25'			2.05, 2.0, 2.1, 2.0, 2.0, 2.4, 2.25, 2.5, 2.3, 2.15						- sample @ 30	
30'										

Driller / Drilling Co.:

Equipment: Ludlum 2241-3

START Region 9

BOREHOLE LOG

Project Name:	Anaconda
Address:	
Borehole Number:	BH-13
Date:	10/31/07
Logged By:	MG/PA

DEPTH	% REC	BLOWS	SAMPLE I.D.	Alpha (CPM)	Gamma (CPM)	DTW First	DTW Static	USCS SYMBOL	SOIL DESCRIPTION	Well Construction
0'			4.6, 4.15, 2.75, 2.3, 2.2, 1.9, 1.9, 1.9, 2.1, 1.8, 1.85						BKG 2.5	
5'			1.9, 2.0, 2.0, 2.0, 1.9, 1.9, 1.9, 2.0, 2.0, 2.1						Sample @ [illegible]	
10'			2.1, 1.9, 1.9, 1.9, 1.95, 2.0, 1.9, 1.9, 2.0, 1.9							
15'			1.85, 1.9, 2.16, 1.9, 2.0, 2.2, 2.4, 2.25, 2.3, 2.3						Sample @ 15	
20'			2.2, 2.3, 2.2, 2.4, 2.4, 2.4, 2.4, 2.4, 2.4, 2.6							
25'			2.8, 3.1, 3.0, 3.3, 3.15, 2.9, 3.1, 2.85						Sample @ 30	
30'										

Driller / Drilling Co.:

Equipment: Ludlum 2241-3

BOREHOLE LOG

Project Name: Anaconda

Address:

Borehole Number: BH-22

Date: 10/31/07

Logged By: MW/DA

DEPTH	% REC	BLOWS	SAMPLE I.D.	Alpha (CPM)	Gamma (CPM)	DTW First	DTW Static	USCS SYMBOL	SOIL DESCRIPTION	Well Construction
0' TP			1.85						BKG 2.5	
			1.85							
			1.9							
			2.0						BH-22- 2	
			2.0							
			2.0							
			2.0							
			2.0							
			2.1							
			2.25							
			2.3							
5'			2.2							
			2.36							
			2.25							
			2.30							
			2.1							
			2.05							
			2.1							
			2.0							
			2.15							
			2.15							
10'			2.15							
			2.1							
			2.15							
			2.25							
			2.15							
			2.1							
			2.1							
			2.15							
			2.2							
			2.35							
15'			2.3						BH-22-15	
			2.4							
			2.65							
			2.3							
			2.3							
			2.6							
			2.6							
			2.7							
			2.75							
			2.45							
20'			2.30							
			2.4							
			2.3							
			2.71							
			2.45							
			2.3							
			2.5							
			2.5							
			2.7							
			2.8							
25'			2.8							
			2.85							
			2.9							
			2.8							
			2.8							
			2.65							
			2.65							
			2.4							
			2.2						BH-22-30	
30'										

Driller / Drilling Co.:

Equipment: Ludlum

BOREHOLE LOG

START Region 9

Project Name:	ANACONDA
Address:	
Borehole Number:	BH-~~22~~49 BH-49
Date:	10/31/07
Logged By:	MG/PA

DEPTH	% REC	BLOWS	~~SAMPLE~~ GAMMA I.D.	Alpha (CPM)	Gamma (CPM)	DTW First	DTW Static	USCS SYMBOL	SOIL DESCRIPTION	Well Construction
0'			2						BKG 2.5	
			2							
			2.25							
			3.4						BH-49-2-3	
			5.6							
			9.5 (?)							
			10.5							
			11.0							
			8.6							
			6.3							
			5.2							
5'			3.9							
			2.8							
			2.8							
			2.7							
			2.65							
			2.5							
			2.25							
			2.1							
			2.1							
			2.4							
10'			2.5							
			2.55							
			2.3							
			2.1							
			2.1							
			2.3							
			2.3							
			2.4							
			2.5							
			2.85							
15'			2.5						BH-49-15	
			2.65							
			2.5							
			2.6							
			2.3							
			1.9							
			2.1							
			2.0							
			2.1							
20'			2.1							
			2.2							
			2.2							
			2.4							
			2.6							
			2.6							
			2.8							
			2.9							
			3.0							
			2.0							
25'			3.1							
			2.8							
			2.75							
			2.7 (?)							
			2.05							
			2.5							
			2.6							
			2.3							
30'			2.6						BH-49-30	
			2.5							

Driller / Drilling Co.:

Equipment: Ludlum

BOREHOLE LOG

START Region 9

Project Name:	ANACONDA
Address:	
Borehole Number:	BH-25
Date:	10/31/07
Logged By:	MG/PA

DEPTH	% REC	BLOWS	SAMPLE I.D.	Alpha (CPM)	Gamma (CPM)	DTW First	DTW Static	USCS SYMBOL	SOIL DESCRIPTION	Well Construction
0' 16			2.55							
			2.24						BK6 - 2.5	
			1.9							
			1.8							
			2.0							
			2.15							
			2.15						BH-25-2	
			2.05							
			1.9							
			2.0							
5'			2.0							
			2.0							
			2.0							
			1.9							
			2.1							
			1.9							
			1.8							
			2.0							
			2.2							
			2.2							
10'			2.15							
			2.15							
			2.0							
			1.9							
			2.0							
			1.95							
			1.95							
			2.1							
			2.1							
			1.95						BH-25-15	
15'			2.2							
			2.15							
			2.3							
			2.2							
			2.3							
			2.3							
			2.25							
			2.4							
			2.1							
			2.2							
20'			2.25							
			2.25							
			2.3							
			2.3							
			2.3							
			2.25							
			2.45							
			2.5							
			2.7							
			2.8							
25'			2.9							
			2.7							
			2.7							
			2.7							
			2.5							
			2.65							
			2.5							
			2.65							
			2.6						BH-25-30	
30'										

Driller / Drilling Co.:

Equipment: Ludlum

Attachment 5: Sampling and Analysis Plan

DRAFT
Sampling and Analysis Plan
Radiation Assessment
Anaconda Mine Site Process Area, Yerington, Nevada

Prepared For:

USEPA Region 9
TO1-09-07-02-0001
Contract: EP-59-06-01

Prepared By:

U.S. EPA START Contractor – Team 9
221 Main Street, Suite 600
San Francisco, California, 94105-1917

July13, 2007

DRAFT –Sampling and Analysis Plan
Radiation Assessment
Anaconda Mine Site Process Area, Yerington, Nevada

Prepared For:

United States Department of Environmental Protection

Prepared By:

U.S. EPA START Contractor – Team 9
221 Main Street, Suite 600
San Francisco, California, 94105-1917

July13, 2007

Approved by START 3 Field Manager	Nicole Testa	Date
Approved by START 3 QA Manager	Howard Edwards	Date
Approved by U.S. EPA On-Scene Coordinator	Will Duncan III	Date
Approved by U.S. EPA QA reviewer		Date

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APPENDICES

Appendix A	Standard Operating Procedures
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ACRONYMS

ARARs	Applicable or Relevant and Appropriate Requirements
COPCs	chemicals of potential concern
DQI	data quality indicator
DQO	data quality objectives
ERS	Emergency Response Section
ERGS	Environment Radiation Ground Scanner
ERT	environmental response team
GPS	global positioning system
IDW	investigation-derived waste
NCP	National Contingency Plan
NDEP	Nevada Department of Environmental Protection
OERR	Office of Emergency and Remedial Response
ORIA	U.S. EPA Office of Radiation and Indoor Air
PM	project manager
PPE	personal protective equipment
PQLs	Practical Quantitation Limits
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
SAP	sampling and analysis plan
START	superfund technical assessment and response team
TM	task monitor
U.S. EPA	United States Environmental Protection Agency
USGS	United States Geological Survey

1.0 INTRODUCTION

The United States Environmental Protection Agency (U.S. EPA), Region IX has directed the Team 9 Superfund Technical Assessment and Response Team (START) to develop and implement a Sampling and Analysis Plan (SAP) to perform a radiation assessment at the Anaconda Mine Site in Yerington, Nevada. A SAP combines the basic elements of a Quality Assurance Project Plan (QAPP) and a Field Sampling Plan (FSP). Funding for the writing of the SAP and completion of the fieldwork described herein has been provided through the U.S. EPA Region IX START-3 contract. The format of the SAP has been derived primarily from *Sampling and Analysis Plan Guidance and Template, Version 1, EPA Analytical Services Used* (U.S. EPA, 2000). The elements described in *EPA Requirements for Quality Assurance Project Plans, QA/R-5* (U.S. EPA, 2001) and *Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G-4* (U.S. EPA, 2006) are included in this SAP.

This SAP describes the project and data use objectives, data collection rationale, quality assurance goals, requirements for sampling and analysis activities, and defines the sampling and data-collection methods that will be used for this project. The SAP is intended to accurately reflect the planned data-gathering activities for this site assessment; however, site conditions and additional U.S. EPA direction may warrant modifications. All significant changes will be recorded in site records and reported in the post-sampling report.

Specific tasks that are documented in the SAP include:

- Real-time radiation detection with Environment Radiation Ground Scanner (ERGS) and direct reading instrument over the entire Anaconda Mine Process area.
- Install soil borings at specific locations determined in the field based on real-time radiation data and data from previous investigation.
- Real-time radiation detection in boreholes.
- Real-time radiation detection of sub-surface soil cores extracted from boreholes.
- Collection of soil samples for laboratory analysis for specific radionuclides.

1.1 PROJECT ORGANIZATION

The following section describes the key members of the planning team. Key members are also indicated in Table 1-1.

U.S. EPA Task Monitor (TM) – The U.S. EPA Task Monitor is Will Duncan. Mr. Duncan is a U.S. EPA Federal On-Scene Coordinator (FOSC) and will be the primary decision-maker, direct the project, specify tasks, and ensure that the project is proceeding on schedule and is within budget. The FOSC is responsible for SAP approval and will determine what additional QA review and approval is needed concerning this SAP. The FOSC is responsible for site access and will be the primary point of contact with the U.S. EPA Remedial Project Manager (RPM), U.S. EPA Office of Radiation and Indoor Air (ORIA) field team, state and local agencies, the responsible parties (RPs) and the public.

U.S. EPA Remedial Project Manager (RPM) – The U.S. EPA RPM for the Anaconda site are James Sickles and Nadia Hollan Burke. Both Mr. Sickles and Ms Hollan Burke will coordinate with the FOSC and assist with decision-making process.

U.S. EPA Office of Radiation and Indoor Air Field Team Manager– The ORIA field team leader for the Anaconda site is Roger Shura. Mr. Shura will coordinate with the FOSC and assist with decision-making process.

U.S. EPA Region IX Emergency Response Sections (ERS) QA Liaison – The Region IX ERS QA Liaison is Hedy Salter. The Region IX ERS QA Liaison will assist the FOSC concerning QA issues as needed.

START QA Manager and Project Manager – The START QA Manager and PM for this project is Howard Edwards. Mr. Edwards will coordinate project and program QA activities with the START field manager START field team and the U.S. EPA FOSC. Mr. Edwards is responsible for preparing the SAP; coordinating with the laboratories and oversight of collecting, handling, documenting, and transporting samples; and preparing a final report for submission to the U.S. EPA.

START Field Team Manager (TM) – The START TM is Nicole Testa. Ms. Testa is responsible for the performance of tasks assigned to the START by the U.S. EPA. Specifically, Ms. Testa is responsible for approving and implementing the SAP; implementing the sampling design; collecting, handling, documenting, and transporting samples; generating field documentation of sampling activities; working with the START QA Manager to ensure project quality assurance goals are met; and preparing a final report for submission to the U.S. EPA.

Analytical Laboratory – The anticipated analytical laboratory will be an unspecified U.S. EPA ERT, ORIA or START contract laboratories. The laboratory tentatively scheduled for analysis is the U.S. EPA Radiation and Indoor Environments National Laboratory (RIENL) in Las Vegas, Nevada. If START subcontract laboratory is used, the laboratory will be General Engineering Laboratory in Charleston, South Carolina.

Field Analytical – Real-time radiation detection data will be generated by ORIA and START. The START team will use The Palladino Company, of San Francisco California to assist with real-time radiation planning, monitoring and sampling.

Table 1-1
Project Organization

Title/Responsibility	Name	Phone Number
U.S. EPA, Region IX Task Monitor/ Federal On-Scene Coordinator	Will Duncan	(415) 972-3412 (o) (415) 309-2655 (c)
U.S. EPA, Region IX Project RPM	James Sickles. Nadia Hollan Burke	(415) 972-3265 (o) (415) 972-3187 (o)
U.S. EPA, ORIA Team Leader	Roger Shura	(702)784-8235 (o)
START QA and Project Manager	Howard Edwards	(415) 828-9320 (c)
START Field Team Leader	Nicole Testa	(415) 828-8314 (c)
Site Radiation Safety Officer	Carl Palladino	(415) 861-1945 (o) (415) 336-1556 (c)
Radioanalysis Laboratory	(Tentatively) RIENL lab in Las Vegas	To Be Determined

Notes: QA – quality assurance
START – Superfund Technical Assessment and Response Team
U.S. EPA – United States Environmental Protection Agency

1.2 DISTRIBUTION LIST

Copies of the final SAP will be distributed to the following persons:

- Will Duncan– U.S. EPA; Region IX, San Francisco, California
- Hedy Salter – Region IX ERS QA QA Liaison, San Francisco, California
- Team 9, START Field Team
- Team 9, START Project File

1.3 STATEMENT OF THE SPECIFIC PROBLEM

The environmental concerns and conditions that will be addressed by this SAP are based on available information.

Ore material from the Anaconda Mine contained naturally occurring radioactive materials (NORM). When the ore was processed at the mine for its copper content, it produced technologically enhanced naturally occurring radioactive materials (TENORM), in which radioactive minerals were concentrated above natural levels or materials have been moved from their natural location which may cause an increase in exposure. TENORM at the site is primarily found in process solutions, tailings and waste streams. Previous investigations of the mine's process area has documented elevated alpha, beta and gamma radiation activity with elevated concentration of the radioisotopes; radium 226, radium 228, thorium 230, thorium 232 and uranium 238. The mine's process area is no longer used for ore processing and is private owned property that could be subject to future commercial development. The contamination within this process area also poses the threat of potential release of radioactive materials to the environment and exposure to local residents. Specific information on the magnitude on contamination is presented in Figure 2-2 through Figure 2-17. U.S. EPA is performing a removal assessment of the process area soil to support removal activities.

2.0 BACKGROUND

The following sections document the history of the site and describe the site setting.

2.1 SITE LOCATION AND DESCRIPTION

The Anaconda Site is located at 102 Burch Drive near Yerington, Nevada. The geographic coordinates for the site are 38° 59' 38.57" latitude and 119° 11' 53.64" longitude, taken by global positioning system (GPS) at the mine office on Burch Drive. This Site covers several square miles and includes Township 13N, Range 25E, Sections 4, 5, 8, 9, 16, 17, 20, and 21 on the Mason Valley and Yerington USGS 7.5 minute quadrangles. The location of the Site is shown in Figure 2-1. The Site occupies 3,468 acres (about 5.5 square miles) of disturbed land in a rural area approximately 1 mile west of the City of Yerington (NDEP, 1994). The Site is bordered to the north by open agricultural fields, to the west and southwest by the Singatse Mountain Range and the town of Weed Heights, to the south by Bureau of Land Management (BLM) land, and to the east by Highway 95A, which separates the site from the city of Yerington (NDEP, 1994; USGS, 1987a; USGS, 1987b). Land ownership includes parcels owned by BLM, Atlantic Richfield Company (ARCO) and Arimetco, Inc.

Facilities associated with copper mining operations at the site include an open-pit mine, mill buildings, tailing piles, waste fluid ponds, and the adjacent residential settlement known as Weed Heights. A network of leach vats, heap leaching pads, and evaporation ponds remain throughout the site, in addition to a lead-working shop, a welding shop, a maintenance shop, two warehouses, an electro-winning plant, and an office building. This assessment will focus on the Process Area which covers an area approximately 5,000 feet long and 2,000 feet wide (approximately 230 acres) and contains the central processing facilities.

2.2 OPERATIONAL HISTORY

The site began operation in or about 1918, and was originally known as the Empire Nevada Mine. From 1951 to 1978, the site was occupied by the Anaconda Copper Company. In approximately 1978, Atlantic Richfield Company (Atlantic Richfield) acquired Anaconda, and began operations. In approximately 1982, Atlantic Richfield sold its interests in the private lands within the site to Don Tibbals, a local resident, who conducted minor mining operations at the site. Mr. Tibbals subsequently sold his interests, with the exception of the Weed Heights community, to Arimetco, Inc. (Arimetco), the current owner. Arimetco operated a copper recovery operation from existing ore heaps within the site from 1989 to November 1999. Arimetco terminated operations at the site, and is currently managed under the protection of the

United States Bankruptcy Court in Tucson, Arizona. The approved bankruptcy plan anticipates a liquidation of Arimetco's operations at the site (E&E, 2001).

During the 25-year period that Anaconda and Atlantic Richfield operated the site, they removed approximately 360 million tons of ore and debris from the open pit mine, much of which now remains in tailings or leach heap piles. Anaconda and Atlantic Richfield extracted copper from the mine by two separate methods for processing copper ore, depending on the ore type. The mined ore contained copper oxides in the upper portion of the open pit, and copper sulfides in a lower portion of the open pit. During on-site milling operations, a copper precipitate was produced from the oxide ore and a copper concentrate was produced from the sulfide ore. Once processing method involves the operator laying the copper oxide ore in leaching vats and leach out copper with sulfuric acid. The resulting tailings are referred to as vat leach tailings (VLT). The copper subsequently precipitated out after passing the leachate over scrap iron. Anaconda and Atlantic Richfield also used a second process for the oxide ore starting in 1965 in which dilute sulfuric acid was spread over the top of low-grade oxide ore piles leaching out the copper. The resulting acidic solution containing copper was collected and the copper recovered by precipitation, by passing the leachate over scrap iron. The copper sulfide ore was processed by crushing and concentration by flocculation. Lime was then added to maintain an alkaline pH, and the resulting copper concentrate was shipped off-site for final processing (NDEP, 1994; Arimetco, 1998).

In another processing method, Arimetco leached the ore successively with a mild acid solution and kerosene in three process vats (approximately 200,000 gallons). A stronger sulfuric acid solution subsequently removed copper from the kerosene solution. A final electro-winning plant plated the copper onto stainless steel sheets. The operator recirculated the acid solution from the electro-winning vats back into the leach heaps. The leach heaps remain on-site and are a continuing source of acidic run-off (E&E, 2001).

Byproducts of the milling operation were wet gangue from the sulfide ore and wet tailings and iron- and sulfate-rich acid brine from the oxide ore. Uranium is also present naturally in virtually all soil and tailings onsite.

The ore material from the Yerington Mine contains naturally occurring radioactive minerals. Processing of that ore produced Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM) in which the radioactive minerals were concentrated above natural levels in tailings and process solutions (EPA, 2006).

2.3 PREVIOUS INVESTIGATIONS AND REGULATORY INVOLVEMENT

2.3.1 Previous Investigations

The following reports provide background information on the Process Areas conditions at the Yearington Mine site. A graphic representation of the contamination documented during previous investigation is presented in Figure 2-2 through Figure 2-17.

Ecology & Environment, Inc., Superfund Technical Assessment and Response Team (START), "Expanded Site Inspection, Anaconda Copper Company, Yerington Mine", December 2000. This inspection was completed at the request of EPA following CERCLA/Superfund protocol. The purpose was to evaluate the site to determine if enough potential hazards existed to warrant additional investigations under CERCLA. The conclusion was that further assessment was needed.

Ecology & Environment, Inc., Superfund Technical Assessment and Response Team (START), "Anaconda, Yerington Mine Site Emergency Response Assessment Final Report", June 2001. This report summarizes the results of the 2000 inspection of the Mine Site along with additional samples collected off-site in 2001 at the Yerington Paiute Indian Colony and other residential locations.

Phillips Services Corporation, "Yerington Nevada Electrowinning Fluids and Drum Removal Project Summary", July 30, 2003. This report is a detailed account of activities at the site to remove remaining process chemicals and drums left by Arimetco.

BLM Carson City Field Office, "BLM Health and Safety Plan, Process Area, Yerington Mine, Yerington, Nevada", August 2004. For preparation of their Health and Safety Plan, the BLM completed some initial soil sampling and radiation monitoring in the Process Areas, completed by subcontractor Walker and Associates. The results of the radiological study are included in Appendix E of the Health and Safety Plan.

Foxfire Scientific "Yearington Mine Site Worker Radiological Dose Assessment", February 26, 2004. This report evaluated exposure of site workers to potential radiological hazards caused by evaporation sprayers and wind blown dust. This report concluded that on site workers are not receiving any significant radiation dose as a result of evaporation sprayers.

Foxfire Scientific, "Yerington Mine Site Fugitive Dust Radiological Dose Assessment", September 2004. This was a report commissioned by NDEP to evaluate radiological hazards to onsite workers as well as off-site, down-wind residential communities originating from the tailings areas and evaporation ponds fugitive dusts. Concluded based on modeling that the calculated dose received by individuals exposed to fugitive dust is not significant.

SRK, "Preliminary Gamma Survey Results for Yearington Mine Site Tailings and Evaporation Ponds Surface Characterization Work Plan" July 8, 2004. This study provided gamma survey results for the tailings piles and evaporation ponds. No summary or conclusions provided.

U.S. EPA "EPA Radiation and Indoor Environments National Laboratory Scanner Van Survey of the Yearington Mine Site and Surrounding Areas" April 18-26, 2005. This document shows the results of the EPA Scanner Van's gamma radiation survey of all of the accessible areas of the site and some offsite locations. This survey documented high gamma readings in the process area and the finger ponds.

Bureau of Land Management, Technical Resources Group, "Review of Yerington Mine Characterization Activities", December, 2004. This report was completed by the BLM in order to summarize recent radiation characterization activities completed within the previous 6 months on the mine site by BLM, Brown and Caldwell, and Foxfire personnel and specifically during a site visit on December 9, 2004. This report documented elevated levels of radiation in the process area.

RMEC Environmental, "Final Radiological Monitoring Report, October 2004 to April 2005, Yearington Mine Site Investigation Operations", October 10, 2005. This document in a summary of health and safety radiological monitoring completed during field investigations of the process area and pumpback wells. Documented one section of the process area above the radiation control level of 0.2 millirem per hour (mrem/hr) established for the site.

Brown and Caldwell, "Data Summary Report for Process Area Groundwater Conditions" September 23, 2005. This report is the final report for groundwater investigations in the process area completed from 2004-2005. 30 groundwater samples of which 0 exceeded the U.S. EPA Maximum Contaminant Level (MCL) for Radium 226, 3 exceeded the MCL for Radium 228 and 15 exceeded the MCL for uranium.

Brown and Caldwell, "Data Summary for Process Areas Soil Characterization", November 1, 2005. Summarizes field investigations of surface and subsurface soil in the process area conducted from September 2004 to April 2005. The process area was divided into 12 areas based on similar historical operations and contiguous process components. Areas included: Administrative and maintenance areas, truck shop and crushers, vat leach tanks, solution tanks, precipitation plant, sulfide plant, calcine ditch, north solution ditch, east solution ditch, north low area, south low area and peripheral process components. This study collected monitoring data for gamma radiation as well as laboratory analysis of samples for radioisotopes. Samples collected during this study documented concentrations of Radium 226 and Radium 228 in multiple areas which exceeded U.S. EPA preliminary remediation goals (PRGs).

2.3.2 Regulatory Involvement

EPA proposed placing the site on the NPL in 2001, however the State of Nevada objected since they were working on the site under a voluntary agreement with Atlantic Richfield Company. EPA agreed to defer listing at that time to allow the State to continue that approach while reserving the right to reconsider listing on the NPL if that approach did not prove effective. EPA negotiated a Scope of Work and Memorandum of Understanding with Nevada and the BLM to cover further site investigations and cleanup activities, with Nevada Department of Environmental Protection (NDEP) retaining lead responsibility and EPA providing oversight. In late 2004, NDEP requested that EPA take the regulatory lead at the site, due to the increased complexity of contaminants at the site such as radioactive contamination. In early 2005, the U.S. Environmental Protection Agency (EPA) assumed regulatory lead of the site and issued a Unilateral Administrative Order to ARCO. Currently, the EPA and ARCO are drafting a series of work plans addressing site-wide investigations, security, and health and safety. (U.S. EPA Website March 27, 2007)

2.4 PHYSICAL SETTING

The following paragraphs related to the physical setting of the site are summarized from United States Geological Survey (USGS) information and other supporting documentation.

2.4.1 Physiographic Conditions

The Process Areas of the Yerington Mine Site are located on the distal edge of an alluvial fan, between the Singatse Mountain Range and fluvial deposits associated with the Walker River. The source area for the fan is a major drainage feature referred to as The Canyon on the USGS Yerington 7.5-minute quadrangle (1986). The head of The Canyon is shown near Singatse Peak at approximately 6,000 feet above mean sea level (amsl) and runs approximately two miles south and east to the head of the alluvial fan at approximately 4,800 feet amsl and the base is between 4380 feet and 4420 feet amsl. The Process Areas are located approximately one mile down slope from the head of the fan at an elevation of approximately 4,450 feet amsl. Natural topography in the area has been altered by mining and milling operations (Brown and Caldwell 2005).

2.4.2 Geologic Conditions

The Yerington Mine site is located on the west side of Mason Valley, a structural basin surrounded by uplifted mountain ranges. The area is typical of basin-and-range topography. The mountain blocks are primarily composed of granitic, metamorphic and volcanic rocks with minor amounts of semi-consolidated to unconsolidated alluvial fan deposits. The Singatse Range has been subject to metals mineralization, as evidenced by the large copper porphyry ore deposit at the Yerington Mine. Unconsolidated alluvial deposits derived by erosion of the uplifted mountain block of the Singatse Range and alluvial materials deposited by the Walker River fill the structural basin occupied by Mason Valley in the vicinity of the mine site. These unconsolidated deposits, collectively called the valley-fill deposits by Huxel (1969), comprise four geologic units: younger alluvium (including the lacustrine deposits of Lake Lahontan), younger fan deposits, older alluvium and older fan deposits. Lake Lahontan lacustrine deposits appear to have been removed and reworked by the Walker River as it meandered back and forth across the valley (Huxel, 1969). Huxel estimated that Pleistocene Lake Lahontan in Mason Valley persisted for a relatively short time and was less than 60 feet deep. Seitz et al., (1982) described the geologic setting of the area around the mine site based on existing information and the sub-surface information obtained through the drilling of test wells (i.e., monitor wells) north of the site by the U.S. Geological Survey in 1978. Alluvial fan deposits along the west margin of the valley and stream- and lake-deposited materials on the valley floor underlie the tailings and evaporation ponds. Bedrock, including the open pit, is exposed along the southwestern, southern and eastern margins of the site. Alluvial fan materials, localized lakebed sediments and fluvial deposits occur along the margins of the mine site (Brown and Cladwell 2005).

ARC installed two shallow monitor wells (MW-2002-1 and MW-2002-2) in the area north and northwest of the mine site in June 2002 (Brown and Caldwell, 2002). These wells were drilled with a sonic core rig to collect detailed lithologic information from the shallow alluvial aquifer. Core samples generally consisted of a relatively uniform mix of fine-grained sand, silt and clay size fractions with little internal structure (i.e., bedding, laminations, etc.). The exception to the homogeneous character of the core samples occurred immediately above, and at the depth, where groundwater was intersected in one of the boreholes. At this horizon, fine clay laminations with minor folding or "slump" features were observed (Brown and Caldwell 2005).

Core samples recovered just above the top of the water table in both monitor well boreholes generally contained higher clay contents than those recovered just below the top of the water table. These fme-grained sediments are generally consistent with a distal alluvial fan depositional environment that may be transitional to lake bed sediments related to Pleistocene-age Lake Lahontan. Based on the lithology of core samples collected during the groundwater investigation conducted in the Process Areas (Brown and Caldwell, 2005c), the alluvial fan underlying the mine site is generally composed of relatively fine-grained mud-flow deposits and relatively coarse-grained water-laid deposits. The mud-flow deposits generally include 50 percent silt and clay, with between 30 and 50 percent sand and between zero and 20 percent gravel. Water-laid deposits are generally moderately sorted and include sands and gravels with variable amounts of silt- and clay-size fractions. The water-laid deposits beneath the Process Areas are interpreted as channel deposits generally comprised of silts and sands, sands with minor amounts of non-plastic finegrained materials, and clay-rich sands with plastic fme-grained materials. As described in Section 2.0 of this DSR, the distal alluvial fan deposits are interbedded with lacustrine and fluvial deposits in the area of the mine site (Brown and Caldwell 2005).

2.5 ENVIRONMENTAL AND/OR HUMAN IMPACT

Radioactive material in the process area has the potential for human impact at the site through three primary pathways, migration to groundwater, exposure to windblown dust and worker/trespasser exposure through direct contact. Windblown dust has the potential to impact residents of the neighboring communities of Weed Heights and Yearington. As water percolates through surface material to the groundwater aquifer, there is some potential that this material can be transported to this aquifer and migrate to local drinking water sources. Additionally, although the mine is no longer active workers are at the site for various reasons and could potentially be exposed to radioactive material. Although the site is fenced there is still potential for trespassers to be exposed if they entered the site.

3.0 PROJECT DATA QUALITY OBJECTIVES

Data quality objectives (DQOs) are quantitative and qualitative criteria that establish the level of uncertainty associated with a set of data.

3.1 PROJECT TASK AND PROBLEM DEFINITION

Previous investigations have documented the presence of TENORM at the Anaconda Mine, specifically in the process area. This assessment will locate and define radioactive material hot spots within the process area. By assessing both surface and subsurface levels of radiation both the horizontal and vertical extent of contamination will be defined.

Initial screening data will be utilized to locate potential hotspots and analytical data will be used to further define and quantify radioactive material. Initial screening performed with the Enivronmental Radiation Ground Scanner (ERGS) and hand screening instrumentation will document the location of surficial hotspots. This data will be used to select soil boring locations from which further screening data will be collected. Based on the results of the additional screening samples will be selected for laboratory analysis.

Monitoring data will be compared to background data while analytical data generated will be compared to the laboratory Practical Quantitation Limits (PQLs) for the COPCs and site specific investigation levels to determine the presence of COPCs above these levels, and establish the presence of hot spots at the site.

3.2 DATA QUALITY OBJECTIVES

The following sections outline the 7-Step DQO process completed in accordance with *Guidance on Systematic Planning Using the Data Quality Objectives Process, U.S. EPA QA/G-4* (U.S. EPA, 2006).

3.2.1 Step 1: State the Problem

The following paragraphs outline Step 1 of the DQO process. A concise description of the problem is given in Section 3.1.

Planning Team

Planning Team members have been identified in Section 1.2, Project Organization. A scoping meeting was held on December 6, 2006 with START and the U.S. EPA TM, and other representatives of the USEPA.

Conceptual Site Model

- The media of concern is soil.
- The principal COPCs are Radium 226, Radium 228, alpha, beta, and gamma radiation.
- The soil medium was potentially contaminated with COPCs due to mining process operations at the site.

Exposure Scenarios

Exposure potential at the site given the current conditions is moderate, because the site is not currently active, the site is reasonably secure, and buildings in the process area reduce the potential for windblown dust.

Available Resources

The current START budget for preparation and implementation of this SAP and the corresponding removal assessment is approximately $150,000.

The U.S. EPA budget for the removal assessment of the Anaconda process area will cover the ORIA field team activities, laboratory analysis, U.S. PST operation of the U.S. EPAs Geoprobe. U.S. EPA owned radiation monitoring equipment will be used for the project.

Other Considerations and Constraints

Some of the project areas may not be accessible to the ERGS for the initial site screening based on topography or the presence of site structures or debris. These areas will be screened using hand held instrumentation.

3.2.2 Step 2 – Identify the Decision

This section describes the decision that requires new data to address the contamination problem. The principal study question and alternative action are outlined below.

Principal Study Question: Are there localized areas within the area of concern that can be defined as contamination hotspots? (For this study the presence of radioactive materials a concentration greater that twice to three times background will be considered a potential contamination hotspot.)

Alternative Action 1: If yes, the magnitude, vertical extent and horizontal extent of each identified contamination hotspot will be assessed and documented. A removal action will be completed in these areas to remove the potential threat to human health and the environment.

Alternative Action 2: If no, then it may be determined that no removal action is necessary or that further assessment is required.

Decision Statement

Determine where removal is needed based upon the magnitude, vertical extent and horizontal extent of radioactive hot spots in process area.

3.2.3 Step 3 – Inputs to the Decision

The following paragraphs describe inputs required to make the decision.

Information Currently Available

- Sampling collected by the RP's consultant during a previous soils investigation in the process area.

- Real-time monitoring data generated during past assessments in the process area.

New Data Required

The following data are required to resolve the decision statement.

- Real-time radiation scanning/mapping data generated by the ERGS and real-time radiation scanning/mapping using field portable radiation detection instrument over the entire process area.

- Maps showing scanning data covering the entire process area.

- Real-time subsurface radiation data collected from monitoring instruments lowered into boreholes.

- Real-time radiation data collected from the scanning of subsurface core samples removed from boreholes.

- Analytical data from surface and subsurface samples collected in areas showing high levels of gamma radiation based on monitoring data.

Basis for Determining the Investigation Levels

The EPA decision team for the assessment and removal effort has decided that the activity investigation levels will be based upon the establishment of background activity. The investigation level should be two to three time the establish background activity.

The EPA decision team for the assessment and removal effort has decided that the radioisotope investigation levels will be the EPA's Preliminary Remedial Goals (PRGs).

Data Collection Methods

Planned data collection techniques are described in detail in Sections 6.3 of this SAP. The following information is provided to assist in documenting that the DQO process has been completed. Field data will be collected using the ERGS and field portable instruments. More definitive analytical data will be generated by submitting surface and subsurface samples for laboratory analysis.

Data Measurement Methods

The site-specific measurement methods are described in Section 5 of this document. The information regarding measurement methods is provided below to assist in documenting that the DQO process has been completed. Potential definitive methods of analyses to determine COPC concentrations are outlined in Table 3-1.

3.2.4 Step 4 – Define the Boundaries of the Study

What is Specific Characteristics that Define the Population Being Studied

The specific characteristics that define the population being studied are the radioactivity rate level (activity/time) and radioactivity concentrations (activity/mass). Real-time field data will be reported as radioactivity rate data. Laboratory data for collected samples will be reported as radioactivity concentrations.

Spatial Boundaries

The Anaconda Mine Process Area in shown in Figure 3-18. The entire study area is based on the boundary of the main process area at the site. The main process area is bounded by the process solution recycling ponds and oxide tailings to the north, a Phase III heap leach pad and waste rock area to the south, a Phase III heap leach pad and oxide tailings to the east to the east and a waste rock area and Phase II heap leach pad to the west. Based on the large surface area of the entire process area, it will be divided into 12 decision units. Decision units were based on areas of concern identified during the previous process area soil investigation conducted by Brown and Caldwell in 2005 and designated by similar historical operations and contiguous process elements. These decision units are shown on Figure 3-18 and listed below.

- **DU 1 – Administration and Maintenance Areas.** This area includes the Administration Office, Change House, School House, Assay Lab), Large Warehouse, Small Warehouse, Quonset Hut, Grease Shop No. 1 and 2, Filling Station No. 1, 2 and 3, and Concrete Pad.

- **DU 2 – Truck Shop and Crushers.** Includes the Truck Shop, Equipment Garage, Truck Wash/Paint Shop, Equipment Wash, Carpenter Shop, Lead Shop, Fire Engine Storage, Emergency Shed, Sheet Metal Shop, Primary Crusher, Secondary Crusher, and Stacker (NN).

- **DU 3 – Vat Leach Tanks.** Includes the eight Vat Leach Tanks and the Sulfide Ore Stockpile area at the northwest end of the Vat Leach Tanks.

- **DU 4 – Solution Tanks.** Includes the three Solution Tanks and the associated Solution Tanks Electrical Building and basements.

- **DU 5 – Precipitation Plant.** Includes the iron launder and precipitation tanks and associated basements and piping in the Precipitation Plant.

- **DU 6 – Sulfide Plant.** Includes the remaining concrete foundations and thickener tanks associated with the Sulfide Plant and the Sulfide Plant Foremen's Office.

- **DU 7 – Calcine Ditch.** Includes approximately 2,400 feet of the large ditch area at the northwest end of the Process Areas known as the Calcine Ditch.

- **DU 8 – North Solution Ditch.** Includes 1,000 feet of a Solution Ditch of unknown origin or purpose located between the Precipitation Plant and the Sulfide Plant.

- **DU 9 – East Solution Ditch.** Includes 1,200 feet of a Solution Ditch located northeast of the Precipitation Plant at the base of the VLT pile.

- **DU 10 – North Low Area.** Includes the north half of a topographically low area on the northeast side of the Process Areas. It also includes an earthen Surge Pond and Concrete Ramps.

- **DU 11 – South Low Area.** This area includes the southern half of the topographically low area in addition to the Upper Truck Sludge Pond, Lower Truck Sludge Pond, and Ditch Between Upper and Lower Truck Sludge Ponds.

- **DU 12 –** Portions of the Process Area not Previously Investigated

The vertical boundary will be 30 feet below ground surface (bgs).

Temporal Boundaries

The temporal boundaries for the investigation are based upon the availability of U.S. EPA resources and personnel. There is no known redevelopment schedule or plans for this area.

There are temporal boundaries for the COPC. All are persistent in the environment. However migration of COPC in surface soil is possible through wind and water erosion.

Based on the above considerations, the following assessment schedule is being implemented. Field work is anticipated to be completed in early late July. Laboratory analysis is expected to take 2 weeks for the generation of preliminary data. Final analytical data and data packages are expected within 4 weeks of sample receipt. If performed, data validation will be completed two weeks after receipt of final analytical data packages. The final report for the project will be completed one month after data validation.

Scale of Decision Making

The entire process area will be scanned with radiation detection instrument during this investigation.

The decision to install a borehole and scan the hole with radiation detection instruments based upon the generated real-time radiation scanning data and data from previous investigations. The boreholes will be at least 100 feet from any other bore hole. Borehole installation is not expected to exceed 50 boreholes.

The decision to sample a borehole will be based upon real-time scanning or the core extracted from the borehole. The will be no more than 4 core samples collected per bole hole.

Decision regarding removal requirements will be based upon the information from within each of the 12 decisional units.

Constraints on Project

Special drilling equipment is needed if boreholes are to be installed under structures.

Constraints on Data Collection

- Turnaround times on analytical data are always estimated and can not be assured. Sample and system problems may indiscriminately increase data turnaround times.

- Field data generation will be limited by instrument availability and unexpected instrument problems.

- No site access issues are expected.

3.2.5 Step 5 – Develop Decision Rules

Site Investigation Level

The first the objective of the project is to determine baseline or background activity rates and concentrations.

The site investigation levels for gamma radiation as determined by the ERGS and portable instruments will be three times the determined baseline or background activity rate level. For specific radiation and radionucliotides by laboratory analysis the investigation level will be three times the determined baseline or background activity concentration level. Table 3-1 specifies the investigation levels for project quality control samples (e.g., blanks).

Project Decision Rules:

Selection of Borehole Locations

- If detected gamma radiation levels over a 10,000 square foot area during the initial screening survey exceed the project investigation level and there is no previous investigation data for that area, then a soil boring will be advanced at that location.

- If gamma radiation levels do not exceed the site investigation levels during the initial survey, soil borings will not be advanced at these locations. The exception will be the baseline/background locations with may be sampled to provide subsurface baseline/background data.

Selection of Laboratory Sampling Locations

- If the core sample from the soil samples collected from soil borings has elevated radiation activity rate levels, then a sample may be collected from the core.

- If the core sample from the soil samples collected from soil borings does not has elevated radiation activity rate levels, then a sample will not be collected from the core.

Selection of Removal Locations

If an area within a decisional unit exceeds the radiation site investigation level, then this decisional unit and the contamination hot spot within the unit will be proposed for removal.

If no area within a decisional unit exceeds the radiation site investigation level, then this decisional unit will not be recommended for removal.

3.2.6 Step 6 – Specify Tolerable Limits on Decision Errors

Range of the parameter(s) of interest

For all investigation areas and parameters, the range of interest for COPCs is from the MDL to anything above the investigation levels or PQL. Quantitatively precise and accurate determinations of contaminant concentrations that are significantly above (i.e., > 100 times) the investigation level are not necessary.

Baseline Condition (The Null Hypothesis)

COPCs in soil are present in process area decisional units above site investigation levels.

Alternative Condition (The Alternative Hypothesis)

COPCs in soil are not present in process area decisional units above site investigation levels.

Decision Error

The decision errors are discussed in Table 3-2. Decision error limit goals are provided in Table 3-3.

Table 3-2
DECISION ERRORS
Radiation Measurement during a Time-Critical Investitgation Situation

Decision Error	Deciding that the exposure rate, activity rate or activity concentrations exceed the investigation level when they do not.	Deciding that the exposure rate, activity rate or activity does not exceed the investigation level when they do.
True Nature of Decision Error	The exposure rate, activity rate or activity concentration does not exceed the investigation level.	The exposure rate, activity rate or activity concentration does exceed the investigation level.
The Consequence of Error	Either additional investigation will be initiated or a removal action will be initiated. The situation would cost the EPA, Region 9, additional resources of time, money, and manpower.	The decision could lead to direct exposure to the community and environment. Exposure would be an imminent threat to human health and/or the environment.
Which Decision Error Has More Severe Consequences near the Investigation Level?	**LESS SEVERE**	**MORE SEVERE** Since the error would impose a risk to human health and/or the environment.
Error Type Based on Consequences	False Acceptance Decisions Decision that the exposure rate, activity rate or activity concentrations are greater than the investigation level when they actually are not.	**False Rejection Decisions** Decision that the exposure rate, activity rate or activity concentrations are less than the investigation level when they actually are not.

Definitions

False Acceptance Decisions = A false acceptance decision error occurs when the null hypothesis is not rejected when it is false.
False Rejection Decisions = A false rejection decision error occurs when the null hypothesis is rejected when it is true.

Table 3-4 **Decision Error Limits Goals** **for** **Radiation Measurement during a Time-Critical Response Situation**		
True **exposure rate, activity rate or activity concentrations with in a Decisional Unit** **(% of Investigation Level)**	**Typical** **Decision Error Probability Goals** **(Based on Professional Judgment)**	**Type of Decision Error**
Less the 50	Less than 1%	False Acceptance Decisions
51 to 100	Gray area[1]	False Acceptance Decisions
101 to 200	Less than 5% [2]	False Rejection Decisions
>200	Small	False Rejection Decisions
The goals in this table are based on professional judgment as relevant to a typical radiation response. Specific project goals may vary with the situation.		

3.2.7 Step 7 – Optimize the Design for Obtaining Data

The sampling design is based on a gross gamma radiation survey of all accessible surface soil in the Process Area. Field screening of the entire area will be used to identify potential hot spots for further sampling. Previous investigation at the Process area has indicated the presence of some hot spots. However, the entire process area has not previously been surveyed.@@

To optimize the sampling design, START members used data from the previous RP investigation. With that set of analytical data points the appropriate COPCs for this investigation were determined. The data from the previous RP data will also be used to limit the number of boreholes installed and samples collected during this investigation

Further optimization was accomplished using both non-definitive field analytical methods with definitive analytical methods to generate the data set needed to make the necessary decisions.

3.2.8 Investigation Level Selection

Investigation Levels

Investigation Levels will be based on the determined baseline/ background radiation levels in the vicinity of the site. The determination of the baseline/background radiation level will be made during this investigation for field screening gross gamma measurements and subsurface soil and by a independent RP funded investigation for surface soil.

3.3 DATA QUALITY INDICATORS (DQIs)

The DQIs for this project were developed following the guidelines in *U.S. EPA Guidance for Quality Assurance Project Plans*, *EPA QA/G-5 Final* (U.S. EPA 240/B-01/003, 2002). All measurement and sampling procedures are documented in Section 6.3 and 6.4, standard operating procedures (SOP), and field operating procedures (FOP) detailed in Appendix A will be followed to ensure representativeness of results by obtaining characteristic samples and measurements. Approved U.S. EPA methods and standard reporting limits will be used. Approved SOPs and FOPs will be used. All data not rejected will be considered complete. Table 3-1 documents the site-specific DQI goals for the COPCs, and the DQI for project quality control samples (e.g., blanks).

3.4 DATA REVIEW AND VALIDATION

START will perform either a U.S. EPA Region IX Tier 1A or Tier 1B data review on the data generated by analytical laboratories. Tier 1A/1B review involves evaluation of quality control data for the project for 100 percent of the data generated.

If during or after the START review of the Tier 1A or 1B evaluation report of the project's analytical data, it is found that the data contain excess QA/QC problems or if the data do not meet the DQI goals, then the START QA manager may determine that additional data evaluation is necessary. Additional evaluation may include the *U.S. EPA Region IX Superfund Data Evaluation/ Validation Guidance R9QA/006.1* Tier 2 or 3 evaluation. The START QA coordinator will request additional validation, if required, through the U.S. EPA TM and U.S. EPA QA Office.

The following criteria will be evaluated during a Tier 1A evaluation:

- Data package completeness
- Laboratory QA/QC summaries
- Holding times
- Blank contamination
- Matrix related recoveries
- Field duplicates

- Random data checks.

Upon completion of evaluation, an analytical data evaluation Tier 1A review report will be delivered to the project manager and the data will be classified within the report as one of the following:

- Acceptable for use without qualifications
- Acceptable for use with qualifications
- Unacceptable for use.

The data with qualifications will be attached to the report. The analytical data evaluation Tier 1A review report will not compare data to specific project quality objectives, which include target analytes, sensitivity, analytical accuracy, analytical and sampling precision, and analytical completeness.

Unacceptable data may be more thoroughly examined to determine whether corrective action could mitigate data usability.

Data generated in the field will be reviewed by ORIA and/or TPC prior to reporting to the U.S. EPA.

3.5 DATA MANAGEMENT

Samples will be collected and logged on chain-of-custody forms as discussed in Section 9.3. Sampling information will also be described in the logbook, as discussed in Section 9.1. Samples will be kept secure in the custody of the sampler at all times, who will assure that all preservation parameters are being followed. All samples will be transferred to the analytical laboratories via a certified carrier in a property custody-sealed container with chain-of-custody documentation, as discussed in Section 9.3. The laboratories will note any evidence of tampering upon receipt.

At the close of the investigation, all complete data packages will be submitted to the U.S. EPA TM for archiving. The data validation reports and laboratory data summary sheets will be included in the final report to be submitted to the U.S. EPA TM. Electronic data will be archived by START. Before submittal, the final report will undergo a technical review to ensure all data have been reported and discussed correctly.

START will use the Scribe data management system developed by U.S. EPA to manage newly generated data, as well as the existing environmental data. The laboratory will generate summary data tables, data validation packages, electronic spreadsheet tables, and a Stage Electronic Data file.

3.6 ASSESSMENT OVERSIGHT

Since the project manager is also the START QA manager, a field audits START activities by the START QA manager is not practical. Given the project budget and current scope of work, no laboratory performance evaluation samples are planned for submissions for this project.@@ A laboratory audit is also not planned.

3.6.1 START QA Assessment Activities

The following assessment activities will be performed by the START.

- All project deliverables (SAP, Data Summaries, Data Validation Reports, TBA Report) will be peer reviewed prior to submission to the U.S. EPA. In time-critical situations or other situations where project schedule requires, the peer review may be concurrent with the release of a draft document to the U.S. EPA. Errors discovered in the peer review process will be reported by the reviewer to the author of the document, who will be responsible for corrective action.

- Program Management may review START project documentation (logbooks, chain-of-custody forms, etc.) to ensure the SAP was followed and that sampling activities were adequately documented. If reviewed, Program Management would document deficiencies and the START PM will be responsible for corrective actions.

3.6.2 U.S. EPA QA Assessment Activities

U.S. EPA assessment activities, which can include surveillance, management system reviews, readiness reviews, technical system audits, performance evaluation, and audits and assessments of data quality have not been formally identified to START by the U.S. EPA at the time of completion of this SAP.

3.6.3 Project Status Reports to Management

It is standard procedure for the START PM to report to the U.S. EPA TM any issues that occur during the course of the project that could affect data quality, data use objectives, or project schedules.

3.6.4 Reconciliation of Data with DQOs

Assessment of data quality is an ongoing activity throughout all phases of a project. The methods to be used by the START for evaluating the results obtained from the project are outlined below:

- DQO outputs and the sampling design will be reviewed by the START QA Manager prior to sampling activities. The reviewer will submit comments to the primary SAP writer for action, comment, or clarification. This process will be iterative.

- A preliminary data review will be conducted by START staff. This review will look for problems or anomalies in the implementation of the sample collection and analysis procedures, and examine QC data for information to verify assumptions underlying the DQOs and the SAP. When appropriate to sample design, basic statistical quantities will be calculated, and the data will be graphically represented.

- Because the final sampling design is a judgmental approach, statistical testing of the assumptions will not be conducted.

4.0 SAMPLING RATIONALE

Sampling rationale for the site survey and soil sample collection is outlined below. Additional information is provided in Sections 3.2.5, Develop Decision Rules, and 3.2.7, Optimize the Design.

An initial survey of the entire process area will be conducted by the ERGS in accessible areas and by field portable instrumentation in areas that the ERGS can not access. Based on the results of the initial survey, soil boring locations will be selected that meet the site investigation level criteria. Soil borings will be screened using hand instrumentation and a sample for laboratory analysis will be collected at the depth interval exhibiting the high gamma radiation measurement. Conducting the initial area wide survey should identify hot spot areas within the study area. Laboratory analysis of samples collected in the hot spot areas will provide definitive data to back up screening level data.

5.0 REQUEST FOR ANALYSES

The scanning with the ERGS and field instruments will be along parallel transect that are approximately 5-10 feet apart. The scanning will be for gross gamma radiation with a combination of detectors including 3-inch (in) by 3-in or 2-in by 2-in sodium iodide (NaI) scintillation detectors.

Boreholes will be surveyed for gross gamma radiation with a ½-in by 1-in NaI scintillation detector.

Extracted core from boreholes will be scanned for gross gamma with a micro-roentgen meter for shipping and laboratory notification purposes.

Selected surface and sub-surface soil samples will be analyzed for the following:

- Radium-226 by Radon Emanation following EPA 903.1 or by Gamma Spectroscopy counting DOE EML HASL-300, Th-01-RC Modified or similar method.

- Radium-228, by Gamma Spectroscopy counting following DOE EML HASL-300 Modified or by EPA 904/9320 Gas Flow Proportional Counting or similar method.

- Gross Alpha and Beta by EPA 900 as Flow Proportional Counting

- Gamma Emitting Radionuclides by Gamma Spectroscopy following EPA 901.1.

It is anticipated that all soil samples will be analyzed by an ERT contracted analytical services laboratory. Samples, sample containers, preservatives, holding times, and estimated number of field, confirmation, and quality control samples are summarized in Table 5 1.

To provide quality control for the analytical program, the following measures will be used:

- Laboratory blind field duplicate will be collected during the investigation.

- Equipment rinse blanks will be collected daily for non-dedicated equipment.

Table 5-1: Required Analytical Services, Anaconda Process Area					
	Field Scanning	**Gross Alpha and Beta by EPA 900 Gas Flow Proportional Counting**	**Total Gamma by Gamma Spectroscopy following EPA 901.1.**	**Radium-226 by Radon Emanation following EPA 903.1 or by Gamma Spectroscopy counting DOE EML HASL-300, Th-01-RC Modified or similar method.**	**Radium-228, by Gamma Spectroscopy counting following DOE EML HASL-300 Modified or by EPA 904/9320 Gas Flow Proportional Counting or similar method.**
Sample Container	None	Two 8-ounce wide mouth glass jar or a 1-gallon plastic bags			
Preservation	Not Required	Not Required	Not Required	Not Required	Not Required
Holding Time	No Holding Time	180 days	180 days	180 days	180 days
# of Surface Samples	Real-Time Rate Measurement over Entire Area	Less than 50	Less than 50	Less than 50	Less than 50
# of Sub-Surface Samples	Real-Time Rate Measurement in Selected Borehole	Less than 50	Less than 50	Less than 50	Less than 50
# of Background Samples	Seven Real-Time Rate Measurement	7	7	7	7
# of Duplicates[1]	All significant elevated reading will be replicated to confirm initial readings	Less than 11	Less than 11	Less than 11	Less than 11
MS/MSDs[1]	Not Applicable	Less than 6	Less than 6	Less than 6	Less than 6
Equipment Blanks	Not Applicable	1 x L plastic	1 x L plastic	1 x L plastic	1 x L plastic
Total Soil Samples	Real-Time Rate Measurement	Less than 117	Less than 117	Less than 117	Less than 117

1. Duplicate and MS/MDS (matrix spike and matrix spike duplicate), sample locations will be determined in the field as discussed in Section 9.1.2 and 10.2.

6.0 FIELD METHODS AND PROCEDURES

The following sections describe in detail the screening data and soil sample collection methods. Specific analysis requests for the soil samples are given in the sections of the SAP preceding this section. Section 7 of this SAP describes sample packaging. Section 9 of this SAP describes sample tracking and shipping, and requirements for field notes.

6.1 FIELD EQUIPMENT

The following sections describe in detail the soil sample collection methods. Specific analysis requests for the soil samples were discussed in previous sections of this SAP. Section 7 of this SAP describes sample packaging. Section 9 of this SAP describes sample tracking and shipping and requirements for field notes.

A Geoprobe™ will be utilized for the collection of shallow subsurface soil samples. The Geoprobe™ is equipped with a concrete drill bit which will be utilized to remove concrete and asphalt which overlies sample locations. Shallow subsurface soil samples will be collected based upon the down hole gamma survey results. Shallow subsurface soil will be collected from sample tubes using dedicated acetate sleeves. Sampling will be conducted in accordance with the EPA Emergency Response Team Standard Operating Procedure (ERT SOP) for Soil Sampling #2012, and Geoprobe Operation #2050. These SOPs are on file with the U.S. EPA ERS. The GeoProbe™ will be operated by the United States Coast Guard, Pacific Strike Team under the direction of a START geologist.

The following sections provide information regarding the field equipment, sampling supplies, and consumables that will be used to conduct sampling and data collection activities outlined in this SAP.

6.1.1 List of Equipment Needed

The equipment listed in Table 6 1 will be used to obtain soil samples in accordance with the following standard operating procedures (SOPs):

- ERT SOP #2001 General Field Sampling Guidelines
- ERT SOP #2012 Soil Sampling

- ERT SOP #2050 Model 5400, Geoprobe^{TM} Operation

There are no project-specific inspection/acceptance criteria for supplies and consumables. It is standard operating procedure that: personnel will not use broken or defective materials; items will not be used past their expiration date; supplies and consumables will be checked against order and packing slips to verify the correct items were received; and the supplier will be notified of any missing or damaged items.

Table 6-1
Data Collection and Sampling Equipment For Anaconda

Matrix	Equipment	Fabrication	Dedicated
Soil	Bucket type hand auger or equivalent	Plastic	Yes
	Geoprobe^{TM} /steel rods	Hardened Steel	No
	Sample Sleeves	Acetate	Yes
	Plastic scoops, 1-gallon plastic bags and 8 ounce jars (if needed.)	Plastic	Yes
Decontamination	3 Buckets	Plastic	No
	Scrub brushes	Plastic	No
	Towels	Paper	Yes
	Tarp	Plastic	No
	Hudson Sprayer	Plastic	Yes

6.1.2 Equipment Maintenance

Field instrumentation for radiation survey will be operated, calibrated, and maintained by START and ORIA staff in accordance to the manufacturer's instruction and in the manner indicated in the SOPs listed in Section 6.1.1 above. Field instrumentation used for health and safety purposes will be operated, calibrated, and maintained by the START and ORIA according to the manufacturer's instruction and the site-specific health and safety plan (Appendix B).

6.2 REAL-TIME DATA COLLECTION

6.2.1 Area Scanning

Real-time data collection for gamma radiation will be conducted over the entire process area using the ERGS and an appropriate real-time radiation detection instruments. The ERGS will generate real-time data for gamma radiation as detected at a height of one-foot above the ground surface. The ERGS will be used to collect gamma radiation data in all process area areas that are accessible to the ERGS vehicle. The ERGS travels over the ground surface at less than 7.5 feet per second and generates a continuous stream of data that is recorded at millisecond intervals. All collected radiation data from the ERGS is automatically paired with real-time global positioning system (GPS) data. Field portable hand-held real-time radiation detection instruments will be conducted in all areas which are not accessible to the ERGS. Hand-held detectors will be held 6-in above the ground surface and moved in a serpentine pattern at a rate of 1-foot to 2-feet per second. The data generated with the field portable instruments is continuous-read data that will be continuously-monitored by START. Areas that exceed the investigation level will be flagged, manually document in a log book, and manually also be recorded on a GPS device. In areas that exceed the investigation level, the GPS location and measurement value will be documented.

All real-time data will be used to generate gamma radiation contour maps of the entire process area.

6.3 BOREHOLE SCANNING

The generated ground surface gamma radiation contour maps that will be compared with radiation data or contour maps generated from previous investigation data. With the two maps, the field team will decide where to locate the subsurface boreholes. No more than 50 boreholes using a direct push technique (DPT) will be installed.

Once a borehole location is determined and located with GPS coordinates, the borehole will be created with the U.S. EPA's Geoprobe that will be operated by the USCG PST with a START sampling team in assistance. All boreholes are to 30 feet below ground surface. The 30 feet of soil core extracted from the borehole will be delivered to the START sampling team. After extraction of the core, the borehole will be lined with a 1-in casing for it entire depth.

Real-time data collection for gamma radiation will be conducted in each borehole with a ½-in by 1-in NaI scintillation detector (Ludlum Model 44-62) with a 30-foot long cable coupled to a ratemeter (Ludlum Model 2241-3). The probe will be lowered in the borehole with the reading documented every 6-inches after the detector has been at the depth of interest for approximately 15 to 20 seconds. Depths that exceed the investigation level will be manually document in a log book.

Based on the down hole measurements, soil samples from the core will be selected for laboratory analysis. Depths with the highest measurements will be selected. However, addition judgmental sample locations may be selected based on professional judgment of the field team.

After completion of the borehole core extraction and real-time radiation data collection the borehole will be backfilled and sealed with bentonite.

6.4 SOIL CORE LOGGING

As needed, START will document the core's lithological characteristics. The need will be based upon lack of historic lithology data for a specific area or uniqueness of extracted core.

As needed, selected samples will be scanned using appropriate real-time radiation detection instruments for gamma radiation. Elevated detection above background will be documented for safety, shipping and laboratory notification purposes.

6.5 SOIL SAMPLING

Additional surface sampling location may be sampled based upon the field generated data. No more than 50 surface locations are expected. All soil sample locations will be recorded in the field logbook and with a global positioning system (GPS) instrument as sampling is completed. A sketch, if needed, of the sample location will be entered into the logbook and any physical reference points will be labeled.

Shallow soil samples will be collected from a depth of 0 to 0.5 feet bgs at all locations. Shallow samples will be collected in accordance with appropriate SOPs. A trowel or hand auger will be used to collect the shallow soil sample. Collected samples will be placed directly into 1-gallon plastic zip-lock sample bags. Sample bags should not be completely filled. The soil samples will be labeled, sealed, and placed into insulated coolers and transported by an appropriate carrier under chain-of-custody procedures to the analytical laboratory.

All holes will then be backfilled with clean soils.

6.6 CORE SAMPLING

Samples selected for laboratory analysis will be removed from the acetate sleeves and homogenized. The homogenized soil samples will be labeled, sealed in plastic bags or clean, glass jars, and placed into insulated coolers and transported by an appropriate carrier under chain-of-custody procedures to the analytical laboratory

6.7 DECONTAMINATION PROCEDURES

All non-dedicated equipment that comes into contact with potentially contaminated soil will be decontaminated in accordance with ERT SOP #2006, and the procedures outlined below.@@ Equipment will be decontaminated in a pre-designated area on pallets, racks, or plastic sheeting, and clean equipment will be stored in an uncontaminated area. Disposable equipment intended for one-time use will not be decontaminated, but will be packaged for appropriate disposal. Decontamination will occur after each use of a piece of equipment. The non-dedicated equipment that will require contamination is itemized in Table 6-1 (for example: Drill auger and rods).

Decontamination for the non-dedicated soil sampling equipment and accessories are as follows:

- Non-phosphate detergent and tap water wash using a brush to scrub solids from the surface
- Tap water rinse
- Triple rinse with deionized or distilled water
- Air dry.

All equipment should be screened with appropriate radiation monitoring equipment prior to being deemed as decontaminated.

7.0 SAMPLE CONTAINERS, PRESERVATION AND STORAGE

All sample containers used will be delivered to the field team in a pre-cleaned and pre-preserved condition from the container supplier. Container, preservation, and holding time requirements are summarized in Table 5-1 and in Section 5.

7.1 SOIL SAMPLES

Soil samples will be stored in a secure location onsite pending shipment to the analytical laboratory. Sample coolers will be retained in the custody of site personnel at all times or secured so as to deny access to anyone else. The procedures for shipping samples are as follows:

- The drain plug of the cooler will be taped shut to prevent leakage.
- The bottom of the cooler will be lined with bubble wrap to prevent breakage during shipment.
- Screw caps will be checked for tightness.
- If shipped, all glass sample containers will be wrapped in bubble wrap.

Samples will be placed in coolers with the appropriate chain-of-custody document. All forms will be enclosed in plastic bags and affixed to the underside of the cooler lid. Empty space in the cooler will be filled with bubble wrap or Styrofoam peanuts to prevent movement and breakage during shipment. Each ice chest will be securely taped shut with strapping tape, and custody seals will be affixed to the front and back of each cooler.

8.0 DISPOSAL OF INVESTIGATION-DERIVED WASTE

In the process of collecting environmental samples at this site during the investigation, START will generate different types of potentially contaminated IDW that include the following:

- Used personal protective equipment (PPE)
- Disposable sampling equipment
- Decontamination fluids
- Soil cuttings from soil borings.

The U.S. EPA's National Contingency Plan (NCP) requires that management of IDW generated during sampling complies with all applicable or relevant and appropriate requirements (ARARs) to the extent practicable. The sampling plan will follow the *Office of Emergency and Remedial Response (OERR) Directive 9345.3-02* (May 1991), and *EPA Guide to Management of Investigation-Derived Wastes*, Office of Solid Waste and Emergency Response (U.S. EPA, 1992), which provide guidance for the management of IDW. In addition, other legal and practical considerations that may affect the handling of IDW will be considered.

- Used PPE and disposable equipment will be screening for radiation following use. If no gamma radiation above twice background is detected then materials will double bagged and placed in a municipal refuse dumpster. These wastes are not considered hazardous and can be sent to a municipal landfill. If gamma radiation is detected above twice background on any of the materials, they will be placed in a drum and stored on site pending appropriate disposal based on the levels detected.

- Decontamination fluids that will be generated in the sampling event will consist of residual contaminants, and water with non-phosphate detergent. Fluids will be placed in a drum stored on site pending appropriate disposal.

- Soil cuttings generated during this investigation will be field screened for radiation and stored onsite for appropriate disposal based on the levels of radiation detected.

9.0 SAMPLE DOCUMENTATION AND SHIPMENT

The following sections discuss field notations and shipping procedures.

9.1 FIELD LOGBOOKS

Field logbooks will document where, when, how, and from whom any vital project information was obtained. Logbook entries will be complete and accurate enough to permit reconstruction of field activities. A separate logbook will be maintained for each project. Logbooks are bound, with consecutively numbered pages. Each page will be dated and the time of entry noted based on a 24-hour clock. All entries will be legible, written in ink, and signed by the individual making the entries. Language will be factual, objective, and free of personal opinions. The following information will be recorded, if applicable, during the collection of each sample;

- Sample location and description
- Site or sampling area sketch showing sample location and measured distances
- Sampler's name(s)
- Date and time of sample collection
- Designation of sample as composite or grab
- Type of sample (matrix)
- Type of sampling equipment used
- Field instrument readings and calibration (e.g., VOC air monitoring data)
- Field observations and details related to analysis or integrity of samples (e.g., weather conditions, noticeable odors, colors, etc.)
- Preliminary sample descriptions (e.g., for soils: clay loam, very wet; for water: clear water with strong ammonia-like odor)
- Sample preservation
- Sample identification numbers and any explanatory codes
- Shipping arrangements (overnight air bill number)
- Name(s) of recipient laboratory(ies).

In addition to the sampling information, the following specific information will also be recorded in the field logbook for each day of sampling:

- Team members and their responsibilities
- Time of arrival/entry on site and time of site departure
- Other personnel on site
- Summary of any meetings or discussions with tribal, contractor, or federal agency personnel
- Deviations from sampling plans, site safety plans, and SAP procedures
- Changes in personnel and responsibilities with reasons for the changes
- Levels of safety protection
- Calibration readings for any equipment used and equipment model and serial number
- Record of Photographs.

9.1.1 Photographs

Photographs will be taken at the sampling locations and at other areas of interest on site. They will serve to verify information entered in the field logbook. For each photograph taken, the following information will be written in the logbook or recorded in a separate field photography log:

- Time, date, location, and weather conditions
- Description of the subject photographed
- Name of person taking the photograph.

9.2 SAMPLE NOMENCLATURE

A unique, identifiable name will be assigned to each soil boring location. Borings will be identified with the prefix SB, followed by the boring number (i.e.@@SB-1). Soil samples from cores will be identified by the soil boring number followed by the depth of the sample (i.e.@@SB-1-5 for the sample collected at SB1 for at a 5 foot depth.

Surface soil sample (that are not from cores) will be identified with the prefix SS, followed by a unique number (i.e.@@SS-1).

Duplicates and blank samples will be assigned fictitious names. For duplicates, the sample location will be 1,000 greater than the associated field samples. For example, the duplicate sample of SB-1-5 will be SB-1-1005. Equipment rinse blanks will be identified with the prefix RB followed by increasing numbers in the order collected (i.e. RB-1, RB-2, etc.).

9.3 SAMPLE CHAIN-OF-CUSTODY FORMS AND CUSTODY SEALS

All sample shipments for analyses will be accompanied by a chain-of-custody record. Chain-of-custody form(s) will be completed and sent with the samples in each cooler.

In the case of samples for analysis at Region IX scheduled commercial laboratories, regional analytical program chain-of-custody record forms will be used to document sample collection and shipment to laboratories for analysis.

The chain-of-custody form will identify the contents of each shipment and maintain the custodial integrity of the samples. Generally, a sample is considered to be in someone’s custody if it is either in someone’s physical possession, in someone’s view, locked up, or kept in a secured area that is restricted to authorized personnel. Until the samples are shipped, the custody of the samples will be the responsibility of START staff. The sampling team leader or designee will sign the chain-of-custody form in the “relinquished by” box and note date, time, and air bill number.

A self-adhesive custody seal will be wrapped around the cap. The shipping containers in which samples are stored (usually a sturdy picnic cooler or ice chest) will be sealed with self-adhesive custody seals any time they are not in someone’s possession or view before shipping. All custody seals will be signed and dated.

9.4 PACKAGING AND SHIPMENT

All sample containers will be placed in a strong shipping container (such as a steel-belted cooler). The packaging procedures low concentration samples are as follows:

1. When ice is used, pack it in zip-locked, double plastic bags. Seal the drain plug of the cooler with fiberglass or duct tape to prevent melting ice from leaking out of the cooler.

2. The bottom of the cooler should be lined with bubble wrap to prevent breakage during shipment.

3. Check screw caps for tightness, and if not full, mark the sample volume level of liquid samples on the outside of the sample bottles with indelible ink.

4. Secure bottle/container tops with clear tape, and custody seal all container tops.

5. Affix sample labels onto the containers with clear tape.

6. Wrap all glass sample containers in bubble wrap to prevent breakage.

7. Place samples in a sturdy cooler(s) lined with a large plastic trash bag. Enclose the appropriate chain-of-custody in a ziplock plastic bag affixed to the underside of the cooler lid.

8. Fill empty space in the cooler with bubble wrap to prevent movement and breakage during shipment.

9. Ice used to cool samples will be double sealed in two ziplock plastic bags and placed on top and around the samples to chill them to the correct temperature.

10. Each ice chest will be securely taped shut with fiberglass strapping tape, and custody seals will be affixed to the front, right, and back of each cooler.

10.0 QUALITY CONTROL

This section discusses the quality control samples that are planned to support the sampling activities, including field and laboratory QC samples and confirmation samples.

10.1 FIELD QUALITY CONTROL SAMPLES

Field contamination is usually assessed through the collection of different types of blanks. Equipment blanks are planned for this investigation and a description of the planned blanks is provided in the paragraphs below.

10.1.1 Equipment Blanks

Equipment blanks will be collected to evaluate field sampling and decontamination procedures by pouring deionized water over the decontaminated sampling equipment and collecting the poured water in sample collection bottles. At lease one equipment blank will be collected to document decontamination of non-dedicated soil sampling equipment. The equipment blank(s) collected will be analyzed for all COPCs.

The equipment rinsate blanks will be preserved, packaged, and sealed in the manner described for the environmental samples. A separate sample number and station number will be assigned to each sample, and it will be submitted blind to the laboratory.

10.1.2 Field Blanks

Field blanks will not be collected to evaluate whether contaminants have been introduced into the samples during the sampling due to ambient conditions or from sample containers.@@

10.1.3 Field Duplicates

Assessment of sample variability is accomplished through the collection and analysis of field duplicate samples. Duplicate soil samples will be collected at the sample locations determined in the field. Duplicate samples will be assigned at a rate of one for every ten field samples.

Field duplicate samples will be preserved, packaged, and sealed in the same manner as other samples of the same matrix. A separate sample number and station number will be assigned to each duplicate, and will be submitted blind to the laboratory.

10.2 LABORATORY QUALITY CONTROL (QC) SAMPLES

Field duplicate samples will be preserved, packaged, and sealed in the same manner as other samples of the same matrix. A separate sample number and station number will be assigned to each duplicate, and will be submitted blind to the laboratory. Samples are identified for use as laboratory QC samples for matrix spike and matrix spike duplicate analysis in Table 5 1. These QC samples are not required for field analysis. Additional volume of samples designated as QC samples will be supplied to the analytical lab when required, and the laboratory will be alerted as to which sample is to be used for QC analysis by a notation on the sample container label and the chain-of-custody record or packing list.

At a minimum, one laboratory QC per twenty samples is required (including blanks and duplicates). The laboratory QC samples will be designated on the chain-of-custody document as laboratory QC samples. The QC samples designated in Table 5-1 were assigned arbitrarily and may be changed in the field based on field data.

11.0 FIELD VARIANCES

As conditions in the field may vary, it may become necessary to implement minor modifications to sampling as presented in this plan. The U.S. EPA TM will be notified and a verbal approval will be obtained before implementing the changes. Modifications to the approved plan will be documented in the sampling project report.

12.0 FIELD HEALTH AND SAFETY PROCEDURES

Due to the compressed schedule for submittal of the SAP, the site-specific health and safety plan will be developed prior to field work and attached to the SAP. All field personnel will review the site-specific health and safety plan prior to the beginning of field work.

13.0 REFERENCES

References will be provided upon request.

TABLES

Table 3-11 Decision Error Limits Goals Groundwater			
True Concentration in Groundwater	Decision Error	Typical Decision Error Probability Goals (Based on Professional Judgment)	Type of Decision Error
Below Detection Limit	A decision that perimeter groundwater is contaminated when it is not contaminated	Less than 1 %	False Acceptance
Above Detection Limit But Less Than The Practical Quantitation Limit (DL< PQL)	A decision that perimeter groundwater is contaminated when it is not contaminated.	Gray Area [1]	False Acceptance
Slightly Greater Or Near The PQL	A decision that perimeter groundwater is not contaminated when it is contaminated	10 %	False Rejection
Much Greater than the PQL	A decision that perimeter groundwater is not contaminated when it is contaminated	Less than 1 %	False Rejection
Notes: The goals in this table are based on professional judgment as relevant to a Phase II Assessment [1] Gray Area is where relatively large decision errors are acceptable			

Add to 3.2.7

Since there is no previous groundwater data for the study area there is no information on sampling variance, standard deviation data, or sigma data for the study area. Without this statistical data it is not possible to statistically calculate the appropriate number of samples needed to satisfy the decision error objective prior to sampling. However, once ongoing monitoring samples are being collected and analyzed, it will be possible to calculate whether the decision error objectives have been achieved.

Attachment 6: Occupational Dose Assessment Plan

Occupational Dose Assessment Plan

Anaconda Mine Removal Radiation Assessment
Yerington, Nevada

December 27, 2007

Prepared for:
U.S. Environmental Protection Agency, Region 9

Prepared by:
Team 9
and
The Palladino Company, Inc.

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1.0 Introduction

The United States Environmental Protection Agency (EPA), Region IX has directed the Team 9 Superfund Technical Assessment and Response Team (START) to perform a radiation assessment in the Process Area of the Anaconda Mine Site in Yerington, Nevada. The START contractor, Team 9, has retained the services of The Palladino Company, Inc. (TPC) for the development and implementation of an occupational dose assessment plan (ODAP) to assist with the determination of appropriate health and safety protocols for on-site EPA personnel and EPA contractors during an investigation in the Processing Area after the results of the ODAP are evaluated.

This ODAP describes the objectives and the data collection methodologies to assess the occupational dose for on-site workers in the Process Area of the Anaconda Mine Site. Specific tasks that are documented in the ODAP include:

- Air sampling for total particulates
- Air monitoring for total particulates
- Real-time radon-222 (Rn-222) monitoring
- Real-time gamma radiation monitoring
- Development of site specific health and safety protocols

Unlike environmental sampling plans which are developed in accordance with EPA guidance documents, this plan is for health and safety purposes thus not required to comply with the elements of a formal sampling and analysis plan. However, the pertinent methodologies and procedures are outlined to document the intended plan.

2.0 Background

Anaconda Mine was a copper mine that included processing of uranium ore. Extraction of copper was the primary production throughout the mine's operating history with the extraction of uranium as a secondary objective for an unknown time period. Accurate information regarding the mining and processing of uranium is unclear. Previous investigations indicate that most of the radioactive waste from processing uranium ore is located in the Process Area which was where copper extraction fluids were processed into copper metal.

A more detailed summary of the site history may be found in the *Sampling and Analysis Plan, Radiation Assessment, Anaconda Mine Site Process Area, Yerington, Nevada* (Team-9, 2007). The Sampling and Analysis Plan details the planned investigation in the Process Area which will involve gamma radiation surveys plus surface and subsurface soil sampling and analysis.

Previous assessments for health and safety purposes have been performed on the site. A Radiological and Chemical Exposure Control Plan (RCECP) was performed by RMEC Environmental, Inc. (RMEC) from October 2004 to April 2005 (RMEC 2005). A report summarizing the results of the plan indicated that no additional engineering, administrative controls or personnel protective equipment were necessary for on-site workers. However, the report also stated that not all areas of the site were surveyed and continuous monitoring should be conducted. The report also indicated that elevated radiation levels were located in the Process Area. In particular, the Iron Launders area was a noted radiological control area (defined as greater than 200 µrem/hour gamma exposure rate) that should require a radiological control technician to perform radiation surveys as it had levels of gamma radiation up to 800 µrem/hour measured at waist level. Other areas that had elevated radiation levels in the Process Area were the Surge Pond area at 145 µrem/hour, the Solution Tank area at 120 µrem/hour, and the Oil Sludge Pit area at 40 µrem/hour; all measurements were the maximum gamma reading detected at waist level.

Air samples were also collected during implementation of the RCECP and several filters were analyzed by a laboratory. The results indicated that the air concentrations were less than the derived air concentration (DAC) for uranium-234 (U-234), uranium-235 (U-235), uranium-238 (U-238), radium-226 (Ra-226), radium-228 (Ra-228), and thorium-232 (Th-232).

During a previous investigation in the Process Area by the EPA in May 2007 elevated levels of alpha radiation were detected on surfaces of personal protective equipment, vehicles, and personnel. In particular, plastic surfaces appeared to have significantly elevated levels of alpha radiation which concerned the EPA's Radiation and Indoor Environments National Laboratory team that detected the contamination. Elevated contamination was detected on hard hats, plastic surfaces of vehicles, and the hands of one worker. The contamination prompted the EPA to conduct a specific assessment to determine the exposure of personnel to the radiological wastes located in the Process Area before additional investigations were performed; i.e. to implement this ODAP.

Previous soil sampling and analyses have indicated that surface contamination in the Process Area is elevated above background (Brown and Caldwell, 2005). Subsurface soil samples were also collected and analyzed but were not evaluated for this occupational dose assessment. The radionuclides of concern were associated with the naturally occurring decay series for U-238, U-235, and Th-232. Analytical results indicated maximum surface soil concentrations as follows:

- Radium-226 at 18 pCi/g
- Radium-228 at 24.4 pCi/g
- Thorium-232 at 235 pCi/g

The Bureau of Land Management (BLM) also conducted an investigation in the Process Area which included sampling and analysis of soil samples (BLM 2004). Analytical results indicated that maximum elevated concentrations of radionuclides were elevated as follows:

- Radium-226 at 157 pCi/g
- Radium-228 at 139 pCi/g
- Thorium-228 at 98.5 pCi/g
- Thorium-230 at 943 pCi/g
- Thorium-232 at 96.5 pCi/g
- Uranium-234 at 196 pCi/g
- Uranium-235 at 22.6 pCi/g
- Uranium-238 at 147 pCi/g

Previous investigations have confirmed the presence of elevated contamination above background levels in the Process Area. Workers in the Process Area will be exposed to the contamination thus warranting development of appropriate health and safety protocols. Completion of this dose assessment in accordance with this ODAP will assist the EPA in establishing an effective and protective site specific safety and health plan for EPA personnel and EPA contractors conducting assessment activities in the Process Area.

3.0 Assessment Plan

A conservative approach has been selected for the determination of an estimated occupational dose to on-site workers in the Process Area. The total dose will be calculated based on the sum of the maximum estimated external dose and maximum estimated internal dose to a hypothetical worker that spends eight hours a day in the Process Area.

The external dose will be based on the maximum gamma radiation exposure as determined by real-time dosimeters worn by the field team during implementing of this health and safety assessment. The internal dose will be based on estimated inhalation of particulates assumed to have been contaminated with Th-232 and inhalation of Rn-222 gas. Exposure to particulates will be determined by the collection and field screening analysis of air filters for alpha radiation. Exposure to Rn-222 will be determined by the field analysis of Rad Elec E-PERM® System radon sampling system; this system is designed for detection of Rn-222 with very minimal interference from Radon-220.

The primary radioisotopes of concern are Ra-226 and Th-232. Th-232 was found at comparable concentrations as Ra-226 in previous investigations and has a lower derived air concentration (DAC) of 5×10^{-13} microcuries per milliliter (µCi/ml) than Ra-226 (Tables 1, 2, and 3). Thus, all particulate collected on air filters will be assumed to be contaminated with Th-232. Therefore, field screening results for alpha radiation detected on the air filters will be assumed to have originated from Th-232. This approach is conservative because, it is very unlikely that all detected alpha radiation would have originated from Th-232.

A minimum of three days of air sampling will be conducted with five air samplers placed at representative locations downgradient of the Process Area. One sampler will be located at a background location based on the predominant wind direction. The four downgradient samplers will be moved to a new location each day to provide coverage over the approximately 230 acre Process Area.

Air monitoring will be conducted to determine the total particulate concentrations during the air sampling. These data will assist in characterizing the relative amount of airborne particulates for comparison to the detected radiation levels. An acceptable correlation between the data sets could provide future monitoring capability without the necessity of air sample collection and analysis. The air monitoring instruments will be collocated with each air sampler.

Rn-222 sampling will be conducted in northwest corner of the Evaporation Pond which is an area with high levels of loose surface soil contamination. A Rad Elec H-chamber with a short-term Electret detector will be placed at 70 inches above the ground surface which represents the breathing zone. The sampling period will be 24 to 48 hours. A background sample will also be collected and analyzed for comparison. The sampling and analysis of the Electrets will be in accordance with the manufacturer's instructions.

4.0 Procedures

The following procedures will be implemented during the dose assessment.

4.1 Particulate Air Sampling and Analysis

F & J Model HV-1SH high volume air samplers will be positioned in the Process Area in accordance with Section 3.0. Portable generators will be used to supply power with the generator placed a minimum of 10 feet and downgradient from the sampler so that emissions will not significantly influence the atmospheric conditions at the sampler intake. FP4.0M Glass Fiber Filter Paper, a four inch diameter filter with 98%+ retention, will be used to collect total particulate for approximately 8 hours at a flow rate of approximately 20 cubic feet per minute (cfm) in accordance with Field Operating Procedure (FOP) No. 1, *F & J Model HV-1SH High Volume Air Sampler*.

Field screening analysis of the air filters will be in accordance with FOP No. 2, *Air and Wipe Filter Field Screening Analysis*. The filters will be field screened with approximately two hours, 24 hours, 48 hours, and one week after collection to determine if alpha activity is due to Ra-222 and progeny. The results of the analyses will be reported in disintegrations per minute (dpm) and used to calculate the internal dose as detailed in Section 4.5.

4.2 Particulate Air Monitoring

Thermo Anderson MIE DataRAM 4, Model DR-4000 portable particle sizing aerosol monitor/data loggers will be collocated with each air sampler, except for two stations since only four instruments are available for this assessment. The DataRAM will measure total particulate ranging from 0.04 to 4.0 micrometers (μm) at concentrations from 0.0001 milligrams per cubic meter (mg/m^3) to 400 mg/m^3.

The DataRAMs will be calibrated and operated in accordance with the manufacturer's instructions. Particulate concentrations will be logged by the instrument and then downloaded to a computer for data review and archiving. The results will not be used directly in this assessment unless exposure action levels are exceeded, then the data will be compared to the radionuclide results obtained as described in Section 4.1.

4.3 Radon-222 Air Sampling

A Rad Elec H-chamber fitted with a short-term Electret will be mounted at 70 inches above the surface soil in the northwest corner of the Evaporation Pond. This area has loose surface soil that contains elevated contamination greater than most other locations in the Process Area. It represents a worse-case, thus conservative, exposure to Rn-222 gas emanation. The sampling time period will be approximately 24 to 48 hours.

A background sample will be collected and analyzed to determine the natural background Rn-222 concentration. The maximum Rn-222 exposure is the difference between the background measurement and the Evaporation Pond measurement.

The Electrets will be analyzed in accordance with the manufacturer's instructions and the Rn-222 concentration calculated as described in Section 4.5. The H-chamber was designed to reduce the influence of thoron (radon-220) to less than five percent to provide an accurate measurement of Rn-222.

4.4 External Dose Measurement

The external dose will be determined from real-time dosimeters (Canberra AN/UDR-14 or SAIC PD-10i) worn by the team implementing this assessment over a three day period. The highest measured dose from all dosimeters during the three days is assumed representative of the maximum external dose to any worker in an eight hour work day and will be used in determining the total estimated external dose. If during the assessment, the daily dose to workers as measured by real-time dosimeters are found higher than the estimated maximum dose determined during the dose assessment then the estimated maximum dose will be adjusted accordingly.

4.5 Internal Dose Calculation

Internal dose will be determined from an estimation of inhalation of Th-232 contaminated particulates and Rn-222 gas. The dose calculation for each component is described below.

<u>Dose from Contaminated Particulates</u>
A Microsoft Excel spreadsheet named "Dose Assessment.xls" can be used to automatically calculate the internal dose by entering pertinent data. For illustrative purposes the internal dose is calculated as described below.

Step 1: Calculate the average flow rate of an air sampler

$$\frac{SFR + FFR}{2} = AFR$$

Where,
SFR = Start flow rate in cfm
FFR = Final flow rate in cfm
AFR = Average flow rate in cfm

Step 2: Calculate the total run time (sampling time)

$$(ET - ST) * 60\,\text{min}/hour = TT$$

Where,
ET = End time in 24 hour notation; i.e. 08:00
ST = Start time in 24 hour notation; i.e. 18:00
TT = Total time in minutes

Step 3: Calculate the total volume of air sampled

$$AFR * TT * 28{,}316.85\,\text{ml/cf} = \text{TV}$$

Where,
TV = Total volume in milliliters
ml = milliliters
cf = cubic foot

Step 4: Calculate alpha concentration from the 48 hour alpha activity result

$$\frac{\left(\frac{AA}{2.22x10^{6}dpm/\mu Ci}\right)}{TV} = AC$$

Where,
AA = Alpha activity in dpm
AC = Alpha concentration in µCi/ml
dpm = disintegrations per minute
µCi = microcuries

Step 5: Calculate the Th-230 equivalent DAC

$$\frac{AC - BAC}{5x10^{-13}\mu Ci/ml} = Th232DAC$$

Where,
5×10^{-13} µCi/ml = Th-232 DAC
BAC = background alpha concentration
Th232 DAC = equivalent fraction of Th-232 DACs

Step 6: Calculate the Th-232 equivalent DAC-Hours

$$ET * Th232DAC = Th232DACHours$$

Where,
ET = Entry time in Process Area in decimal hours (assumed for 8 hours)

Step 7: Calculate the Th-232 equivalent dose

$$\frac{Th232DACHours * 5{,}000mrem}{2{,}000Hours} = ID$$

Where,
5,000 mrem = maximum allowed total dose per year (10 CFR 20.1201)
2,000 hour = maximum hours of exposure at the DAC (10 CFR 20.1204)
ID = Internal Dose in mrem

Dose from Rn-222

Step 1: Calculate the correction factor (formula provided by RadElec)

$$CF = 7.2954 + 0.004293x\left(\frac{I+F}{2}\right)$$

Where,
CF = correction factor
I = initial Electret voltage
F = final Electret voltage

Step 2: Calculate the concentration of Rn-222

$$Rn222 = \left(\frac{I-F}{CFxD}\right) - (Gx0.07)$$

Where,
Rn222 = Rn-222 concentration in pCi/L
G = gamma rate in μR/hr

Note that Rn-220 is not a significant factor in the calculation for Rn-222 as the sampling device is designed to reduce Rn-220 to less than five percent of influence.

4.6 Total Dose Calculation

The total estimated occupational dose is the sum of the estimated external dose and estimated internal dose as determined by the procedures outlined in the previous sections. The total estimated dose will be determined for a minimum of three days during the week of July 23, 2007 before additional investigation activities commence. Results of the dose assessment will be reviewed by the EPA and included in the site specific health and safety plan. Depending on the results, appropriate health and safety procedures will be implemented including the possibility of upgrading respiratory protection from Level D to Level C.

4.7 Contamination Control Assessment

During the previous investigation conducted by the EPA in April 2007, elevated alpha contamination was detected on protective equipment, vehicles, and personnel. The contamination was suspected to have originated from Ra-222 that is attracted to plastic surfaces due to natural build up of a static electric charge. During the ODAP, various investigations into the nature of the contamination will be examined.

Antistatic spray will be used on various plastic surfaces in an attempt to reduce the contamination while additional similar plastic surfaces will receive no treatment. The contamination levels on these two surfaces will be evaluated for alpha radiation periodically throughout the day after workers exit the Process Area. Alpha radiation level will be measured on the surfaces in accordance with FOP 3, *Radiation Scanning Survey* and FOP 4, *Radiation Static Measurement*.

Wipe samples will also be collected from these surfaces to determine if the contamination is fixed or removable. The wipe samples will be field screened after collection in accordance with FOP 2.

5.0 References

Brown and Caldwell, *Data Summary Report for Process Areas Soils Characterization*, November 1, 2005

Bureau of Land Management, *BLM Health and Safety Plan, Process Area*, August 14, 2004.

RMEC Environmental, Inc., *Final Radiological Monitoring Report, October 2004 – April 2005*, October 10, 2005.

Team-9, *Sampling and Analysis Plan, Radiation Assessment, Anaconda Mine Site Process Area, Yerington, Nevada*, July 2007.

Title 10 Code of Federal Regulations Part 20, *Standards for Protection Against Radiation*, 56 Federal Register 23391, May 21, 1991, as amended.

Appendix A

Tables

Table 1
Derived Air Concentrations for Uranium-238 Decay Series

Radionuclide[1]	Class[2]	ALI (µCi)	DAC (µCi/ml)
Uranium-238	Y	0.04	2×10^{-11}
Thorium-234	Y	200	6×10^{-8}
Protactinium-234meta	Y	7,000	3×10^{-6}
Uranium-234	Y	0.04	2×10^{-11}
Thorium-230	W	0.006	3×10^{-12}
Radium-226	W	0.6	3×10^{-10}
Radon-222	+D	100	3×10^{-8}
Polonium-218	n/a	n/a	n/a
Lead-214	D	800	3×10^{-7}
Bismuth-214	D	800	3×10^{-7}
Polonium-214	n/a	n/a	n/a
Lead-210	D	0.2	1×10^{-10}
Bismuth-210	W	30	1×10^{-8}
Polonium-210	W	0.6	3×10^{-10}

Reference: 10 CFR 20, Appendix B, Table 1 and Handbook of Health Physics and Radiological Health, Third Edition, 1998

Key:
1 = Radionuclides listed in order of decay series. When the decay series has two decay pathways the radionuclide with the highest decay probability is listed.
2 = Class with the lowest DAC was selected.
µCi = microcuries
ml = milliliters
Y = Clearance half –time of greater than 100 days for radionuclide in the pulmonary region of the lungs
W = Clearance half –time from 10 to 100 days for radionuclide in the pulmonary region of the lungs
D = Clearance half –time of less than 10 days for radionuclide in the pulmonary region of the lungs
+D = With daughters present
n/a = not available

Table 2
Derived Air Concentrations for Uranium-235 Decay Series

Radionuclide[1]	Class[2]	ALI (µCi)	DAC (µCi/ml)
Uranium-235	Y	0.04	2×10^{-11}
Thorium-231	W	6,000	3×10^{-6}
Protactinium-231	W	0.003	6×10^{-13}
Actinium-227	D	0.0004	2×10^{-13}
Thorium-227	W	0.3	1×10^{-10}
Radium-223	W	0.7	3×10^{-10}
Radon-219	n/a	n/a	n/a
Polonium-215	n/a	n/a	n/a
Lead-211	D	600	3×10^{-7}
Bismuth-211	n/a	n/a	n/a
Polonium-211	n/a	n/a	n/a

Reference: 10 CFR 20, Appendix B, Table 1 and Handbook of Health Physics and Radiological Health, Third Edition, 1998

Key:

1 = Radionuclides listed in order of decay series. When the decay series has two decay pathways the radionuclide with the highest decay probability is listed.
2 = Class with the lowest DAC was selected.
µCi = microcuries
ml = milliliters
Y = Clearance half –time of greater than 100 days for radionuclide in the pulmonary region of the lungs
W = Clearance half –time from 10 to 100 days for radionuclide in the pulmonary region of the lungs
D = Clearance half –time of less than 10 days for radionuclide in the pulmonary region of the lungs
n/a = not available

Table 3
Derived Air Concentrations for Thorium-232 Decay Series

Radionuclide[1]	Class[2]	ALI (µCi)	DAC (µCi/ml)
Thorium-232	W	0.003	5×10^{-13}
Radium-228	W	1	5×10^{-10}
Actinium-228	D	9	4×10^{-9}
Thorium-228	W	0.01	4×10^{-12}
Radium-224	W	2	7×10^{-10}
Radon-220	+D	20	9×10^{-9}
Polonium-216	n/a	n/a	n/a
Lead-212	D	30	1×10^{-8}
Bismuth-212	D	200	1×10^{-7}
Polonium-212	n/a	n/a	n/a
Thallium-208	n/a	n/a	n/a

Reference: 10 CFR 20, Appendix B, Table 1 and Handbook of Health Physics and Radiological Health, Third Edition, 1998

Key:
1 = Radionuclides listed in order of decay series.
2 = Class with the lowest DAC was selected.
µCi = microcuries
ml = milliliters
Y = Clearance half –time of greater than 100 days for radionuclide in the pulmonary region of the lungs
W = Clearance half –time from 10 to 100 days for radionuclide in the pulmonary region of the lungs
D = Clearance half –time of less than 10 days for radionuclide in the pulmonary region of the lungs
+D = With daughters present
n/a = not available

Appendix B

Field Operating Procedures

Field Operating Procedure No. 1
Anaconda Mine Removal Radiation Assessment
F & J Model HV-1SH High Volume Air Sampler

GENERAL INFORMATION	
Equipment Name	F & J Model HV-1SH High Volume Air Sampler
Indicated use	High volume air sampler
Manufacturer	F & J
Orifice Adapter Size	4 inches

Step No.	OPERATION GUIDE
1	Assemble the unit as described in the manual.
2	Adjust the tripod to the desired height based on sampling objectives. Typically, the height is adjusted to the standard breathing zone height of 5 feet.
3	Plug unit into a stable power source; fluctuation in power will cause erratic air flow rates.
4	Unscrew the outer ring from the orifice and insert a clean FP4.0M Glass Fiber Filter Paper, 4-inch filter, or similar.
5	Attach the air flow calibrator to the sampler with the filter in place and turn on the unit. Record the initial flow rate on the “Air Sampling Field Data Log,” see attached example. Flow rates should be between 12 and 15 cubic feet per minute (cfm).
6	Once the initial flow rate has been recorded, turn off the unit. Remove the calibrator and re-attach the outer ring over the same filter.
7	Turn on the unit and record the time on the “Air Sampling Field Data Log”.
8	After the air sampler has collected the air sample for the allotted time period, turn off the unit.
9	Unscrew the outer ring from the adapter without removing the filter from the sampler.
10	Attach the calibrator to the sampler with the filter in place and turn on the unit. Record the final flow rate and time on the “Daily Air Sampling Field Datasheet”.
11	Turn off the unit and remove the calibrator.
12	Remove the filter paper and place in the pre-labeled sample container, typically a glassine envelope.
13	Replace the outer ring on the adapter.
14	The unit should be cleaned between uses (i.e. moist towelettes, pressurized canned air).

Field Operating Procedure No. 1

Cautions:

1. The tripod may require an anchor during windy conditions.
2. The air filter can become loaded during high particulate conditions. An increase in loading will reduce the flow rate and cause the motor to work harder, increasing the motor temperature. It is possible for the temperature to increase to sufficient levels that the metal motor housing can cause a third degree burn on bare flesh. Additionally, the motor can burn out if the strain is severe and prolonged. Air filters may require frequent replacement during the sampling period under these conditions. It is not uncommon for several replacements in an eight hour period.
3. The outer ring should be lightly tightened onto the intake manifold just enough to hold it in place. Excessive force can damage the air filter.
4. During rainy conditions the air sampler should either be turned off or a small rain shield placed over the top of the intake manifold to prevent rain from hitting the air filter. The air filter can become damaged or tear if it becomes wet.
5. Extension cords should have proper gauge ratings and have a ground fault indicator.

Field Operating Procedure No. 2
Anaconda Mine Removal Radiation Assessment
Air and Wipe Filter Field Screening Analysis

Step No.	Air Filter Field Screening Analysis
1	Use tweezers to carefully remove the air or wipe filter from its container; typically a glassine envelope.
2	Refer to the Ludlum alpha/beta counter manual for details on setup and operation of the instrument for field screening. Allow the instrument to warm up for 5 minutes before use. Verify that the instrument is within current calibration and has met the daily calibration requirements.
3	Place the air or wipe filter in the sample holder with the sample side facing upward; i.e. the side that collected the particulate. Slide the sample holder into the detector and start the measurement. Warning: If the filter is torn or partially folded then it may become lodged in the instrument. After the sample holder is inserted.
4	The filter should be counted for a specified count time to achieve the minimum detectable concentration in accordance with the project Sampling Plan.
5	Record the count time, sample ID, alpha or beta counts, date, time, analyst, etc. in a field logbook or field form.
6	After every 10 analyses, select an air or wipe filter for duplicate analysis. In addition, select a blank air or wipe filter for a method blank analysis. Record the results accordingly.

Field Operating Procedure No. 3
Anaconda Mine Removal Radiation Assessment
Radiation Scanning Survey

Step No.	GAMMA AREA SCAN SURVEY
1	Select the appropriate detector and meter for conducting a gamma area scan survey in accordance with the applicable Sampling Plan. If measurements exceed the instrument's capability, obtain an instrument capable of detecting higher levels of radiation.
2	If necessary, wrap the detector and meter in plastic to prevent contamination.
3	If the meter is equipped with a fast/slow response option, begin the survey in the fast response mode. Refer to the FOP for the selected meter for details.
4	Hold the detector at waist level (typically 3 feet above ground surface) and walk at a rate slow enough for the meter to respond (typically 1 to 3 feet per second). Depending on the objectives of the gamma area scan survey, the surveyor may walk an area to determine the exposure rate or to locate radioactive materials. If surveying surfaces, objects, or the ground surface the survey is typically conducted approximately 6 to 12 inches away from relevant surfaces or objects.
5	Once an increase in the count rate or exposure rate is detected, move the detector slowly in all directions until the highest measurement is noted.
6	If the meter is equipped with a fast/slow response option, switch to the slow response mode for a more accurate measurement. Refer to the FOP for the selected meter for details.
7	Record the required information on the designated survey form such as survey location, instrument, measurements, date, surveyor, etc.
8	Return the fast/slow response switch to fast and continue the gamma scan survey.

Field Operating Procedure No. 3

Step No.	SURFACE SCAN SURVEY
1	Select the appropriate detector and meter for conducting a direct scan survey (survey of a surface or object). Ensure the selected detector is appropriate for the type and levels of radiation to be surveyed. If measurements exceed the instrument's capability, obtain an instrument capable of detecting higher levels of radiation.
2	If necessary, wrap the detector and meter in plastic to prevent contamination. However, do not cover the detector face if using an alpha detector.
3	If the meter is equipped with a fast/slow response option, begin the scan survey in the fast response mode. Refer to the FOP for the selected meter for details.
4a	When scanning for gamma contamination, hold the detector 6 inches or less from the surface of interest.
4b	When scanning for beta contamination, hold the detector 1/2 inch or less from the surface of interest.
4c	When scanning for alpha contamination, hold the detector 1/4 inch or less from the surface of interest.
5	Scan the surface by moving the detector at approximately 1 to 2 inches per second or at the calculated scan rate to achieve the desired scan minimum detectable concentration.
6	Once an increase in the count rate is detected, move the detector slowly until the highest measurement is noted.
7	If the meter is equipped with a fast/slow response option, switch to the slow response mode for a more accurate measurement. Refer to the FOP for the selected meter for details.
8	Perform a static measurement as necessary. Refer to the Radiation Static Measurement FOP #4 for details.
9	Record the required information on the designated survey form such as survey location, instrument, measurements, date, surveyor, etc.
10	Return the fast/slow response switch to fast and continue the scan survey.

Field Operating Procedure No. 4
Anaconda Mine Removal Radiation Assessment
Radiation Static Measurement

Step No.	Static Measurement
1a	Alpha Radiation: To prevent contamination of the detector, ensure the detector face does not touch the surface of the measurement location. The detector, excluding the detector face, can be wrapped in plastic to prevent contamination of the detector housing. Typically, the detector should be held approximately 1/4 inch from the surface. Plastic or rubber spacers 1/4 inch thick or the desired thickness can be adhered to the detector frame to prevent the detector face from touching a contaminated surface. If the detector housing apparatus has a height adjustment feature, e.g. Ludlum Model 239-1F with Model 43-37 detector, adjust the height to the desired distance from the surface. As indicated in the FOPs for each detector, the instrument setup should be performed in the same configuration that it will be used to take measurements.
1b	Beta Radiation: In general, the same precautions should be taken as described in Step 1a above. The detector should be 1/2 inch or less from the surface of the measurement location.
1c	Gamma Radiation: To prevent contamination of the detector, ensure the detector face does not touch the surface of the measurement location. Typically, the detector should be wrapped in plastic, e.g. placed in a plastic bag, prior to use in the field, as plastic will not effect the measurements for gamma radiation.
1d	Certain static measurements may require direct contact with a surface, e.g. Final Status Survey or external measurement of shipping container. After conducting a measurement the detector frame should be wiped to ensure removal of any contamination.
2	Place the detector on or above the surface of the measurement location at the appropriate distance. The distance from the detector to the object or surface of interest is critical and should be specified in the applicable Field Sampling Plan. Deviation from the desired distance can cause inaccurate measurements.
3	Refer to the FOP for details on the operation of the selected detector and meter.
4	Perform a count for the specified count time, also known as sampling time, to achieve the desired minimum detectable concentration. Some meters have a scaler function that can be set for the specified count time.
5	Some meters have a logging function that will record the measurement. Refer to the meter FOP or operation manual for further details.
6	Record the required information on the designated survey form such as sample ID, measurement location, date, surveyor, measured value, etc.