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ARCO

# Rico Mining Area
# Construction Completion Report

**Argentine Tailings**
**Columbia Tailings**
**Silver Swan Mine**
**Santa Cruz Mine**
**Shamrock Tailings**
**Pro-Patria Tailings**
**Grand View Smelter**

**Atlantic Richfield Company**
**444 South Flower Street**
**Los Angeles, California 90071**

**Prepared by:**

**Anderson Engineering Co., Inc.**
**975 West 2100 South Street**
**Salt Lake City, Utah 84119**

**January 1997**

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# Rico Mining Area
# Construction Completion Report

## 1.0 Project Summary

### 1.1 Background

The Rico mining area is located in southwest Colorado between Cortez and Telluride along the Dolores River. The site includes former silver, lead and zinc mines, and milling and smelting operations that are located around the town of Rico. The priority mining and milling areas are shown in Figure 1-1. These locations have varied ownership histories and reclamation needs.

The International Smelting and Refining Company, an Anaconda subsidiary, had an ownership interest in a company which owned the Pro Patria Mill and other mining properties in the area. The Rico Argentine Mining Company built a mill along Silver Creek in the late 1930's. In the early 1980's Anaconda, a division of Atlantic Richfield Company (ARCO), controlled about 7,500 acres in the Rico area, and implemented a drilling program for molybdenum. At this time hazard elimination work was completed by Anaconda. In 1988 Anaconda sold its property located around the Rico area to Rico Development Corporation. The property has since been divided and sold to several parties for development.

### 1.2 Voluntary Cleanup

Prior to remediation the Rico mining area had various environmental concerns that include eroding mine waste, mine water discharge, water seeps from waste piles and various remnants of ore processing facilities.

The State of Colorado passed into law the Voluntary Cleanup and Redevelopment Act (HB94-1299) which provides a mechanism for owners and cooperating parties to take action to address human health and environmental concerns, and promote redevelopment and reuse of disturbed lands. The property owners of the particular mining or milling area, in cooperation with ARCO, submitted applications to the State of Colorado Department of Public Health and Environment under the Voluntary Cleanup and Redevelopment Act (VCRA) to address reclamation, human health and environmental concerns of the Rico priority sites. Following is a list of the VCRA applications made and submitting parties:

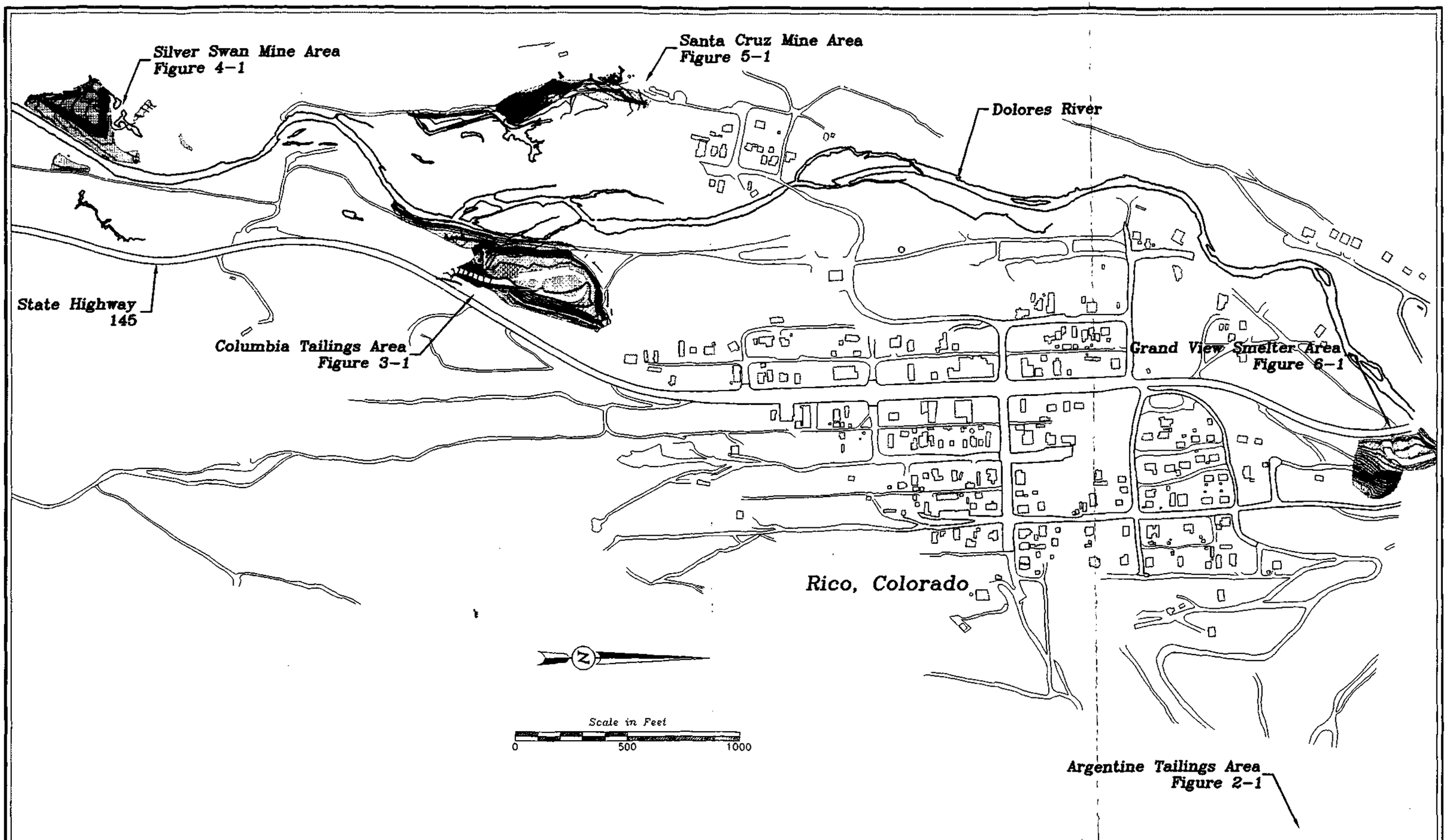
| | |
|---|---|
| Argentine Tailings Site | Atlantic Richfield Company<br>Rico Development Corporation<br>Rico Properties, L.L.C.<br>Val and Deanna Truelsen |
| Columbia Tailings | Atlantic Richfield Company<br>Rico Properties, L.L.C.<br>Town of Rico |
| Santa Cruz Mine Site | Atlantic Richfield Company<br>Rico Properties, L.L.C.<br>Frieda Davis<br>Robert Hancock & Max Sitton<br>Laura Hannegan<br>Myron Jones<br>Margaret Matzick |
| Silver Swan Mine | Atlantic Richfield Company<br>Rico Properties, L.L.C. |
| Grand View Smelter Site | Atlantic Richfield Company<br>Rico Properties, L.L.C. |

## 1.3 Cleanup Activities

The reclamation work by ARCO in cooperation with the land owners, was completed under approved VCRA Permits issued by the Colorado Department of Public Health and Environment (CDPHE). Areas reclaimed include the Santa Cruz Mine Site, Silver Swan Mine Site, the Columbia Tailings, the Argentine Mill Site Tailings and the Grand View Smelter Site. The work activities at these sites were done in accordance with the approved VCRA applications and the included Voluntary Cleanup Plans (VCUP), Colorado Stormwater Discharge Permits, Minimal Discharge Permits, Division of Water Resources notices, Corps of Engineers (COE) 404 notifications and United States Forest Service (USFS) Special Use and Road Use Permits.

Cleanup activities began on July 1, 1996 and were completed by November 13, 1996. The work accomplished under the VCRA permits for the Argentine, Columbia Tailings, Santa Cruz Mine, Silver Swan Mine, and Grand View Smelter Site included:

- Removal of waste rock and tailings material from active waterways and drainages.
- Reconfiguration, consolidation and stabilization of waste rock and tailings piles to minimize erosion and eliminate slope instability.
- Implementation of source controls to reduce the generation or transport of dissolved metals.
- Provide capping and erosion protection to effectively minimize the potential for direct human health exposure to the mill tailings and mine waste rock.
- Construct passive treatment features to reduce current metal loadings from adit discharge to receiving waters.




ATLANTIC RICHFIELD COMPANY
RICO MINING AREA
CONSTRUCTION COMPLETION REPORT

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| NO. | REVISION/DESCRIPTION | DATE |
|---|---|---|
| | | |

| | |
|---|---|
| DRAWN BY: | R. TATE |
| CHECKED BY: | S. ANDERSON |
| CLIENT CONTACT: | R. ELLIOTT |
| SCALE: | 1" = 400' |
| OTHER REFS: | . |

**PROJECT BASE MAP AND SHEET INDEX**

References:

FIG. 1-1

File: RICOTOWN.DWG view (plan)

# 2.0 Argentine Tailings

## 2.1 Site History

The Argentine Site is located on the north side of Silver Creek approximately 0.6 miles northeast of the town of Rico. Since 1938, the Site area has been occupied by a flotation mill, and mine and tailings disposal facilities. The Site covers approximately 15 acres.

## 2.2 Permit

The VCRA application, Revision 1 dated February 5, 1996 and supplemental information to the application dated March 19, 1996 were approved by the CDPHE on March 20, 1996. The CDPHE approval stated that the VCUP would meet a degree of cleanup and control of hazardous substances such that the property does not present an unacceptable risk to human health or the environment based on the property's proposed use as an open space. The approved VCUP remedial design for the Argentine Tailings Site involves shaping of tailings pond outslopes to control erosion, consolidation of Pond 4 materials into Ponds 2 and 3, grade the area to route upland surface water around the tailings wastes for runon control, and surface adjustments and compaction to shed rainfall and snowmelt from the tailings to control erosion and limit infiltration. The VCUP also calls for providing erosion protection through placement of growth medium and revegetation.

## 2.3 Geohazards

The natural hazards that may have been expected and could require attention at the Argentine Tailings are flooding and seismicity. No substantial natural hazards were encountered during construction. Caution was taken during slope modification of Pond 1 to avoid slimes tailings movement and slope instability. Grading plan modifications were made to deal with soft slimes during slope recontouring of Pond 1. Silver Creek flows did not constitute any excavation problems above those expected, however, some repairs were made for erosion protection along the Silver Creek channel.

## 2.4 Site Access

Access to the Argentine was by existing roads which cross both private and National Forest lands. All roads were maintained and left in as good or better condition than existed prior to their use on this project. Site access ways were maintained in compliance with the USFS Special Permit.

## 2.5 Construction Site Controls

Controls were implemented during construction to address requirements of applicable federal, state or local permits, codes or regulations. All construction and specifications employed appropriate Best Management Practices to protect Silver Creek from sedimentation during remedial activities. Temporary berms to control runoff to Silver Creek were constructed in work or active traffic areas. Silt fencing and hay bales were used as barriers to prevent sediment migration into Silver Creek during excavation activities. Also, construction activities were conducted in a manner to preserve existing vegetation buffers in the work areas. Runoff water from disturbed areas was retained for settling of sediments prior to allowing discharge into Silver Creek. Strict precautions to avoid dust and excavation spillage during operations were followed by the use of water spray and control of load heaping on haul units.

The onsite construction activities were conducted in strict compliance with the VCUP, Site Specific Safety and Health Plan and Site Pre-Excavation Construction Plans as well as regulatory permits obtained for the specific work area.

## 2.6 Hydraulic Controls

### 2.6.1 Runon

The runon generated from rainfall or snowmelt upland of the Site is directed away from the Argentine Tailings reclaimed tailings ponds by a 1700 linear foot lined runon ditch. The runon ditch was excavated into the natural ground surface north of the Site, adjacent to the existing access road. Stormwater is directed under the road by a culvert and into an erosion resistant outfall channel to convey flows around Pond 3 and through the former Pond 4 area. Pond 4 was cleaned of residual tailings and the area used

as a retention site for runon water prior to spilling into Silver Creek. Figure 2-1 shows the alignment of the runon ditch.

The runon ditch consists of a combination of riprap lined channel, corregated metal pipe (CMP) and a reinforced concrete pipe (RCP) energy dissipation drop structure. From the start of the ditch at the Pond 4 area to the drop structure is a trapezoidal designed channel built with Type A riprap (as defined in Section 2.8.2) about 2.4 ft. thick laid over 6 inches of Type D and 6 inches of Type E bedding. All bedding in the riprap lined ditches was placed over 60 mil high density polyethylene (HDPE) textured liner. The energy dissipation drop structure was constructed of 42 inch concrete and is approximately 180 feet in length. This structure handles runon flows from the upland areas to the north collected in the ditch and passes this flow to the lower elevation near the Pond 4 area. Extending about 250 ft. to the northeast is a "v" notch ditch lined with Type C riprap averaging 1.2 ft. thick over 6 inches of Type E bedding and HDPE liner. Where the runon ditch closely parallels the road north of the Argentine Tailings, a 36 inch CMP was placed for a distance of 250 ft. to carry flows beneath the road and to maintain a minimum 20 ft. road weight. The CMP is constructed with a grouted riprap inlet and outlet. The runon ditch upgradient of the CMP extends for 770 feet. This final reach of the runon ditch is constructed of Type D riprap placed over HDPE textured liner.

Water that collects in the Pond 4 retention area is released to Silver Creek by a spillway and outfall channel. The outfall channel from the Pond 4 area conveys runon waters down the south slope into Silver Creek. The outfall channel is a 40 ft. wide riprap trapezoidal spillway that moves water down slope at a 4h:1v angle. The riprap placement was constructed similarly to that of the runon ditch between the drop structure and the Pond 4 area. The outfall channel discharges flow onto the existing river rock material along Silver Creek. A riprap lined emergency spillway is located at the southwest end of the Pond 4 retention area.

### 2.6.2 Runoff

The top surfaces of Tailings Ponds 1, 2 and 3 have been shaped to drain precipitation and not retain runoff on the reclaimed surface. The surface grade of Ponds 2 and 3 is generally to the southwest at 3%.

The surface of Pond 1 was graded to direct runoff flows at about 3% to the runoff ditch from the east and west segments of the Pond. The runoff ditch at the Argentine Tailings was constructed as a drainage swale in the central portion of Pond 1. The runoff ditch drains to the south and follows the outslope contour to more gradually drop water into Silver Creek. The flow area of the runoff ditch is lined with a textured liner (60 mil HDPE) and is also riprap lined with 6 inches of Type B erosion protection riprap. The runoff ditch was constructed to a width of 6 ft. and is 1.0 ft. deep. The runon and runoff ditches are sized to pass peak flows for a 100 year precipitation event. Figure 2-1 shows the runoff ditch location.

Outslopes of the reconfigured tailings ponds are 3h:1v slopes and drain runoff water into the Silver Creek watershed.

### 2.6.3 Infiltration

Infiltration of water into the tailings ponds at the Argentine Tailings Site is controlled by rerouting runon away from the reclaimed areas, reducing the surface area of the tailings, regrading of the tailings to prevent the ponding of water and compaction of the top surface of the reclaimed tailings to impede infiltration.

The rerouting of runon and runoff away from the tailings will significantly reduce infiltration. The runon water contribution to the tailings areas has been eliminated by the newly constructed runoff ditches.

Pond 4 material was removed and consolidated into Ponds 2 and 3. The surface area of the tailings pile has been reduced by 13%, therefore reducing the infiltration surface available. The total area of the tailings was reduced by 1.3 acres, leaving a total of 10 acres of surface. The tailings were consolidated by excavation of the tailings material from Pond 4, hauled and placed as compacted cover over the surface of Ponds 2 and 3.

The upper 18 inches of top surface and outslopes of the Argentine Tailings pile were compacted to reduce infiltration. With the material types encountered in the tailings, the density that is achieved by this compaction will reduce the hydraulic conductivity. The results of compaction testing

conducted on the Argentine Tailings reconfigured surface are summarized in Section 2.10.

### 2.6.4 Drainage Stabilization

The Argentine Tailings Ponds are adjacent to Silver Creek and may be susceptible to seasonal flooding. Flood protection work was completed in 1981 and 1982 by Anaconda at the tailings pond slope toe along Silver Creek using grouted riprap. The erosion protection in place is in good condition, and minor repairs were completed to enhance protection. Some of this area had experienced minor undercutting by Silver Creek during periods of high flow. Repairs involved placement of a riprap revetment at the toe of Pond 1 along the Silver Creek as shown on Figure 2-1. The revetment length is about 125 feet and consists of Type A riprap (see Section 2.8.3 for description).

## 2.7 Waste Materials

### 2.7.1 *Consolidation*

The tailings material from Pond 4 at the Argentine Tailings was relocated to Ponds 2 and 3. Approximately 10,500 cubic yards of tailings were relocated and shaped to meet the lines and grades presented in the VCUP. This work was accomplished using bulldozers, wheel loaders and highway type trucks. The removal location of the tailings and the final graded surface of the area are shown on Figure 2-1.

Tailings were removed in layers of about 12 inches in thickness. Following removal, confirmatory sampling was conducted to detect if all tailings material had been removed. This process was repeated until conformation sampling showed that no additional material removal was required.

Verification of tailings removal was accomplished by collecting confirmatory samples of the underlying alluvium. Waste rock excavation was considered completed, as defined in the VCUP, when the Zinc content fell within or below the range of local natural bedrock and surficial materials. This range is 200 to 4720 ppm Zinc. The sampling of the removal areas confirms that

the majority of tailings was excavated from the areas of concern. Sampling results and summaries for the Argentine removal are contained in Section 2.10.2.

Relocated wet tailings were spread thinly and filled until moisture conditions of the material allowed for compaction. The relocated tailings were placed onto Ponds 2 and 3 in lifts not exceeding 12 inches in depth. The compaction effort was accomplished by placement equipment making a minimum of one pass over the entire surface of each 12 inch lift. Tailings placed in the upper 12 inches of the top surface, but below the lime amended area, were compacted as previously discussed.

### 2.7.2 Surface Shaping and Slopes

The top surface of the consolidated tailings on Pond 1 drains to the swale runoff ditch at a 3% grade. Ponds 2 and 3 are graded to drain runoff to the southwest. The tailings have been reconfigured with the outslopes draining the Site. Although the outslopes vary in length from about 150 ft. to about 220 ft., all are constructed to a 3h:1v geometry. An intermediate slope exists between Pond 1 and Pond 2, and between Pond 3 and Pond 4, the area that has been graded to 3h:1v. Due to the extremely wet conditions and slime tailings encountered in grading the Pond 1 slope, the configuration was modified. The slope crest was moved and the slope toe extended to use a fill approach rather than a cut and fill as originally planned. Fill was obtained from the Argentine Borrow Area and from adjacent land shaping activities. The reconfigured Argentine Tailings was graded to a tolerance of $\pm$ 0.3 ft. of construction drawings and free of irregularities. Figure 2-1 shows the preexisting conditions, VCUP configuration and the as built conditions of the Argentine Tailings.

## 2.8 Erosion Protection

### 2.8.1 Growth Medium

Growth medium material comprises compacted surface tailings and soil cover. The top surface of the reshaped Argentine Tailings was sampled to determine agricultural lime ($CaCO_3$) requirements for plant establishment. Areas requiring agricultural lime amendment and areas where lime

amendment was unnecessary were delineated in the field. The lime was applied at a rate of 200 tons/acre to the upper 6 inches of compacted tailings. Table 2.1 shows the lime application rates by area for the Argentine Tailings. The lime was spread evenly over the Site by mechanical methods then incorporated. Multiple tilling passes were made to insure complete mixing of the lime into the material. The liming process was accomplished immediately following waste pile shaping to provide the greatest reaction time prior to revegetation. The amended layer was re-compacted prior to placement of soil cover material.

Borrow soil used for plant growth, also referred to as rock mulch, was tested and identified prior to excavation. The borrow soil was obtained from the Argentine borrow area 0.2 miles from the Argentine Tailings. The soil was transported by truck to the Argentine Tailings, placed on the top surface and slopes, and covers the entire areal extent of the regraded waste pile. Soil cover application rates by area are listed in Table 2.1. The traffic over the soil was kept to a minimum to avoid unnecessary compaction of the seed bed. The finished grade for the soil growth medium is $\pm$ 0.3 ft. of design and contains no irregularities.

**Table 2.1**
***Argentine Tailings***
**Agricultural Lime and Cover Material Application Rates**

| SITE AREA | LIME APPLICATION RATE FOR TAILINGS | SOIL COVER APPLICATION RATE |
|---|---|---|
| Pond No. 1 | 200 tons/acre (1.1 in. thick) Amended 6 inches deep and compacted. (Approx. ½ of Pond 1 was lime amended). | 6-inch rock mulch cover. |
| Pond Nos. 2 and 3 Tailings Removal Area | No lime. | 24-inch rock mulch cover. |
| 3:1 slope between Pond Nos. 1 and 2. | 200 tons/acre (1.1 in. thick) Amended 6 inches deep and compacted. (Approximately 1/3 of the slope was lime amended). | 12-inch rock mulch cover above elevation 9245.<br>24-inch rock mulch cover below elevation 9245. |
| 3:1 slope between Pond Nos. 3 and 4. | 200 tons/acre (1.1 in. thick) Amended 6 inches deep and compacted. (Approximately 2/3 of the slope was lime amended). | 12-inch rock mulch cover. |

### 2.8.2 Revegetation

All seed was applied using hydroseeding methods due to wet surface conditions and time constraints. Table 2.2 contains seed mixtures and applications used at the Argentine Tailings. The hydroseeding and fertilization sequence of activity completed is as shown on Table 2.3. Mulch was also spread by hydro application methods and held in place by tacking agents.

## Table 2.2
## Seed Mixtures and Application Rates

| Type A (1) General Seed Mixture | | | |
|---|---|---|---|
| **Species** | **Preferred Variety(s)** | **Rate (lbs./acre) Planted (broadcast)** | **PLS (seeded/acre)** |
| Big bluegrass<br>Poa ampla | Sherman | 0.50 | 458,500 |
| Mountain brome<br>Bromus carinatus | Bromar | 8.00 | 496,000 |
| Slender wheatgrass<br>Agropyron trachycaulum | Primar, San Luis | 3.00 | 480,000 |
| Streambank wheatgrass<br>Agropyron riparium | Sodar | 3.00 | 480,000 |
| Birdsfoot trefoil<br>Lotus corniculatus | Empire | 1.00 | 410,000 |
| Lewis flax<br>Linum lewisii | Apar | 2.00 | 570,000 |
| Rocky Mountain penstemon<br>Penstemon strictus | Bandera | 1.00 | 592,000 |
| Cicer milkvetch<br>Astragalus cicer | Lutana, Monarch | 1.50 | 290,000 |
| | **Totals** | **20.00** | **3,776,500 (approx. 87 seeds per square foot)** |

(1) Applied on lower portion of Pond No. 1 west slope, on consolidated Pond Nos. 2 and 3, and on Pond No. 4, except embankment slope.

**Type B (2)**
**Sideslope Stabilization Mixture**

| Species | Preferred Variety(s) | Rate (lbs./acre) Planted (broadcast) | PLS (seeded/acre) |
|---|---|---|---|
| Big bluegrass<br>Poa ampla | Park | 0.50 | 1,100,000 |
| Mountain brome<br>Bromus carinatus | Bromar | 15.00 | 975,000 |
| Slender wheatgrass<br>Agropyron trachycaulum | Primar, San Luis | 6.00 | 960,000 |
| Streambank wheatgrass<br>Agropyron riparium | Sodar | 6.00 | 960,000 |
| Cicer milkvetch<br>Astragalus cicer | Lutana, Monarch | 1.50 | 290,000 |
| | **Totals** | **29.00** | **4,285,000 (approx. 98 seeds per square foot)** |

**Type C (3)**
**(Acid-Tolerant Mixture)**

| Species | Preferred Variety(s) | Rate (lbs./acre) Planted (broadcast) | PLS (seeded/acre) |
|---|---|---|---|
| Hard Fescue<br>Festuca ovina var. duriuscula | Durar | 2.00 | 1,130,000 |
| Orchardgrass<br>Dactylis glomerata | Latar | 2.00 | 1,080,000 |
| Tall fescue<br>Festuca arundinaceae | Alta | 5.00 | 1,135,000 |
| | **Totals** | **9.00** | **3,345,000 (approx. 77 seeds per square foot)** |

(2) Type B applied on Pond No. 1 access road side slope and Pond 4 embankment slope.
(3) Type C applied on majority of Pond No. 1, except as noted above.

**Table 2.3**
**Argentine Tailings**
**Revegetation Sequence**

| Item | Seed Bed Preparation | Fertilizer | Seed | Mulch |
|---|---|---|---|---|
| **Period** | Prior to fertilization and seeding. | Concurrent with seeding. | After September 30th, immediately following final seed bed preparation. | Immediately following seeding. |
| **Method** | Mechanical scarification of soil. | Combined with hydroseeding Liquid fertilizer mixture. | Hydroseeding on all areas. | Hydromulch - 1500 lbs./acre. all areas.<br>Slurry pH> - 3.5. |
| **Equipment** | Disc or rippers pulled by tractor. | Mobile hydroseeding equipment. | Mobile hydroseeding with spray and tank equipment. | |
| **Discing/Raking** | Disc or rip to 12 inch depth maximum. | | | |
| **Other** | Insure adequate seed bed without hard surface resistant to seed placement. | Nutrient application applies to all sites:<br>Nitrogen (lb./acre) 40<br>Phosphate (lb./acre) 60<br>Potash (lb./acre) 40 | Type<br>A General seed mix (<3:1)<br>B Side slope mix (>3:1)<br>C Acid-tolerant mix | Purpose: twofold:<br>1. Conserve water<br>2. Deter erosion |
| Note: Ripping of final graded surface completed prior to broadcasting fertilizer. Ripped to a maximum depth of 12 inches. | | | | |

### 2.8.3 Riprap

Rock erosion protection was placed in areas where runoff, runon and drainage way flows were considered to be highly erosive. Riprap types and bedding are shown on Table 2.4.

**Table 2.4**
**Argentine Tailings**
**Riprap and Bedding**

| | | Percent Passing | | | | | |
|---|---|---|---|---|---|---|---|
| **Type** | **Description** | **100** | **85** | **50** | **30** | **15** | **0** |
| A | Riprap | 1.7-2.4' | - | 1.4'-1.6' | 1.2' | 0.9' | 0.8' |
| B | Riprap | Larger Rock Material Generated By Borrow Processing | | | | | |
| C | Riprap | 0.9-1.2' | - | 0.7-0.8' | 0.6' | 0.5' - 0.65' | 0.4 |
| D | Riprap/Bedding | 3.0-8.0" | 3.0-6.0" | - | - | 0.75"- 1.5" | 0"-0.5" |
| E | Filter Material/Bedding | 2.0" | 0.5-1.5" | - | - | 0.5 - 0.65mm | 0.6mm |

The runon ditch and runoff ditch locations and erosion protection riprap are shown in the plan view on Figure 2-1. These ditches contain bedding, HDPE textured liner and riprap to handle flows resulting from a 100 year precipitation event. These designs are discussed in detail under Section 2.3.

## 2.9 Quantity Summary

The quantities moved for remedial action for the Argentine Tailings involved nine categories of materials. The total volume of material moved was 56,692 cubic yards. Table 2.5 contains the volume moved by category for earthwork at the Argentine Tailings.

**Table 2.5**
**Argentine Tailings**
**Relocated Materials, Riprap and Bedding**

| Activity | Material Type | Units | Quantities | Comments |
|---|---|---|---|---|
| Relocated Tailings | *** | CY | 10,506 | |
| Unprocessed Borrow | *** | CY | 23,700 | |
| Riprap | A | CY | 569 | |
| Riprap | B | CY | 85 | |
| Riprap | C | CY | 193 | |
| Riprap Bedding | D | CY | 240 | |
| Riprap Filter Bedding | E | CY | 199 | |
| Growth Medium | | CY | 21,200 | (Also called Rock Mulch) |
| Textured Liner | | $Yd.^2$ | 1,206 | plus 510 @ runoff ditch |

## 2.10 Soil Testing Summary

### 2.10.1 Geotechnical Testing

Field soil density testing was conducted to determine compliance with the technical specifications of the construction contract. The technical specifications relating to compaction were selected to achieve various engineering objectives relating to infiltration and enhancing stability in fill materials. The applicable technical specifications required that the upper 12 inches of the waste piles be of a compactable gradation, and attain 95% of Standard Proctor maximum dry density (or 90% of maximum Providence index density for soils with little or no fines). Table 2.6 summarizes the field soil moisture/density tests conducted for the Argentine Tailings. Nuclear density gauges were used to obtain in-place densities for comparison to laboratory generated Proctor or Providence mold laboratory density tests as appropriate for a given soil. Where moisture/density tests were deficient, footnotes in Table 2.6 indicates the action taken by the field engineer, e.g. - recompaction of the affected area or in cases where additional compaction or replacement of fill materials would not have provided any additional benefits

to the long-term performance of the fill with respect to design objectives, no action was directed. Laboratory and field tests were performed and results approved by ARCO. Tests were conducted according to the following standards:

| ASTM Method | Description: |
|---|---|
| Field Tests: | |
| D-2922 | Density of Soil and Soil-Aggregate in Place by Nuclear Methods |
| Laboratory Tests: | |
| D-422 | Sieve Analysis |
| D-698 | Moisture Density Relationships (5.5 lb. hammer) |
| D-4253 | Modified Providence Moisture Density Relationships |

Table 2.6 summarizes the results of field tests.

**Table 2.6**
**Argentine Tailings**
**Field Soil Testing Summary**

| Date | Test No. | Location | Density | Moisture | Proctor No. | Maximum Density | Optimum Moisture | Percent Compaction | Notes | % Compaction Required | Percent +\- Moisture |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 7-Aug-96 | AR-NU-01 | Ponds 2&3 | 108.6 | 13.5% | EF-06-SP-01 | 123 | 12% | 88% | (1) | 95% | 1.5% |
| " | AR-NU-02 | | 119.6 | 8.4% | " | 123 | 12% | 97% | | 95% | -3.6% |
| " | AR-NU-03 | | 114.4 | 9.9% | " | 123 | 12% | 93% | (1) | 95% | -2.1% |
| " | AR-NU-04 | | 113.3 | 12.4% | " | 123 | 12% | 92% | (1) | 95% | 0.4% |
| " | AR-NU-05 | | 115.3 | 10.0% | " | 123 | 12% | 94% | (1) | 95% | -2.0% |
| " | AR-NU-06 | | 119.1 | 10.0% | " | 123 | 12% | 97% | | 95% | -2.0% |
| " | AR-NU-07 | | 119.0 | 12.2% | " | 123 | 12% | 97% | | 95% | 0.2% |
| " | AR-NU-08 | | 128.6 | 13.3% | " | 123 | 12% | 105% | | 95% | 1.3% |
| " | AR-NU-09 | | 117.5 | 16.6% | " | 123 | 12% | 96% | | 95% | 4.6% |
| " | AR-NU-10 | | 121.4 | 12.7% | " | 123 | 12% | 99% | | 95% | 0.7% |
| 8-Aug-96 | AR-NU-11 | Pond 1 North | 101.6 | 12.5% | EF-05-SP-01 | 124 | 9% | 82% | (2) | 95% | 3.5% |
| " | AR-NU-12 | | 112.6 | 17.2% | " | 124 | 9% | 91% | (2) | 95% | 8.2% |
| " | AR-NU-13 | | 133.7 | 8.7% | " | 124 | 9% | 108% | | 95% | -0.3% |
| " | AR-NU-14 | | 113.6 | 14.4% | " | 124 | 9% | 92% | (2) | 95% | 5.4% |
| " | AR-NU-15 | | 139.5 | 13.3% | " | 124 | 9% | 113% | | 95% | 4.3% |
| " | AR-NU-16 | | 138.2 | 7.0% | " | 124 | 9% | 111% | | 95% | -2.0% |
| " | AR-NU-17 | | 137.0 | 6.5% | " | 124 | 9% | 110% | | 95% | -2.5% |
| " | AR-NU-18 | | 138.3 | 6.5% | " | 124 | 9% | 112% | | 95% | -2.5% |
| " | AR-NU-19 | | 142.9 | 6.0% | " | 124 | 9% | 115% | | 95% | -3.0% |
| " | AR-NU-20 | | 143.2 | 10.6% | " | 124 | 9% | 115% | | 95% | 1.6% |

(1.) Tested material consisted of tailings slimes removed from Pond 4. The relative impermeability due to the fine-grained nature of this material meets the infiltration performance standards. Therefore, additional compaction effort of the slightly substandard results was deemed to be non-beneficial and was not required.

(2.) Low densities are due to intermixed pockets of saturated tailings slimes. The low permeability of these slimes does not affect the performance of the compacted fill. Therefore, additional compactive effort was deemed to be non-beneficial and was not required.

*Soil testing provided by ESA, Inc, Fort Collins, CO.

**Table 2.6**
**Argentine Tailings**
**Field Soil Testing Summary**

| Date | Test No. | Location | Density | Moisture | Proctor No. | Maximum Density | Optimum Moisture | Percent Compaction | Notes | % Compaction Required | Percent +\- Moisture |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 13-Aug-96 | AR-NU-21 | Pond 1 | 137.1 | 5.1% | EF-05-SP-01 | 124 | 9% | 111% | | 95% | -3.9% |
| " | AR-NU-22 | | 127.6 | 7.1% | " | 124 | 9% | 103% | | 95% | -1.9% |
| " | AR-NU-23 | | 107.8 | 9.5% | " | 124 | 9% | 87% | (2) | 95% | 0.5% |
| " | AR-NU-24 | | 115.7 | 11.7% | " | 124 | 9% | 93% | (2) | 95% | 2.7% |
| " | AR-NU-25 | | 144.1 | 10.1% | " | 124 | 9% | 116% | | 95% | 1.1% |
| " | AR-NU-26 | | 124.5 | 12.7% | " | 124 | 9% | 100% | | 95% | 3.7% |
| " | AR-NU-27 | | 132.4 | 7.3% | " | 124 | 9% | 107% | | 95% | -1.7% |
| " | AR-NU-28 | | 122.6 | 5.3% | " | 124 | 9% | 99% | | 95% | -3.7% |
| " | AR-NU-29 | | 134.7 | 2.7% | " | 124 | 9% | 109% | | 95% | -6.3% |
| " | AR-NU-30 | | 111.5 | 11.0% | " | 124 | 9% | 90% | (2) | 95% | 2.0% |
| " | AR-NU-31 | | 105.8 | 16.4% | " | 124 | 9% | 85% | (2) | 95% | 7.4% |
| " | AR-NU-32 | | 117.8 | 18.8% | " | 124 | 9% | 95% | | 95% | 9.8% |
| 14-Aug-96 | AR-NU-33 | Pond 1 | 101.6 | 17.1% | EF-05-SP-01 | 124 | 9% | 82% | (3) | 95% | 8.1% |
| " | AR-NU-34 | | 107.2 | 13.3% | " | 124 | 9% | 86% | (3) | 95% | 4.3% |
| " | AR-NU-35 | | 106.6 | 10.6% | " | 124 | 9% | 86% | (3) | 95% | 1.6% |
| " | AR-NU-36 | | 103.4 | 11.5% | " | 124 | 9% | 83% | (3) | 95% | 2.5% |
| " | AR-NU-37 | | 114.8 | 6.6% | " | 124 | 9% | 93% | (3) | 95% | -2.4% |
| " | AR-NU-38 | | 104.5 | 14.7% | " | 124 | 9% | 84% | (3) | 95% | 5.7% |
| 15-Aug-96 | AR-NU-39 | 3:1 Slope - Below Pond 1 | 115.9 | 8.6% | "Estimated" | 135 | *** | 86% | (4) | 90% | |
| " | AR-NU-40 | | 133.0 | 8.0% | " | 135 | *** | 99% | | 90% | |
| " | AR-NU-41 | | 125.2 | 9.5% | " | 135 | *** | 93% | | 90% | |
| " | AR-NU-42 | | 130.0 | 5.0% | " | 135 | *** | 96% | | 90% | |
| " | AR-NU-43 | | 145.0 | 6.7% | " | 135 | *** | 107% | | 90% | |
| " | AR-NU-44 | | 127.9 | 6.4% | " | 135 | *** | 95% | | 90% | |

*** Modified Providence Tests and estimated maximum densities did not generate an optimum moisture.

(2.) Low densities are due to intermixed pockets of saturated tailings slimes. The low permeability of these slimes does not affect the performance of the compacted fill. Therefore, additional compactive effort was deemed to be non-beneficial and was not required.

(3) Tested material consisted of sandy tailings and tailings slimes. Contractor was directed to recompact this area to the approval of the Engineer. Caution was directed to prevent pumping of the slimes.

(4.) Investigation revealed the soil representative of this test was confined to a small zone and was not representative of the general area.

*Soil testing provided by ESA, Inc, Fort Collins, CO.

**Table 2.6**
**Argentine Tailings**
**Field Soil Testing Summary**

| Date | Test No. | Location | Density | Moisture | Proctor No. | Maximum Density | Optimum Moisture | Percent Compaction | Notes | % Compaction Required | Percent +\- Moisture |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 19-Aug-96 | AR-NU-45 | 3:1 Slope - Below Pond 3 | 111.9 | 11.3% | EF-05-SP-01 | 124 | 9% | 90% | (5) | 95% | 2.3% |
| " | AR-NU-46 | | 113.4 | 13.1% | " | 124 | 9% | 91% | (5) | 95% | 4.1% |
| " | AR-NU-47 | | 110.5 | 14.3% | " | 124 | 9% | 89% | (5) | 95% | 5.3% |
| " | AR-NU-48 | | 109.1 | 7.6% | " | 124 | 9% | 88% | (5) | 95% | -1.4% |
| " | AR-NU-49 | | 119.4 | 12.9% | " | 124 | 9% | 96% | | 95% | 3.9% |
| " | AR-NU-50 | | 120.9 | 15.8% | " | 124 | 9% | 98% | | 95% | 6.8% |
| 21-Aug-96 | AR-NU-51 | 3:1 Slope - Below Pond 1 | 133.6 | 6.2% | "Estimated" | 135 | *** | 99% | | 90% | |
| " | AR-NU-52 | | 129.0 | 5.9% | " | 135 | *** | 96% | | 90% | |
| " | AR-NU-53 | | 118.8 | 7.8% | " | 135 | *** | 86% | (6) | 90% | |
| " | AR-NU-54 | | 117.9 | 6.9% | " | 135 | *** | 87% | (6) | 90% | |
| " | AR-NU-55 | | 135.9 | 8.4% | " | 135 | *** | 101% | | 90% | |
| " | AR-NU-56 | | 129.2 | 5.5% | " | 135 | *** | 96% | | 90% | |
| " | AR-NU-57 | | 121.0 | 8.5% | " | 135 | *** | 90% | | 90% | |
| 24-Aug-96 | AR-NU-58 | Runon Ditch | 118.9 | 12.5% | EF-10-SP-01 | 129 | *** | 92% | | 90% | |
| " | AR-NU-59 | | 113.3 | 10.7% | " | 129 | *** | 88% | (7) | 90% | |
| " | AR-NU-60 | | 115.2 | 14.7% | " | 129 | *** | 89% | (7) | 90% | |

*** Modified Providence Tests and estimated maximum densities did not generate an optimum moisture.

(5.) Contractor provided additional compaction effort in this area after nuclear gauge testing. This effort was considered sufficient and the area was accepted.

(6.) Slightly substandard results were likely due to the material being less well-graded than comparable surrounding material. However, the material was sufficiently well-graded to achieve the intent of the structural design standard based on the observed compactive effort.

(7.) Additional compaction effort was deemed to be non-beneficial in this non-critical area.

*Soil testing provided by ESA, Inc, Fort Collins, CO.

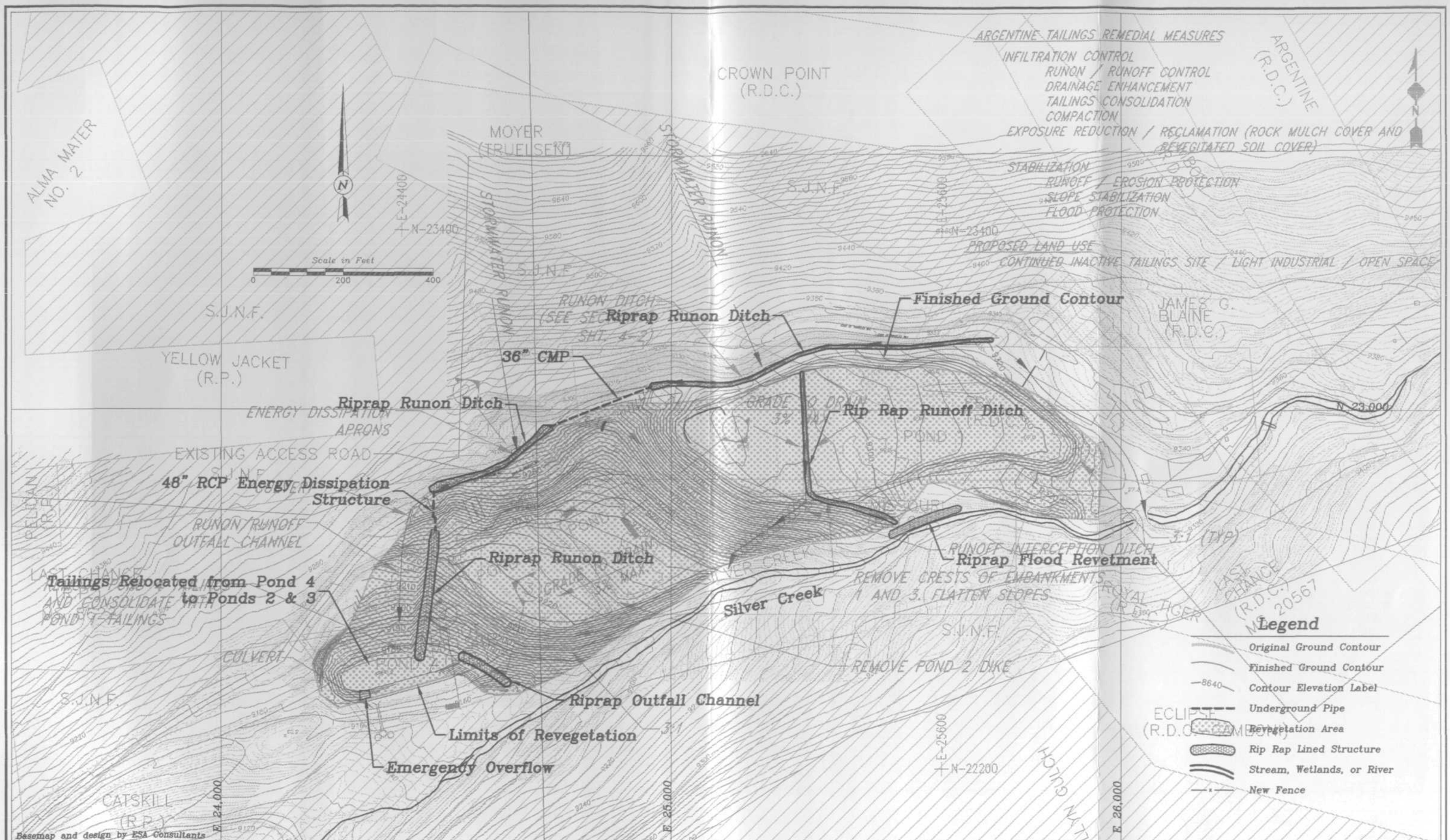
### 2.10.2 Confirmatory Testing

Confirmatory testing was performed at each location where specific removal of mill tailings was specified in the Voluntary Cleanup Plan (VCUP). Based on soil investigations within and surrounding the Town of Rico, Zinc levels range from 200 to 4720 ppm. The cleanup level was set at a maximum of 4720 ppm for testing of subgrade after the removal of materials. Sample results above the limit resulted in further removal and sampling. Final samples indicate the cleanup was successful. Table 2.7 summarizes the confirmatory sampling results. The comprehensive report of confirmatory testing on the Rico Project is contained in the Appendix.

**Table 2.7**
**Argentine Tailings**
**Confirmatory Testing**

| Removal Site | Sample ID | Zinc (ppm) | Sample Type |
|---|---|---|---|
| Argentine Tailings Pond 4 | EX-AR-01 | 1,130 | Composite |
| | EX-AR-02 | 1,120 | Composite |

## 2.11 As Built Drawings




**ATLANTIC RICHFIELD COMPANY**
RICO MINING AREA
CONSTRUCTION COMPLETION REPORT

ANDERSON ENGINEERING CO., INC.
975 West 2100 South Street Suite 100
Salt Lake City, UT 84119
Tel. (801) 972-6222

| NO. | REVISION/DESCRIPTION | DATE |
|---|---|---|
| | | |

| | |
|---|---|
| DRAWN BY: | R. TATE |
| CHECKED BY: | S. ANDERSON |
| CLIENT CONTACT: | R. ELLIOTT |
| SCALE: | 1" = 200' |
| OTHER REFS: | ar_prop.dwg |

# ARGENTINE TAILINGS AREA FINAL CONFIGURATION PLAN VIEW

References: arconcep.dwg, ar-econt.dwg

FIG. 2-1

File: ARG.DWG view (plan)

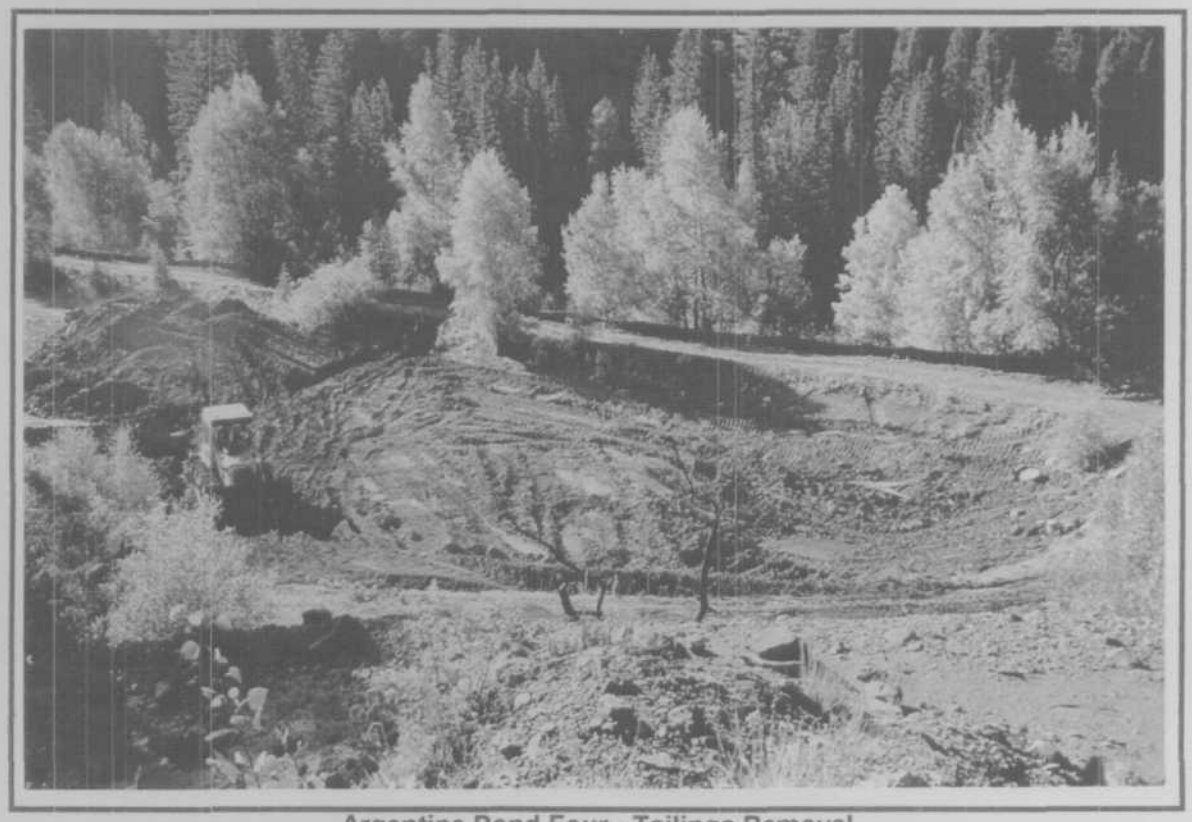
## 2.12 Photographs

# Color Photo(s)

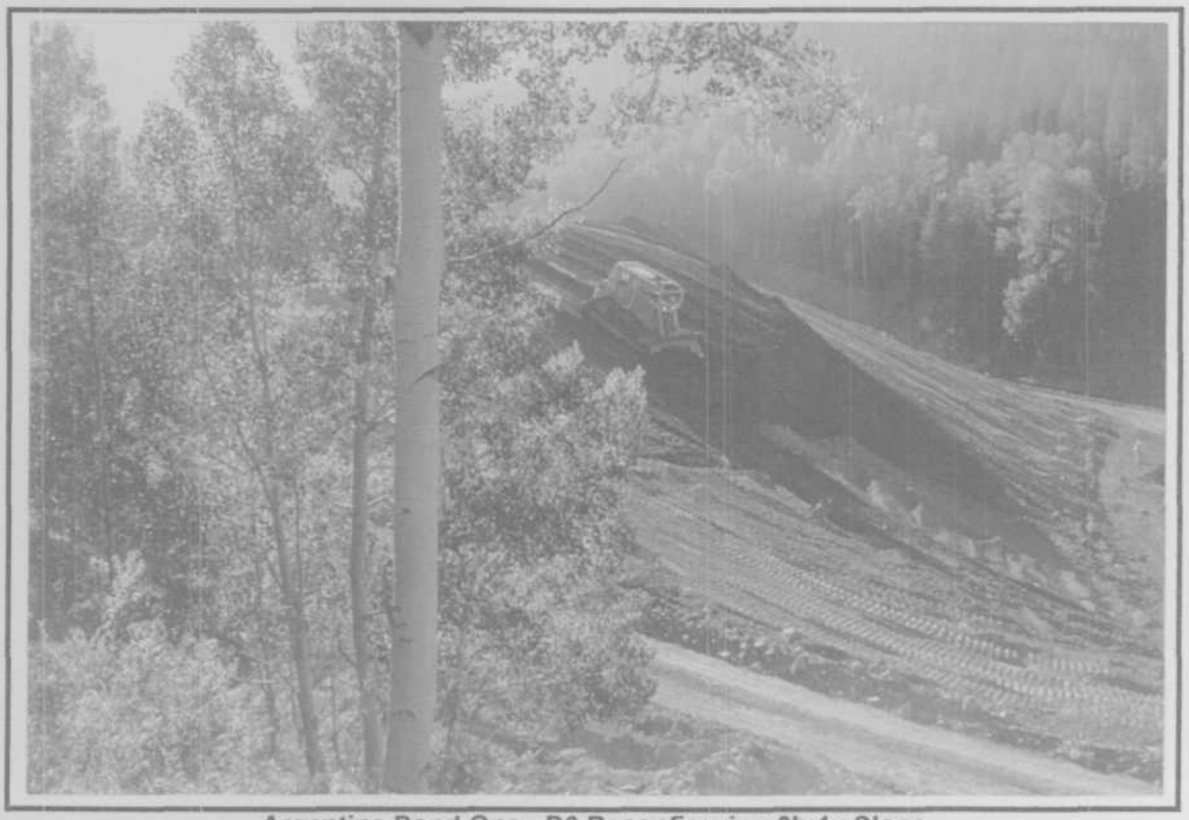
The following pages contain color that does not appear in the scanned images.

To view the actual images, please contact the Superfund Records Center at (303) 312-6473.

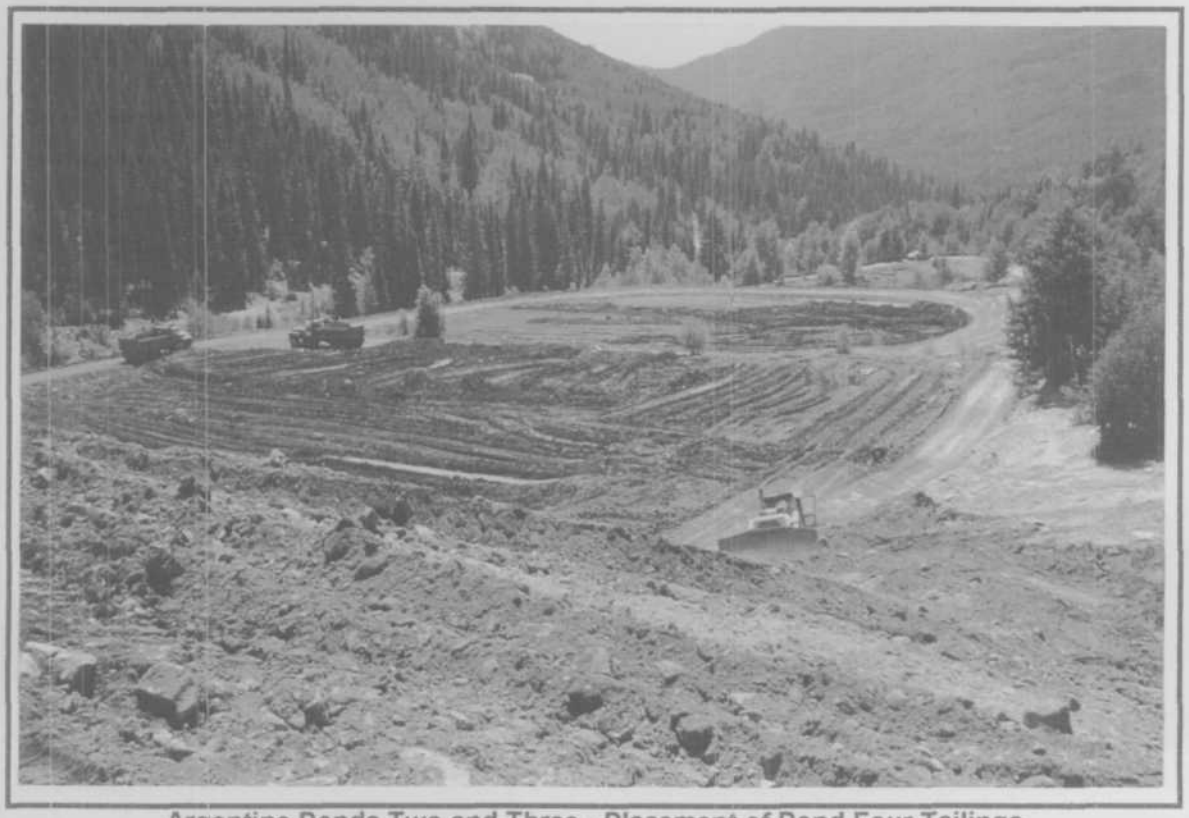
Argentine Pond One - Grading



Argentine Pond Four - Tailings Removal



Argentine Pond One - D6 Reconfiguring 3h:1v Slope



Argentine Ponds Two and Three - Placement of Pond Four Tailings

Argentine Pond One - Placing Plant Growth Medium

Argentine Pond One - Processing Soil with Lime Amendment

Drainage Line Construction - Offset for Energy Dissipation Structure

# 3.0 Columbia Tailings

## 3.1 General

The Columbia Tailings Site is located on the east side of the Dolores River corridor west of Highway 145. The east side of the pile is against the base of a steep hillside slope below Highway 145. The west side of the pile is bounded by the old railroad grade that initially served as the retention dam for the tailings pile. This inactive mill tailings disposal pile encompasses an area of approximately 3.3 acres. The Columbia Tailings surface consists of fine grained oxidized sand and silt tailings. The historic railroad grade forms a berm between the Dolores River and the steep west side of the pile.

The Columbia Tailings Site work area also includes the old Pro Patria Mill Site, the Silver Swan East waste rock pile, the Santa Cruz wetlands and the main pile excess material, and the Shamrock Mine waste rock pile. The old Pro Patria Mill Tailings Site is located on the east side of the Dolores River corridor east of the historic Rio Grande Southern Railroad grade, west of River Street and southwest of the west end of Mantz Avenue (where the historic Pro Patria Mill was located). The Pro Patria areas include approximately two acres. The Pro Patria Tailings Site was occupied with tailings and oxidized waste rock (heavy metals - predominantly iron, lead, and zinc) contained in historic mill tailings derived from sulfide ore. The Silver Swan East waste rock pile is located on the east side of the Dolores River across from the Silver Swan Mine area. The east waste rock pile occupies approximately 0.2 acres. The Shamrock Mine waste rock pile was also located on the east side of the Dolores River. The Shamrock Mine waste rock was within the Dolores River corridor about ½ mile north of the Columbia Tailings Site. The Santa Cruz is located on the west side of the Dolores River corridor south of Rico. Excess waste rock from grading activities was transported to the Columbia Tailings for ultimate disposal.

## 3.2 Permit

The VCRA application dated January 18, 1996 and supplemental information to the application dated February 27, 1996 and March 1, 1996 were approved by the CDPHE on March 4, 1996. The CDPHE approval stated that the VCUP would meet a degree of cleanup and control of hazardous substances such that the property does not present an unacceptable risk to human health or the environment based on the property's proposed use as an open space. The approved VCUP remedial design for the Columbia Tailings Site involves reconfiguration of tailings outslopes to control erosion, consolidation of the south area tailings, consolidation of waste rock

materials from the Silver Swan East area, Pro Patria Mill area, the Shamrock Mine waste rock pile and excess waste rock from land shaping at the Santa Cruz Mine area. The Columbia Tailings is to be graded to route offsite surface water around the wastes for runon control, and surface adjustments and compaction to shed rainfall and snowmelt from the waste to control erosion and limit infiltration. The VCUP also calls for providing erosion protection through construction of reclamation covers consisting of growth medium with some amendments and seeding. Riprap was placed along the Dolores River for erosion protection. An access road, parking lot and an open air information center were also constructed on the reshaped top surface of the Columbia Tailings.

## 3.3 Geohazards

The hazard of concern at the Columbia Tailings Site was flooding of the Dolores River. No substantial engineering, geologic or geotechnical problems were encountered during implementation of the remedial work for the Columbia Tailings area. No slope failure problems were experienced during the materials movement and waste pile grading and contouring. Revetment was placed along the north toe of the reshaped tailings and also on the railroad grade berm susceptible to erosion from the Dolores River flooding. Areas of riprap placement are shown on Figure 3-1.

## 3.4 Site Access

Access to the Columbia Tailings, Pro Patria Tailings, Silver Swan East and Shamrock waste rock Sites was available on existing roads. Direct access between the Sites is along the historic railroad grade, dirt roads and some paved roads in west Rico. Properties encompassing the railroad grade are owned by the private party applicant, Rico Properties, L.L.C. All roads were maintained and left in as good or better condition than existed prior to their use on this project. Waste hauled from the Santa Cruz Mine area to Columbia used access over a USFS bridge and this access was maintained in compliance with the USFS Road Use Permit. A Colorado Department of Transportation State Highway Access Permit was obtained for the access to the Columbia Tailings Visitors Center from State Highway 145.

## 3.5 Construction Site Controls

Controls were implemented during construction to address requirements of applicable federal, state or local permits, codes or regulations. All construction and specifications employed appropriate Best Management Practices in accordance with

the Stormwater Discharge Permit and COE 404 Permit to protect the Dolores River from sedimentation during remedial activities. Temporary berms to control runoff to the Dolores River were constructed in work or active traffic areas. Silt fencing and hay bales were used as barriers to prevent sediment migration into the Dolores River during excavation activities. Also, construction activities were conducted in a manner to preserve existing vegetation buffers in the work areas. Runoff water from disturbed areas was retained for settling of sediments prior to allowing discharge into Dolores River. Strict precautions to avoid dust and excavation spillage during operations were followed by the use of water spray and control of load heaping on haul units.

The onsite construction activities were conducted in strict compliance with the VCUP Site Specific Safety and Health Plan and Site Pre-Excavation Construction Plans as well as regulatory permits obtained for the specific work area.

## 3.6 Hydraulic Controls

### 3.6.1 Runon

The runon generated from rainfall or snowmelt upland of the Site is directed away from the Columbia reclaimed tailings ponds by a 600 linear foot riprap lined runon ditch. The runon/runoff ditch was excavated into the natural ground surface at the toe of the east reconfigured slope of the Site. Stormwater is directed south and west in the runon/runoff ditch and spills into a retention area south of the Columbia Tailings. The retention area was created by the removal of tailings in between the main tailings area and the railroad grade. Figure 3-1 shows the alignment of the runon/runoff ditch. The main portion of the ditch consists of a riprap lined channel over 60 mil HDPE textured liner. Type B riprap 6 inches thick was laid over 6 inches of Type D and 6 inches of compacted soil material in a trapezoidal designed ditch up to the access road. The runon/runoff ditch stormwater is passed under the access road from State Highway 145 in a 24 inch RCP. The 24 inch RCP was 142 ft. in length and was installed with a riprap inlet and outlet. The remaining runon/runoff ditch from the access road to the retention area is about a 12-inch deep trapezoidal channel approximately 2.0 feet wide at the base. The channel was lined with Type B riprap 6 inches thick over 6 inches of Type D bedding and 6 inches of compacted soil material.

### 3.6.2 Runoff

The top surface of the consolidated waste pile has been shaped to drain precipitation and not retain runoff on the pile. The graded pile drains stormwater to the west. The top surface and areas within the access roads on the top surface are graded at about 2% to the west. Runoff is passed across the west road in a concrete lined swale (pan) and drains from the pile to the north west.

The runoff from the eastern graded outslope is captured by the runon/runoff ditch and drained to the south of the pile. The design of the runon/runoff ditch is discussed in Section 3.6.1. Stormwater is drained into a retention area south of the Columbia Tailings. This flow will eventually reach the Dolores River through a 24-inch RCP across the existing railroad grade. This drain consists of Type B riprap placed 15 ft. deep by 3 ft. and is 2 ft. deep. Figure 3-1 shows the location of the retention area and the RCP pipe.

Outslopes of the reconfigured tailings are 4h:1v and runoff water is drained away from the pile. The north slope of the Columbia drains into the existing wetlands. The west slope drains into the Dolores River and the east and south slopes into the retention area and then into the Dolores by way of the RCP pipe.

The runon and runoff ditches are sized to pass peak flows for a 100 year precipitation event. Figure 3-1 shows the runoff ditch location.

### 3.6.3 Infiltration

Infiltration of water into the tailings ponds at the Columbia Site is controlled by rerouting runon away from the reclaimed areas, reducing the surface area of the tailings, regrading of the tailings to not pond water and compaction of the top surface of the reclaimed tailings to impede infiltration.

The rerouting of the runon and runoff away from the tailings will be of significant impact for reducing infiltration. The runon water contribution to the tailings areas has been eliminated.

The area south of the Columbia Tailings was removed and placed onto the main portion of the tailings. The surface area of the tailings pile has been reduced by 15% and therefore reducing the infiltration surface available. The

total area of the tailings was reduced by 0.4 acres which left a total of 2.7 acres of surface. The tailings were consolidated by excavation of the tailings material from the south area between the railroad grade and the natural ground to the east, then hauled and placed as compacted cover over the surface of the main tailings area.

The upper 18 inches of top surface and outslopes of the Columbia Tailings pile were compacted to impede infiltration. With the material types encountered in the tailings, the density that is achieved by this compaction will reduce the hydraulic conductivity. The results of compaction testing conducted on the Columbia Tailings reconfigured surface are summarized in Section 3.10.

### 3.6.4 Drainage Stabilization

The Columbia Tailings Ponds are adjacent to the Dolores River and may be susceptible to seasonal flooding. The Columbia Tailings are protected by the existing railroad fill between the Site and the Dolores River. This railroad fill serves as a protective dike and adequately contains the flood flow of the Dolores River for the estimated 500 year flood event with a 2 ft. freeboard. Riprap revetment was placed on the railroad fill bank slope to protect the fill from peak flow velocities experienced during flooding. The north slope of the Columbia Tailings is also protected from high river flood velocities by the riprap revetment. Riprap construction is discussed in Section 3.8 of this report.

## 3.7 Waste Materials

### 3.7.1 Consolidation

Waste materials from several areas along the Dolores River corridor in the vicinity of the Columbia were excavated and consolidated at the Columbia Tailings Site. Tailings existing at the Pro Patria and some mixed waste rock, approximately 7,300 cubic yards, were removed from the Pro Patria Mill area and hauled to the Columbia Tailings. About 600 cubic yards of waste rock from the dump on the east bank of the Dolores River at the Silver Swan Mine area was excavated, hauled and deposited at the Columbia Tailings pile.

Additionally, 5,200 cubic yards of waste rock from the Santa Cruz Mine cleanup activities that did not fit into the grading plan were relocated to the

Columbia Tailings. Approximately 1,270 cubic yards of waste rock from the Shamrock Mine located north of the Pro Patria Site on the east bank of the Dolores River was removed to the Columbia Tailings pile. Shallow tailings totaling 1,500 cubic yards located at the south end of the main Columbia Tailings were excavated and relocated to the main pile. The consolidation of these wastes to the Columbia Tailings reduced the net area of the sites by over 2 acres. The locations of the areas excavated are shown on Figures 3-1, 4-1 and 5-1.

Tailings were removed in layers of about 12 inches in thickness by conventional earthmoving equipment. Following removal, confirmatory sampling was conducted to detect if all waste material had been removed. This process was repeated until confirmation sampling showed that no additional material removal was required.

Verification of tailings removal was accomplished by collecting confirmatory samples of the underlying materials. Waste rock and tailings excavation was considered completed, as defined in the VCUP, when the Zinc content fell within or below the range of local natural bedrock and surficial materials. This range is 200 to 4720 ppm Zinc. The sampling of the removal areas confirms that the majority of tailings was excavated from the areas of concern. Sampling results and summaries for the removal of the respective areas are contained in Section 3.10.2.

The relocated tailings were placed onto the top of the main Columbia Tailings pile in lifts not exceeding 12-inches in depth and were compacted. The compaction effort was accomplished by placement equipment making a minimum of one pass over the entire surface of each 12-inch lift. Tailings placed in the upper 18-inches of the top surface were compacted as previously described.

### 3.7.2 Surface Shaping and Slopes

The top surface of the consolidated tailings drains to the west at 2%. The tailings have been reconfigured with all of the outslopes draining the Site. The outslopes of the reconfigured Columbia Tailings are constructed to a 4h:1v geometry. The reconfigurement of the Columbia Tailings was accomplished by a cut and fill approach with a major portion of the slope fill being from consolidation of other waste areas. The grading was completed to a tolerance of $\pm$ 0.3 ft. of construction drawings and free of irregularities.

Figure 3-1 shows the pre-existing conditions, VCUP design configuration and the as built conditions of the Columbia Tailings.

## 3.8 Erosion Protection

### 3.8.1 Growth Medium

Growth medium material comprises compacted surface tailings and soil cover. The top surface of the reshaped Argentine Tailings was sampled to determine agricultural lime ($CaCO_3$) requirements for plant establishment. Areas requiring lime amendment were delineated in the field. Lime was applied at rates of 125 to 500 tons/acre to the upper 6-inches of waste material. Table 3.1 shows the lime application rates for the Columbia Tailings. Agricultural lime was also added to the tailings existing on the hillside slopes at the Pro Patria Tailings Area and is described on Table 3.1. The lime was spread evenly over the Site by mechanical methods then incorporated. Multiple tilling passes were made to insure complete mixing of the lime into the material. The liming process was accomplished immediately following waste pile shaping to provide the greatest reaction time prior to revegetation. Amended material was re-compacted prior to placement of soil cover material.

Borrow soil used for plant growth was tested and identified prior to excavation. The borrow soil was obtained from the St. Louis borrow area 1.5 miles north of the Columbia Tailings, the Pro Patria Tailings and the Shamrock Mine Area. The soil was transported by truck to the Columbia Tailings and placed over the top of the lime amended material to a depth of 24-inches. Table 3.1 describes the placement of the soil material at the Columbia Tailings, Pro Patria Area and the Shamrock Mine Area. This soil was placed on the top surface and slopes and covered the entire areal extent of the regraded waste pile. Approximately 9,000 cubic yards of soil cover material were transported and placed onto the Columbia. The traffic over the soil was kept to a minimum to avoid unnecessary compaction of the seed bed. The finished grade for the soil cover is $\pm$ 0.3 ft. of design and does not contain irregularities.

**Table 3.1**
**Columbia Tailings, Pro Patria Tailings Area, Shamrock Mine Area**
**Agricultural Lime and Cover Material Application Rates**

| SITE | LIME APPLICATION RATE FOR WASTE MATERIAL | SOIL COVER APPLICATION RATE |
|---|---|---|
| North and West 4:1 slopes | 500 tons/acre (2.9 in. thick) Amended 6 inches deep and compacted | 18-inches of unprocessed borrow soil covered by 6 inches of growth processed borrow soil. |
| East 4:1 slope | 225 tons/acre (1.3 in. thick) Amended 6 inches deep and compacted | |
| Tailings on east side of runon/runoff ditch | 225 tons/acre (1.3 in. thick) Amended 6 inches deep and compacted | |
| Small area on south top of pile | 500 tons/acre (2.9 in. thick) Amended 6 inches deep and compacted | |
| Top of Columbia pile | 125 tons/acre (0.7 in. thick) Amended 6 inches deep and compacted | |
| Pro Patria Tailings Area | 200 tons/acre (1.0 in. thick) Amended 6 inches deep and compacted (hillside slopes) | 12-inches of processed borrow soil |
| Shamrock Mine Area | No lime application required | 6 to 12 inches of processed borrow soil |

### 3.8.2 Revegetation

All seed was applied using hydroseeding methods due to wet surface conditions and time constraints. Table 3.2 contains the seed mixtures and application rates at the Columbia Tailings. Seeding of the Pro Patria Tailings Area included Type D in the wetlands area and Type B in the slopes. The Shamrock Mine Area was hydroseeded with the Type D mixture. Revegetation activities were sequenced as shown on Table 3.3.

## Table 3.2
## Seed Mixtures and Application Rates

| Type A (1) General Seed Mixture | | | |
|---|---|---|---|
| **Species** | **Preferred Variety(s)** | **Rate (lbs./acre) Planted (broadcast)** | **PLS (seeded/acre)** |
| Big bluegrass<br>Poa ampla | Sherman | 0.50 | 458,500 |
| Mountain brome<br>Bromus carinatus | Bromar | 8.00 | 496,000 |
| Slender wheatgrass<br>Agropyron trachycaulum | Primar, San Luis | 3.00 | 480,000 |
| Streambank wheatgrass<br>Agropyron riparium | Sodar | 3.00 | 480,000 |
| Birdsfoot trefoil<br>Lotus corniculatus | Empire | 1.00 | 410,000 |
| Lewis flax<br>Linum lewisii | Apar | 2.00 | 570,000 |
| Rocky Mountain penstemon<br>Penstemon strictus | Bandera | 1.00 | 592,000 |
| Cicer milkvetch<br>Astragalus cicer | Lutana, Monarch | 1.50 | 290,000 |
| | **Totals** | **20.00** | **3,776,500 (approx. 87 seeds per square foot)** |

(1) Type A applied over entire area of disturbances, except for the railroad grade, access road loop and areas protected by riprap.

**Type B (2)**
**Sideslope Stabilization Mixture**

| Species | Preferred Variety(s) | Rate (lbs./acre) Planted (broadcast) | PLS (seeded/acre) |
|---|---|---|---|
| Big bluegrass<br>Poa ampla | Park | 0.50 | 1,100,000 |
| Mountain brome<br>Bromus carinatus | Bromar | 15.00 | 975,000 |
| Slender wheatgrass<br>Agropyron trachycaulum | Primar, San Luis | 6.00 | 960,000 |
| Streambank wheatgrass<br>Agropyron riparium | Sodar | 6.00 | 960,000 |
| Cicer milkvetch<br>Astragalus cicer | Lutana, Monarch | 1.50 | 290,000 |
| | **Totals** | **29.00** | **4,285,000 (approx. 98 seeds per square foot)** |

**Type D (3)**
**(Wetland Planting Mixture)**

| Species | Preferred Variety(s) | Rate (lbs./acre) Planted (broadcast) | PLS (seeded/acre) |
|---|---|---|---|
| Redtop (FACW)<br>Agrostis alba | Any | 0.50 | 2,495,000 |
| Red fescue (FAC)<br>Festuca rubra | Any | 3.00 | 1,845,000 |
| Tall (Kentucky) fescue (FACW-)<br>Festuca arundinaceae | Any | 5.00 | 1,135,000 |
| | **Totals** | **8.25** | **5,475,000 (approx. 126 seeds per square foot)** |

(2) Type B applied on east slope of railroad grade between the Columbia Tailings and the RCP at the south end of the Site.
(3) Wetlands Type B planting mixture used at Pro Patria and Shamrock areas.

## Table 3.3
## Columbia Tailings, Pro Patria Tailings Area, Shamrock Mine Area
## Revegetation Sequence

| Item | Seed Bed Preparation | Fertilizer | Seed | Mulch |
|---|---|---|---|---|
| **Period** | Prior to fertilization and seeding. | Concurrent with seeding. | After September 30th, immediately following final seed bed preparation. | Immediately following seeding. |
| **Method** | Mechanical scarification of soil. | Combined with hydroseeding. Liquid fertilizer mixture. | Hydroseeding on all areas. | Hydromulch - 1500 lbs./acre, all areas.<br>Slurry pH> 3.5. |
| **Equipment** | Disc or rippers pulled by tractor. | Mobile hydroseeding equipment. | Mobile hydroseeding with spray and tank equipment. | |
| **Discing/Raking** | Disc or rip to 12 inch depth maximum. | | | |
| **Other** | Insure adequate seed bed without hard surface resistant to seed placement. | Nutrient application applies to all sites:<br><br>Nitrogen (lb./acre) 40<br>Phosphate (lb./acre) 60<br>Potash (lb./acre) 40 | Seed depth = 1/4" to 1/2"<br>Spacing = 6"<br><br>Type<br>A General seed mix (<3:1)<br>B Side slope mix (>3:1)<br>C Acid-tolerant mix | Purpose: twofold:<br>1. Conserve water<br>2. Deter erosion |
| **Note:** Ripping of final graded surface completed as needed prior to applying fertilizer. | | | | |

### 3.8.3 Riprap

Rock erosion protection was placed in areas where runoff, runon and drainage way flows were considered to be highly erosive. Riprap and bedding types are shown on Table 3.4.

**Table 3.4**
**Columbia Tailings**
**Riprap and Bedding**

| | | Percent Passing | | | | | |
|---|---|---|---|---|---|---|---|
| **Type** | **Description** | **100** | **85** | **50** | **30** | **15** | **0** |
| A | Riprap | 1.7-2.4' | - | 1.4'-1.6' | 1.2' | 0.9' | 0.8' |
| B | Riprap | Larger Rock Material Generated By Borrow Processing | | | | | |
| C | Riprap | 0.9-1.2' | - | 0.7-0.8' | 0.6' | 0.5-0.65' | 0.4 |
| D | Riprap/Bedding | 3.0-8.0" | 3.0-6.0" | - | - | 0.75"-1.5" | 0"-0.5" |
| E | Filter Material/Bedding | 2.0" | 0.5-1.5" | - | - | 0.5-0.65mm | 0.6mm |

The runon and runoff ditch alignments are shown in the plan view on Figure 3-1. These ditches contain riprap, bedding and HDPE textured liner to handle flows resulting from a 100 year precipitation return event. These designs are discussed in detail under Section 3.3.

The railroad fill embankment and the north 4h:1v slope of the Columbia Tailings were protected from erosive flood flow by placement of revetment. The revetment placed along the Dolores River over the historical railroad fill consists of a scour toe of Type A riprap placed about 3.6 ft. thick below the water level. Type A riprap was placed over the existing scour toe and up the existing slope. The Type A riprap was constructed over 6 inches of Type D bedding and 6 inches of Type E bedding, respectively, existing at or below the water surface where fill was placed with Type D material. The riprap placed above the average water line is Type A. This revetment was constructed to provide a 2 ft. freeboard above the 500 year flood level of the Dolores River.

Revetment placed on the northwest corner of the railroad fill is built of a 2.4 ft. layer of Type A riprap over Type D and Type E bedding. Flood protection revetment on the north slope of the reconfigured Columbia Tailings slope is also a 1.2. ft. layer of Type C riprap over 6 inches of Type D and 6 inches of Type E bedding. The existing ground in the wetland area north of the Columbia Tailings was pushed up to and over the lower portion of the revetment on the north slope.

### 3.9 Quantity Summary

The quantities moved for implementation of the VCUP for the Columbia Tailings involved ten categories of materials. The total volume of materials moved was 28,247 cubic yards. Table 3.5 contains the volume of moved materials by category for earthwork at the Columbia Tailings.

**Table 3.5**
**Columbia Tailings**
**Relocated Materials, Riprap and Bedding**

| Activity | Material Type | Units | Quantities |
|---|---|---|---|
| Relocated Waste Rock | *** | CY | 14,650 |
| Unprocessed Cover Soil | Borrow Soil | CY | 1,968 |
| Processed Cover Soil | -3/4" Borrow Soil | CY | 8,945 |
| Riprap | A | CY | 1,171 |
| Riprap | B | CY | 119 |
| Riprap | C | CY | 429 |
| Riprap Bedding | D | CY | 542 |
| Riprap Bedding | E | CY | 423 |
| Textured Liner | HDPE | $Yd.^2$ | 1,073 |
| Road Subgrade Reinforcement | Geogrid | $Yd.^2$ | |
| Soil Amendment | Agricultural Lime | Tons | 166 |

## 3.10 Soil Testing Summary

### 3.10.1 Geotechnical Testing

Field soil density testing was conducted to determine compliance with the technical specifications of the construction contract. The technical specifications relating to compaction were selected to achieve various engineering objectives relating to infiltration and enhancing stability in fill materials. The applicable technical specifications required that the upper 12 inches of the waste piles be of a compactable gradation, and attain 95% of Standard Proctor maximum dry density (or 90% of maximum Providence index density for soils with little or no fines). Table 3.6 summarizes the field soil moisture/density tests conducted for the Argentine Tailings. Nuclear density gauges were used to obtain in-place densities for comparison to laboratory generated Proctor or Providence mold laboratory density tests as appropriate for a given soil. Where moisture/density tests were deficient, footnotes in Table 3.6 indicates the action taken by the field engineer, e.g. - recompaction of the affected area or in cases where additional compaction or replacement of fill materials would not have provided any additional benefits to the long-term performance of the fill with respect to design objectives, no action was directed. Laboratory and field tests were performed and results approved by ARCO. Tests were conducted according to the following standards:

| ASTM Method | Description: |
|---|---|
| Field Tests: | |
| D-2922 | Density of Soil and Soil-Aggregate in Place by Nuclear Methods |
| Laboratory Tests: | |
| D-422 | Sieve Analysis |
| D-698 | Moisture Density Relationships (5.5 lb. hammer) |
| D-4253 | Modified Providence Moisture Density Relationships |

Table 3.6 summarizes the results of field tests.

**Table 3.6**
**Columbia Tailings**
**Field Soil Testing Summary**

| Date | Test No. | Location | Density | Moisture | Proctor No. | Maximum Density | Optimum Moisture | Percent Compaction | Notes | % Compaction Required | Percent +\- Moisture |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 14-Aug-96 | CO-NU-01 | Runon/Runoff Ditch and RCP Compacted Bedding | 125.5 | 17.8% | EF-03-MP-01 | 130 | *** | 97% | | 90% | |
| " | CO-NU-02 | | 118.7 | 19.4% | " | 130 | *** | 91% | | 90% | |
| " | CO-NU-03 | | 101.5 | 18.1% | " | 130 | *** | 78% | (1) | 90% | |
| " | CO-NU-04 | | 125.9 | 16.7% | " | 130 | *** | 97% | | 90% | |
| 21-Aug-96 | CO-NU-05 | 4:1 slopes north and west, Pre Amendment | 125.1 | 9.5% | EF-03-MP-01 | 130 | *** | 96% | | 90% | |
| " | CO-NU-06 | | 118.3 | 11.5% | EF-08-MP-01 | 120 | *** | 99% | | 90% | |
| " | CO-NU-07 | | 105.2 | 11.3% | EF-08-MP-01 | 120 | *** | 88% | (2) | 90% | |
| " | CO-NU-08 | | 105.2 | 14.6% | EF-08-MP-01 | 120 | *** | 88% | (2) | 90% | |
| " | CO-NU-09 | | 112.0 | 11.7% | EF-03-MP-01 | 130 | *** | 86% | (2) | 90% | |
| " | CO-NU-10 | | 125.8 | 12.6% | EF-03-MP-01 | 130 | *** | 97% | | 90% | |
| " | CO-NU-11 | | 102.4 | 16.2% | EF-08-MP-01 | 120 | *** | 85% | (2) | 90% | |
| " | CO-NU-12 | | 116.9 | 11.8% | EF-03-MP-01 | 130 | *** | 90% | | 90% | |
| " | CO-NU-13 | | 104.7 | 11.0% | EF-03-MP-01 | 130 | *** | 81% | (2) | 90% | |

*** Modified Providence Tests and estimated maximum densities did not generate an optimum moisture.

(1.) Investigation revealed the soil representative of this test was confined to a small zone and was not representative of the general area. Additional compactive effort was deemed non-beneficial and was not required.

(2.) Tested material consisted of tailings slimes. The relative impermeability due to the fine-grained nature of this material meets the infiltration performance standards. Therefore, additional compaction effort of the slightly substandard results was deemed to be non-beneficial and was not required.

* Soil testing provided by ESA, Inc., Fort Collins, CO.

**Table 3.6**
**Columbia Tailings**
**Field Soil Testing Summary**

| Date | Test No. | Location | Density | Moisture | Proctor No. | Maximum Density | Optimum Moisture | Percent Compaction | Notes | % Compaction Required | Percent +\- Moisture |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3-Sep-96 | CO-NU-14 | Top of Pile, Pre-Amendment | 120.0 | 17.4% | EF-03-MP-01 | 130 | *** | 92% | | 90% | |
| " | CO-NU-15 | | 124.5 | 16.5% | " | 130 | *** | 96% | | 90% | |
| " | CO-NU-16 | | 117.1 | 13.3% | " | 130 | *** | 90% | | 90% | |
| " | CO-NU-17 | | 118.2 | 15.6% | " | 130 | *** | 91% | | 90% | |
| " | CO-NU-18 | | 120.7 | 18.7% | " | 130 | *** | 93% | | 90% | |
| " | CO-NU-19 | | 119.1 | 18.4% | " | 130 | *** | 92% | | 90% | |
| " | CO-NU-20 | | 126.9 | 13.9% | " | 130 | *** | 98% | | 90% | |
| " | CO-NU-21 | | 122.6 | 15.0% | " | 130 | *** | 94% | | 90% | |
| " | CO-NU-22 | | 122.4 | 13.0% | " | 130 | *** | 94% | | 90% | |
| " | CO-NU-23 | | 144.4 | 12.9% | " | 130 | *** | 111% | | 90% | |
| 5-Sep-96 | CO-NU-24 | Top of Pile, Post-Amendment | 121.9 | 11.9% | Estimate | 132 | *** | 92% | | 90% | |
| " | CO-NU-25 | | 126.0 | 11.1% | " | 132 | *** | 95% | | 90% | |
| " | CO-NU-26 | | 120.6 | 10.9% | " | 132 | *** | 91% | | 90% | |
| " | CO-NU-27 | | 129.3 | 8.8% | " | 132 | *** | 98% | | 90% | |
| " | CO-NU-28 | | 125.4 | 11.6% | " | 132 | *** | 95% | | 90% | |
| " | CO-NU-29 | | 123.2 | 11.1% | " | 132 | *** | 93% | | 90% | |
| " | CO-NU-30 | | 122.3 | 9.9% | " | 132 | *** | 93% | | 90% | |
| 5-Sep-96 | CO-NU-31 | Runon/Runoff Ditch & Liner Bedding | 106.9 | 12.8% | EF-10-SP-01 | 129 | 12% | 83% | (3) | 90% | 0.8% |
| " | CO-NU-32 | | 99.0 | 13.0% | " | 129 | 12% | 77% | (3) | 90% | 1.0% |
| " | CO-NU-33 | | 97.1 | 12.3% | " | 129 | 12% | 75% | (3) | 90% | 0.3% |
| " | CO-NU-34 | | 104.3 | 12.4% | " | 129 | 12% | 81% | (3) | 90% | 0.4% |

*** Modified Providence Tests and estimated maximum densities did not generate an optimum moisture.

(3.) Additional compaction effort was undertaken by the contractor.

* Soil testing provided by ESA, Inc., Fort Collins, CO.

**Table 3.6**
**Columbia Tailings**
**Field Soil Testing Summary**

| Date | Test No. | Location | Density | Moisture | Proctor No. | Maximum Density | Optimum Moisture | Percent Compaction | Notes | % Compaction Required | Percent +\- Moisture |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 11-Sep-96 | CO-NU-35 | 4:1 Slopes | 122.4 | 6.9% | Estimate | 135 | *** | 91% | | 90% | |
| " | CO-NU-36 | Post Amendment | 112.2 | 16.3% | EF-03-MP-01 | 130 | *** | 86% | (4) | 90% | |
| " | CO-NU-37 | | 120.4 | 15.5% | " | 130 | *** | 93% | | 90% | |
| " | CO-NU-38 | | 124.4 | 12.7% | " | 130 | *** | 96% | | 90% | |
| " | CO-NU-39 | | 119.6 | 10.5% | Estimate | 135 | *** | 89% | (4) | 90% | |
| " | CO-NU-40 | | 114.8 | 13.3% | " | 135 | *** | 85% | (4) | 90% | |
| " | CO-NU-41 | | 123.8 | 9.9% | EF-03-MP-01 | 130 | *** | 95% | | 90% | |
| " | CO-NU-42 | | 108.5 | 8.3% | " | 130 | *** | 83% | (4) | 90% | |
| " | CO-NU-43 | | 121.0 | 8.1% | " | 130 | *** | 93% | | 90% | |
| " | CO-NU-44 | | 129.5 | 11.8% | " | 130 | *** | 100% | | 90% | |
| 1-Oct-96 | CO-NU-45 | Subgrade for | 116.1 | 14.1% | EF-10-SP-01 | 129 | 12% | 90% | | 90% | 2.1% |
| " | CO-NU-46 | Visitor's Center | 112.4 | 14.7% | " | 129 | 12% | 87% | (5) | 90% | 2.7% |
| " | CO-NU-47 | Concrete Slab | 109.4 | 14.0% | " | 129 | 12% | 85% | (5) | 90% | 2.0% |
| " | CO-NU-48 | " | 109.8 | 13.7% | " | 129 | 12% | 85% | (5) | 90% | 1.7% |
| " | CO-NU-49 | | 118.5 | 14.9% | " | 129 | 12% | 92% | | 90% | 2.9% |
| " | CO-NU-46R | Retests after | 122.1 | 15.3% | EF-10-SP-01 | 129 | 12% | 95% | | 90% | 3.3% |
| " | CO-NU-47R | reworking subgrade | 122.1 | 14.9% | " | 129 | 12% | 95% | | 90% | 2.9% |
| " | CO-NU-48R | " | 123.0 | 15.1% | " | 129 | 12% | 95% | | 90% | 3.1% |

*** Modified Providence Tests and estimated maximum densities did not generate an optimum moisture.

Note: Since Columbia Access Road was not part of the remediation earth work, the field density tests are not presented here.

(4.) Contractor provided additional compaction effort in this area after nuclear gauge testing. The additional effort was considered sufficient.

(5.) Additional compaction effort was directed. Results of retests met design standards and the area was accepted.

* Soil testing provided by ESA, Inc., Fort Collins, CO.

### 3.10.2 Confirmatory Testing

Confirmatory testing was performed at each location where specific removal of mine waste rock or mill tailings was specified in the VCUP. Based on soil investigations within and surrounding the Town of Rico, Zinc levels range from 200 to 4720 ppm. The cleanup level was set at a maximum of 4720 ppm for testing of subgrade after the removal of materials. Sample results above the limit resulted in further removal and sampling. Final samples indicate the cleanup was successful. Table 3.7 summarizes the confirmatory sampling results. The comprehensive report of confirmatory testing on the Rico Project is contained in the Appendix.

**Table 3.7**
**Columbia Tailings, Silver Swan East, Pro Patria, Shamrock, Santa Cruz**
**Confirmatory Testing**

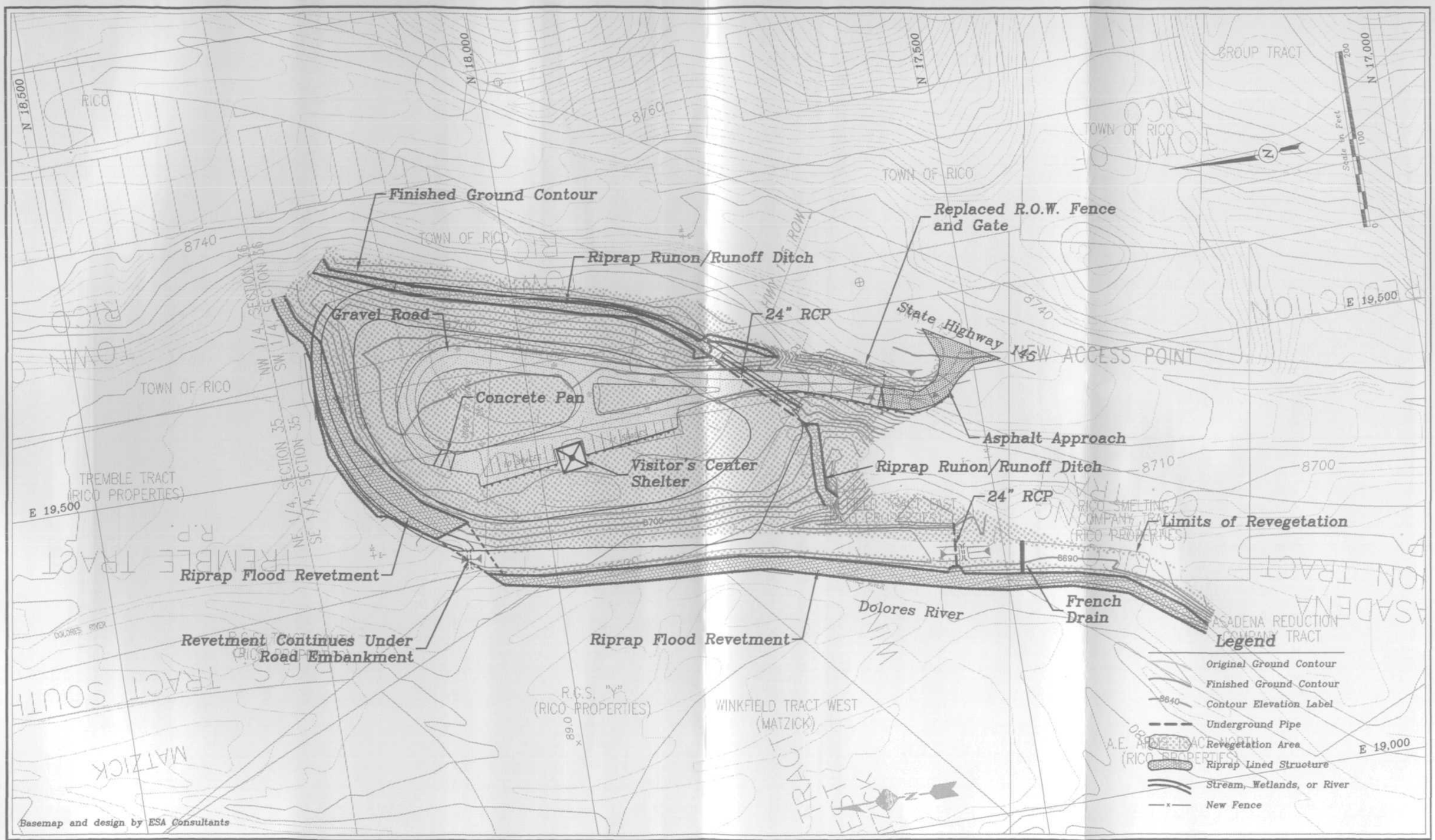
| Removal Site | Sample ID | Zinc (ppm) | Sample Type |
|---|---|---|---|
| Columbia Tailings south | EX-CO-01 | 651 | Composite |
| Pro Patria | EX-PP-02 | 3,840 | Composite |
| Santa Cruz | EX-SC-02 | 1,440 | Composite |
| | EX-SC-03 | 2,640 | Single sample |
| | EX-SC-04 | 422 | Single sample |
| Shamrock east bank | EX-SH-01 | 3,740 | Composite |
| Silver Swan east bank | EX-SSE-01 | 2,030 | Composite |

## 3.11 Visitor Center

As shown on Figure 3-1, visitor center was constructed over the completed surface of the Columbia Tailings to comply with land use described in the approved VCRA application. The visitor center consists of a loop access road from Colorado State Highway 145, a parking area and an information pavilion. The open air center is constructed of decorative concrete support columns with a metal type standing seam roof. The access road and parking area were surfaced with of clean gravel. Some Columbia waste materials are subject to soft ground conditions. To improve the

effective bearing capacity of the loop road and parking areas, the constructed subgrade comprises 12 inches of structural fill reinforced with geogrid.

### 3.12 As Built Drawings




ATLANTIC RICHFIELD COMPANY
RICO MINING AREA
CONSTRUCTION COMPLETION REPORT

ANDERSON ENGINEERING CO., INC.
975 West 2100 South Street Suite 100
Salt Lake City, UT 84119
Tel. (801) 972-6222

| NO. | REVISION/DESCRIPTION | DATE |
|---|---|---|
| | | |

| | |
|---|---|
| DRAWN BY: | R. TATE |
| CHECKED BY: | S. ANDERSON |
| CLIENT CONTACT: | R. ELLIOTT |
| SCALE: | 1" = 100' |
| OTHER REFS: | sc_econt.dwg |

# COLUMBIA TAILINGS AREA FINAL CONFIGURATION PLAN VIEW

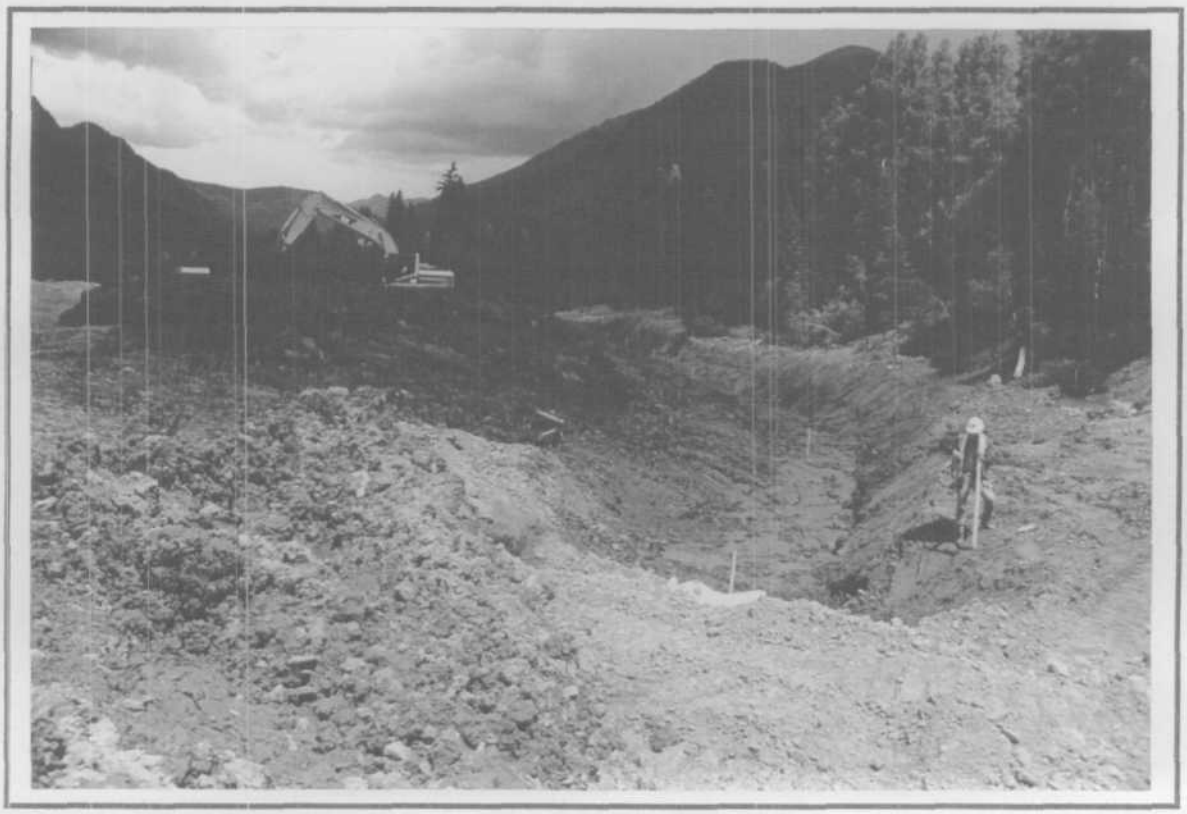
References: scconcep.dwg sc_prop.dwg

FIG. 3-1

File: COLUMBIA.DWG view (plan)

## 3.13 Photographs

View Looking South Along R.R. Grade - Revetment Excavation Along Dolores River

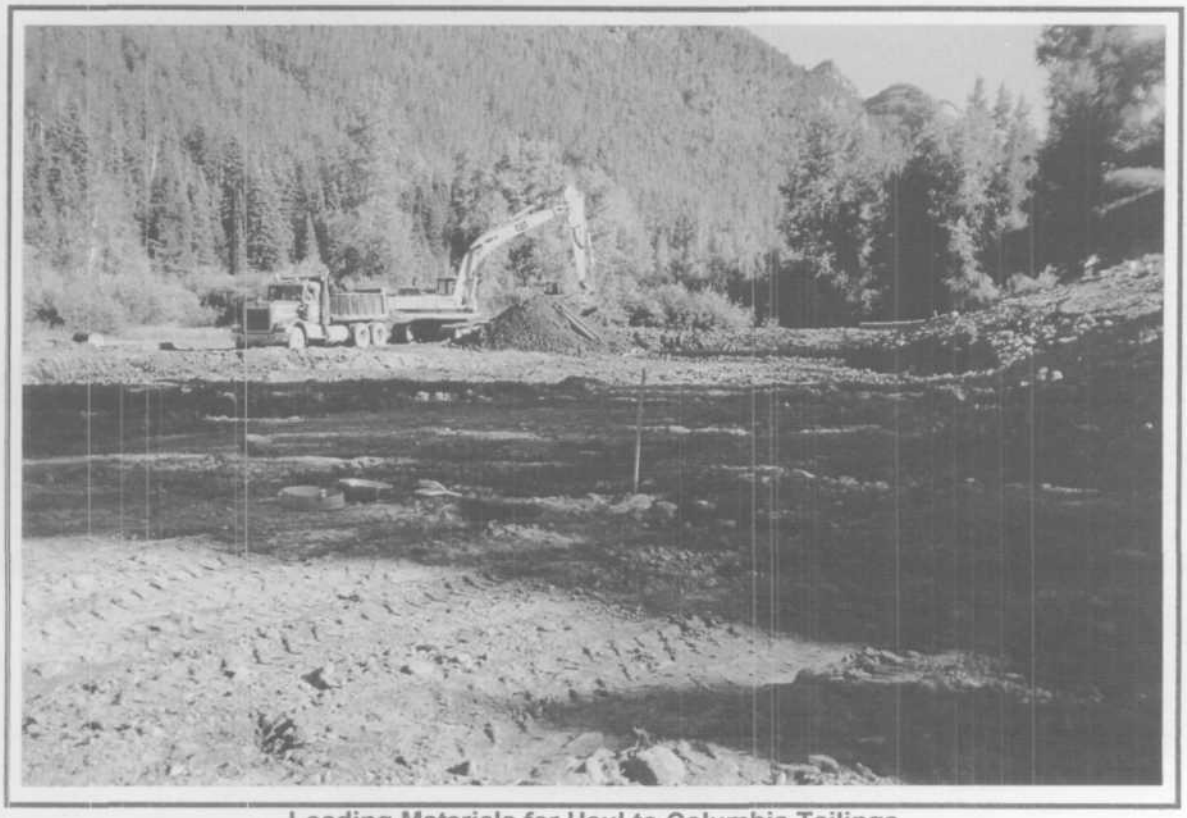


Excavation for Run-on Ditch - East Side of Columbia Tailings

Hauling and Placing Mine Waste at Columbia Tailings

Construction of Visitor's Center

**Trackhoe Removing Tailings**



**Loading Materials for Haul to Columbia Tailings**

Shamrock Material being Loaded for Haul to Columbia

Shamrock after Soil Cover Placement

# 4.0 Silver Swan Mine Area

## 4.1 General

The Silver Swan Mine adit and waste rock piles are located along the Dolores River about ½ mile south of Rico. Pyrite and galena bearing materials are present in the mine waste rock piles that surround the mine adit. Water from the Silver Swan Mine adit was partly seeping through the mine dump and discharging into the Dolores River.

## 4.2 Permit

The VCRA application dated February 13, 1996 and supplemental information to the application dated March 19, 1996 were approved by the CDPHE on March 20, 1996. The CDPHE approval stated that the VCUP would meet a degree of cleanup and control of hazardous substances such that the property does not present an unacceptable risk to human health or the environment based on the property's proposed use as an open space. The approved VCUP remedial design for the Silver Swan Mine Site involves shaping of waste rock outslopes to control erosion, consolidation of waste rock materials, removal of waste rock from the active river channel, grade the Site to route offsite surface water around the wastes for runon control, and surface adjustments and compaction to shed rainfall and snowmelt from the wastes piles to control erosion and limit infiltration. The VCUP also calls for providing erosion protection through revegetation and rock covers. The existing adit discharge will be intercepted in an excavated lined trench in the adit area and routed through existing wetlands systems for passive treatment.

## 4.3 Geohazards

As expected in the VCUP application, no substantive engineering geologic or geotechnical issues were encountered associated with the work to implement the remedial design for the Silver Swan Mine. No slope failure problems were experienced during the materials movement and waste pile grading and contouring. Dikes constructed across wetland area did possess saturated weak foundation conditions, however, soil was placed until the wet area materials were displaced and a firm working surface was obtained. River flows did not constitute any excavation problems above those expected.

## 4.4 Site Access

Access to the Silver Swan was by existing roads and by a Ford type crossing over the Dolores River. Two 24" diameter CMP and six 8" diameter CMP culverts were used to pass the river's flow and an access road was built of soil over the culverts for heavy equipment access. This road and crossing were kept to the minimum safe size to reduce local disturbance. The existing roads were improved for heavy equipment access to the work areas. All roads were maintained and left in as good or better condition than existed prior to their use on this project. The Ford crossing was removed and the area returned to its pre-crossing condition. The access to the Site was completed in compliance with the COE 404 permit notification, Colorado Stormwater and USFS Road Use and Special Use Permits.

## 4.5 Construction Site Controls

Controls were implemented during construction to address requirements of applicable federal, state or local permits, codes or regulations. The construction contractor was responsible for supplying a pre-excavation Construction Plan for ARCO's approval prior to commencing work operation. Work was completed to comply with COE requirements for wetlands and State of Colorado Discharge Permit System Stormwater. All construction and specifications employed appropriate Best Management Practices to protect the Dolores River from sedimentation during remedial activities. The Dolores River banks were armored as needed for control of erosional losses during fording of the river. Temporary berms to control runoff to the Dolores River were constructed in work areas. Silt fencing and hay bales were used as barriers to sediment migration into the Dolores River during excavation activities. Also, construction activities were conducted in a manner to preserve existing vegetation buffers in the work areas in compliance with the Stormwater Management Plan. Runoff water was retained from disturbed areas prior to allowing discharge into the Dolores River. Strict precautions to avoid dust and excavation spillage during operations were followed by the use of water spray and control of load heaping on haul units.

The onsite construction activities were conducted in strict compliance with the Site Specific Safety and Health Plan, the Site Pre-Excavation Construction Plan and applicable permits for the work area or access roads.

## 4.6 Hydraulic Controls

### 4.6.1 Runon

The runon generated from rainfall or snowmelt up gradient of the Site is directed away from the Silver Swan Mine's reclaimed areas by a 250 linear foot lined runon ditch. The runon ditch was excavated into the reconfigured waste pile along the western boundary of the Site. The ditch is constructed of a combination of half pipe and open trapezoidal channel that is lined. The open channel liner consists of 6 inches of riprap, 6 inches of riprap bedding, textured liner (HDPE), and 6 inches of liner bedding. The ditch middle reach was constructed with 18" diameter half pipe 16 gauge CMP. The CMP was anchored by 2" x 2" x 1/4" angle iron driven into the ground and welded to the CMP.

The adit interception channel was constructed using a "v" notch design and lined with 12 inches of bedding with an intermediate textured liner. A 6 inch cap of Type B riprap was placed as the uppermost layer within the channel. This channel serves as a drainage for adit water and also directs runon from the west away from the consolidated waste rock pile into the existing wetlands. Figure 4-1 shows the locations of the runon ditch. A 60 ft. length of 12" CMP drains the adit discharge under the access road.

### 4.6.2 Runoff

The top surface of the consolidated waste rock has been shaped to drain precipitation and not retain runoff on the pile surface. The surface grade is generally to the south at 3%. A portion of the runoff will be captured by the runon ditch on the west side of the Site and directed to the Dolores River. The runon and runoff ditches are sized such that peak flows for a 100 year precipitation event are drained from the Site.

### 4.6.3 Infiltration

Infiltration of water into the waste rock pile at the Silver Swan Mine is controlled by rerouting of adit discharge away from the reclaimed pile, reducing the surface area of the pile itself, regrading of the waste rock pile to not pond water and compaction of the waste rock top surface.

The constructed adit drainage interception channel transfers drainage away from the pile and into the adjacent existing wetlands area. The channel is constructed as described in Section 4.6.1. The rerouting of the drainage away from the waste rock pile has eliminated the infiltration of mine water into the waste rock.

The surface area of the waste pile has been reduced by 60% and therefore reduces the infiltration surface available. The waste rock was consolidated by relocation into the main pile of material from the Dolores River bank and along the east side of the pile.

Below the placed growth medium, 12 inches of the Silver Swan waste rock pile top surface were compacted to aid in prohibiting infiltration. With the material types encountered in the waste dumps the density that was achieved by this compaction will reduce the hydraulic conductivity. The results of compaction testing conducted on the Silver Swan Mine reconfigured surface are summarized in Section 4.11.

### 4.6.4 Drainage Stabilization

Waste rock material was removed from the bank of the Dolores River. This removal extended for the length of the waste pile, approximately 440 feet and was 50 feet wide on average. The removal of waste rock cleared this material from contact with the Dolores River during peak spring runoff and for flows up to the 500 year return event flood level. Flood erosion protection revetment was placed on the reconfigured outslope adjacent to the Dolores River. The revetment consisted of Type A riprap placed 24 ft. deep over a 0.5 ft. thick Type E bedding over 0.5 ft. of Type E bedding. This removal was in compliance with ARCO's Army Corps of Engineers Nation Wide Permit 38 Notification, the Colorado Stormwater Permit and the VCUP.

## 4.7 Waste Materials

### 4.7.1 Consolidation

The waste rock material at the Silver Swan Mine extended around the Site and down into the Dolores River. A total of 1.8 acres were originally occupied by the waste rock piles. In order to achieve the VCUP goals of controlled infiltration, runoff and runon control and stabilization of the

drainage in this area the pile was reshaped and waste rock consolidated onto the main pile.

Waste rock was removed in layers of about 12 inches in thickness. Following removal, confirmatory sampling was conducted to detect if all tailings material had been removed. This process was repeated until confirmation sampling showed that no additional material removal was required.

Verification of waste rock removal was accomplished by collecting confirmatory samples of the underlying alluvium. Waste rock excavation was considered completed, as defined in the VCUP, when the Zinc content fell within or below the range of local natural bedrock and surficial materials. This range is 200 to 4720 ppm Zinc. The sampling of the removal areas confirms that the majority of tailings was excavated from the areas of concern. Sampling results and summaries for the Silver Swan removal are contained in Section 4.11.

The relocated waste rock was placed in lifts not exceeding 12 inches in depth. The compaction effort was accomplished by placement equipment making a minimum of one pass over the entire surface of each 12 inch lift. Tailings placed in the upper 12 inches of the top surface, but below the lime amended area, were compacted as described later in this report.

### 4.7.2 Surface Shaping and Slopes

The top surface of the consolidated waste rock pile drains to the south at 3%. The pile has been reconfigured with surrounding outslopes. Although the outslopes vary in length from 20 ft. to 70 ft., all are constructed to a 3h:1v geometry. The reconfigured Silver Swan waste rock pile is graded to a tolerance of $\pm$ 0.3 ft. of construction drawings and free of irregularities. Figure 4-1 shows the preexisting conditions, VCUP configuration and the as built conditions of the Silver Swan waste pile.

## 4.8 Erosion Protection

### 4.8.1 Growth Medium

Over the compacted one foot of waste rock is a 12 inch layer of uncompacted lime amended waste rock and 12 inches of soil cover to provide a suitable

growth medium approximately 2 feet deep. Agricultural lime ($CaCO_3$) was applied at a rate of 25 tons/acre to the upper 12 inches of waste rock. The lime was spread evenly over the Site by mechanical methods and then incorporated. Multiple tillage passes were made to insure complete mixing of the lime into the material seed bed. The liming process was accomplished immediately following waste pile shaping to provide the greatest reaction time prior to revegetation.

Borrow soil used for plant growth was tested and identified prior to excavation. The borrow soil was obtained from the St. Louis borrow area about two miles from the Silver Swan Mine. The soil was transported by truck to the Silver Swan Mine and placed. This soil was placed on the top surface and slopes, and covers the entire areal extent of the regraded waste pile. Soil cover was also placed over the waste removal areas. Table 4.1 describes the soil cover application at the Silver Swan Mine. The traffic over the soil was kept to a minimum to avoid unnecessary compaction of the seed bed. The finished grade for the soil growth medium is $\pm$ 0.3 ft. of design and does not contain irregularities.

**Table 4.1**
**Silver Swan**
**Agricultural Lime and Cover Material Application Rates**

| SITE | LIME APPLICATION RATE FOR WASTE ROCK | SOIL COVER APPLICATION RATE |
|---|---|---|
| Silver Swan East | | |
| Removal area on east river bank. | No lime. | Area of coarse gravel and cobble - covered with 3" - 6". Slope from R.R. grade to flat area - covered with 3" - 6". |
| Silver Swan West | | |
| Main Pile | 25 tons/acre (.14" thick) Amended 12" deep. | 12" of processed borrow soil (-3/4"). |
| Removal area to north of main pile. (Currently cobbles and coarse gravel). | No lime. | 3"- 6" of processed borrow soil (-3/4"). |
| Waste rock area between north toe (of main pile) and wetlands dike. | 25 tons/acre (.14" thick) Amended 12" deep. | 12" soil: 6" of unprocessed borrow and 6" of processed borrow soil. |

### 4.8.2 Revegetation

All seed was applied using hydroseeding methods due to wet surface conditions and time constraints. Table 4.2 contains the seed mixtures and application rates. The hydroseeding and fertilization sequence of activity completed is as shown on Table 4.3. Mulch was also spread by hydro application methods and held in place by tacking agents.

## Table 4.2
## Seed Mixtures and Application Rates

| Type A (1) General Seed Mixture | | | |
|---|---|---|---|
| **Species** | **Preferred Variety(s)** | **Rate (lbs./acre) Planted (broadcast)** | **PLS (seeded/acre)** |
| Big bluegrass<br>Poa ampla | Sherman | 0.50 | 458,500 |
| Mountain brome<br>Bromus carinatus | Bromar | 8.00 | 496,000 |
| Slender wheatgrass<br>Agropyron trachycaulum | Primar, San Luis | 3.00 | 480,000 |
| Streambank wheatgrass<br>Agropyron riparium | Sodar | 3.00 | 480,000 |
| Birdsfoot trefoil<br>Lotus corniculatus | Empire | 1.00 | 410,000 |
| Lewis flax<br>Linum lewisii | Apar | 2.00 | 570,000 |
| Rocky Mountain penstemon<br>Penstemon strictus | Bandera | 1.00 | 592,000 |
| Cicer milkvetch<br>Astragalus cicer | Lutana, Monarch | 1.50 | 290,000 |
| | **Totals** | **20.00** | **3,776,500 (approx. 87 seeds per square foot)** |

(1) Type A applied on entire surface of consolidated waste rock pile and west sideslope of railroad grade at east waste rock removal area.

**Type B (2)**
**Sideslope Stabilization Mixture**

| Species | Preferred Variety(s) | Rate (lbs./acre) Planted (broadcast) | PLS (seeded/acre) |
|---|---|---|---|
| Big bluegrass<br>Poa ampla | Park | 0.50 | 1,100,000 |
| Mountain brome<br>Bromus carinatus | Bromar | 15.00 | 975,000 |
| Slender wheatgrass<br>Agropyron trachycaulum | Primar, San Luis | 6.00 | 960,000 |
| Streambank wheatgrass<br>Agropyron riparium | Sodar | 6.00 | 960,000 |
| Cicer milkvetch<br>Astragalus cicer | Lutana, Monarch | 1.50 | 290,000 |
| | **Totals** | **29.00** | **4,285,000 (approx. 98 seeds per square foot)** |

**Type D (3)**
**(Wetland Planting Mixture)**

| Species | Preferred Variety(s) | Rate (lbs./acre) Planted (broadcast) | PLS (seeded/acre) |
|---|---|---|---|
| Redtop (FACW)<br>Agrostis alba | Any | 0.50 | 2,495,000 |
| Red fescue (FAC)<br>Festuca rubra | Any | 3.00 | 1,845,000 |
| Tall (Kentucky) fescue (FACW-)<br>Festuca arundinaceae | Any | 5.00 | 1,135,000 |
| | **Totals** | **8.25** | **5,475,000 (approx. 126 seeds per square foot)** |

(2) Type B applied on hillside slope along runon/runoff ditch.
(3) Type D applied on all removal areas and area disturbed to access wetland dike construction area.

**Table 4.3**
**Silver Swan Mine Area**
**Revegetation Sequence**

| Item | Seed Bed Preparation | Fertilizer | Seed | Mulch |
|---|---|---|---|---|
| **Period** | Prior to fertilization and seeding. | Concurrent with seeding. | After September 30th, immediately following final seed bed preparation. | Immediately following seeding. |
| **Method** | Mechanical scarification of soil. | Combined with hydroseeding, liquid fertilizer mixture. | Hydroseeding on all areas. | Hydromulch - 1500 lbs./acre, all slopes.<br>Slurry pH> 3.5. |
| **Equipment** | Disc or rippers pulled by tractor. | Mobile hydroseeding equipment. | Mobile hydroseeding with spray and tank equipment. | |
| **Discing/Raking** | Disc or rip to 12 inch depth maximum. | | | May disc to crimp hay/straw mulch. |
| **Other** | Insure adequate seed bed without hard surface resistant to seed placement. | Nutrient application applies to all sites:<br><br>Nitrogen (lb./acre) 40<br>Phosphate (lb./acre) 60<br>Potash (lb./acre) 40 | Seed depth = 1/4" to 1/2"<br>Spacing = 6"<br><br>Type<br>A General seed mix (<3:1)<br>B Side slope mix (>3:1)<br>D Wetland mix | Purpose: twofold:<br>1. Conserve water<br>2. Deter erosion |

### 4.8.3 Riprap

Rock erosion protection was placed in areas where runoff, runon and drainage way flows were considered to be highly erosive. Riprap design gradations types, rock covers and bedding are shown on Table 4.4 by Type.

**Table 4.4**
**Riprap, Rock Covers and Bedding**

| | | Percent Passing | | | | | |
|---|---|---|---|---|---|---|---|
| **Type** | **Description** | **100** | **85** | **50** | **30** | **15** | **0** |
| A | Riprap | 1.7-2.4' | - | 1.4'-1.6' | 1.2' | 0.9' | 0.8' |
| B | Riprap | Larger Rock Material Generated By Borrow Processing | | | | | |
| C | Riprap | 0.9-1.2' | - | 0.7-0.8' | 0.6' | 0.5-0.65' | 0.4 |
| D | Riprap/Bedding | 3.0-8.0" | 3.0-6.0" | - | - | 0.75"-1.5" | 0"-0.5" |
| E | Filter Material | 2.0" | 0.5-1.5" | - | - | 0.5-0.65mm | 0.6mm |

A riprap revetment was placed and buried along the toe of the east slope of the waste rock pile. The revetment was placed to protect the reclaimed waste pile from erosion scour resulting from a Dolores River 500-year return peak event flood stage. A 2 ft. freeboard was also added to the top elevation of the revetment. Figure 4-1 shows the flood protection revetment location at the Silver Swan Mine. The revetment consists of 6 inches of Type D bedding, 6 inches of Type E bedding and a 2.4 ft. thick layer of Type A riprap.

The locations of the runon and runoff ditches with erosion protection riprap are also shown in plan view on Figure 4-1. These ditches contain bedding, 60 mil HDPE textured liner and riprap to handle flows resulting from a 100 year precipitation event. These designs are discussed in detail under Section 4.6.

## 4.9 Passive Treatment of Mine Drainage

Mine discharge from the Silver Swan adit is directed through a ditch from the mine opening to the wetlands passive treatment area. The flow of mine adit discharge water will continue over soil types used for passive wetland treatment. Only minor modifications were made to the existing wetland system were made. A dike

approximately 4 ft. in height and 5 ft. wide (top) was built to the northeast of the existing pond to provide sufficient retention capacity for settling of precipitates from the mine discharge. Bentonite was placed on the inside toe of the dike to prevent seepage between the floor of the pond and the toe of the dike.

The wetlands ponded water was isolated from the waste rock pile by relocating the waste material from the flowpath of the wetlands discharge, eliminating the adit flow into the waste rock. The one acre retention area pond was enclosed by the dike. A riprap lined spillway was contracted to regulate flow out of the pond. The dike is about 140 ft. in length and was constructed of unprocessed borrow material over the wetlands floor. An overflow spillway was constructed to allow water to pass from the retention area to the existing wetlands. A 1.2 ft. thick Type C riprap layer was placed in the overflow over 6 inches of Type D bedding and 6 inches of Type E. Figure 4-1 shows the location of the wetlands and dike.

The wetlands layout provides for an aerobic treatment step in an up gradient pond to enable oxidation precipitation of dissolved iron and to serve as a sludge storage area. The assumptions, calculations, and further description of the wetlands passive treatment is contained in the Silver Swan VCRA application submitted in February 1996.

## 4.10 Quantity Summary

The quantities moved for remedial action for the Silver Swan Mine area involved nine categories of materials. The total volume of material moved was 3,863 cubic yards.

**Table 4.5**
**Silver Swan Mine Area**
**Relocated Materials, Riprap and Bedding**

| Activity | Material Type | Units | Quantities |
|---|---|---|---|
| Relocated Waste Rock | *** | CY | 1,100 |
| Riprap | A | CY | 608 |
| Riprap | B | CY | 63 |
| Riprap | C | CY | 15 |
| Riprap Bedding | D | CY | 133 |
| Riprap Bedding | E | CY | 133 |
| Plant Growth Medium | | CY | 2,700 |
| Textured Liner | | $Yd.^2$ | 284 |
| Soil Amendment | Agricultural Lime | Tons | 102 |

## 4.11 Soil Testing Summary

### 4.11.1 Geotechnical Testing

Field soil density testing was conducted to determine compliance with the technical specifications of the construction contract. The technical specifications relating to compaction were selected to achieve various engineering objectives relating to infiltration and enhancing stability in fill materials. The applicable technical specifications required that the upper 12 inches of the waste piles below the amended material be of a compactable gradation, and attain 95% of Standard Proctor maximum dry density (or 90% of maximum Providence index density for soils with little or no fines). Table 4.6 summarizes the field soil moisture/density tests conducted for the Argentine Tailings. Nuclear density gauges were used to obtain in-place densities for comparison to laboratory generated Proctor or Providence mold laboratory density tests as appropriate for a given soil. Where moisture/density tests were deficient, footnotes in Table 4.6 indicates the action taken by the field engineer, e.g. - recompaction of the affected area or in cases where additional compaction or replacement of fill materials would

not have provided any additional benefits to the long-term performance of the fill with respect to design objectives, no action was directed. Laboratory and field tests were performed and results approved by ARCO. Tests were conducted according to the following standards:

| ASTM Method | Description: |
|---|---|
| Field Tests: | |
| D-2922 | Density of Soil and Soil-Aggregate in Place by Nuclear Methods |
| Laboratory Tests: | |
| D-422 | Sieve Analysis |
| D-698 | Moisture Density Relationships (5.5 lb. hammer) |
| D-4253 | Modified Providence Moisture Density Relationships |

Table 4.6 summarizes the results of field tests.

**Table 4.6**
**Silver Swan Mine**
**Field Soil Testing Summary**

| Date | Test No. | Location | Density | Moisture | Proctor No. | Maximum Density | Optimum Moisture | Percent Compaction | Notes | % Compaction Required | Percent +\- Moisture |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 22-Aug-96 | SS-NU-01 | Wetlands Dike | 114.6 | 16.6% | Estimate | 125 | *** | 92% | | 90% | |
| " | SS-NU-02 | | 99.4 | 17.9% | " | 125 | *** | 80% | (1) | 90% | |
| " | SS-NU-03 | | 99.4 | 16.5% | " | 125 | *** | 80% | (1) | 90% | |
| " | SS-NU-04 | | 108.4 | 18.6% | " | 125 | *** | 87% | (1) | 90% | |
| " | SS-NU-05 | | 109.9 | 17.2% | " | 125 | *** | 88% | (1) | 90% | |
| " | SS-NU-06 | | 110.3 | 16.8% | " | 125 | *** | 88% | (1) | 90% | |
| 5-Sep-96 | SS-NU-07 | Main Pile | 108.2 | 13.1% | EF-09-MP-01 | 128 | *** | 85% | (2) | 90% | |
| " | SS-NU-08 | Pre-Amendment | 113.9 | 12.5% | " | 128 | *** | 89% | (2) | 90% | |
| " | SS-NU-09 | | 125.2 | 15.5% | " | 128 | *** | 98% | | 90% | |
| " | SS-NU-10 | | 121.0 | 11.3% | " | 128 | *** | 95% | | 90% | |
| " | SS-NU-11 | | 124.8 | 10.1% | " | 128 | *** | 98% | | 90% | |
| " | SS-NU-12 | | 112.8 | 12.1% | " | 128 | *** | 88% | (2) | 90% | |
| " | SS-NU-13 | | 119.8 | 12.9% | " | 128 | *** | 94% | | 90% | |
| 12-Sep-96 | SS-NU-14 | Runon- | 106.3 | 13.8% | EF-10-SP-01 | 129 | 12% | 82% | (3) | 90% | 1.8% |
| " | SS-NU-15 | Runoff Ditch | 98.1 | 15.4% | " | 129 | 12% | 76% | (3) | 90% | 3.4% |
| " | SS-NU-16 | Liner Bedding | 102.9 | 14.8% | " | 129 | 12% | 80% | (3) | 90% | 2.8% |
| " | SS-NU-17 | | 107.4 | 15.6% | " | 129 | 12% | 83% | (3) | 90% | 3.6% |
| 16-Sep-96 | SS-NU-18 | Runon ditch | 103.6 | 12.9% | EF-10-SP-01 | 129 | 12% | 80% | (3) | 90% | 0.9% |
| 16-Sep-96 | SS-NU-19 | Pipe Bedding | 108.9 | 14.9% | " | 129 | 12% | 84% | (3) | 90% | 2.9% |

*** Modified Providence Tests and estimated maximum densities did not generate an optimum moisture.

(1.) Low densities were the result of saturated materials procured from the Cayton Campground borrow area. Subgrade was reworked and additional compaction effort was completed.

(2.) Contractor provided additional compaction effort in this area after nuclear gauge testing. This effort was considered sufficient.

(3.) Low densities were the result of saturated materials procured from the St. Louis borrow area. Subgrade was reworked and additional compaction effort was completed.

* Soil testing provided by ESA, Inc., Fort Collins, CO.

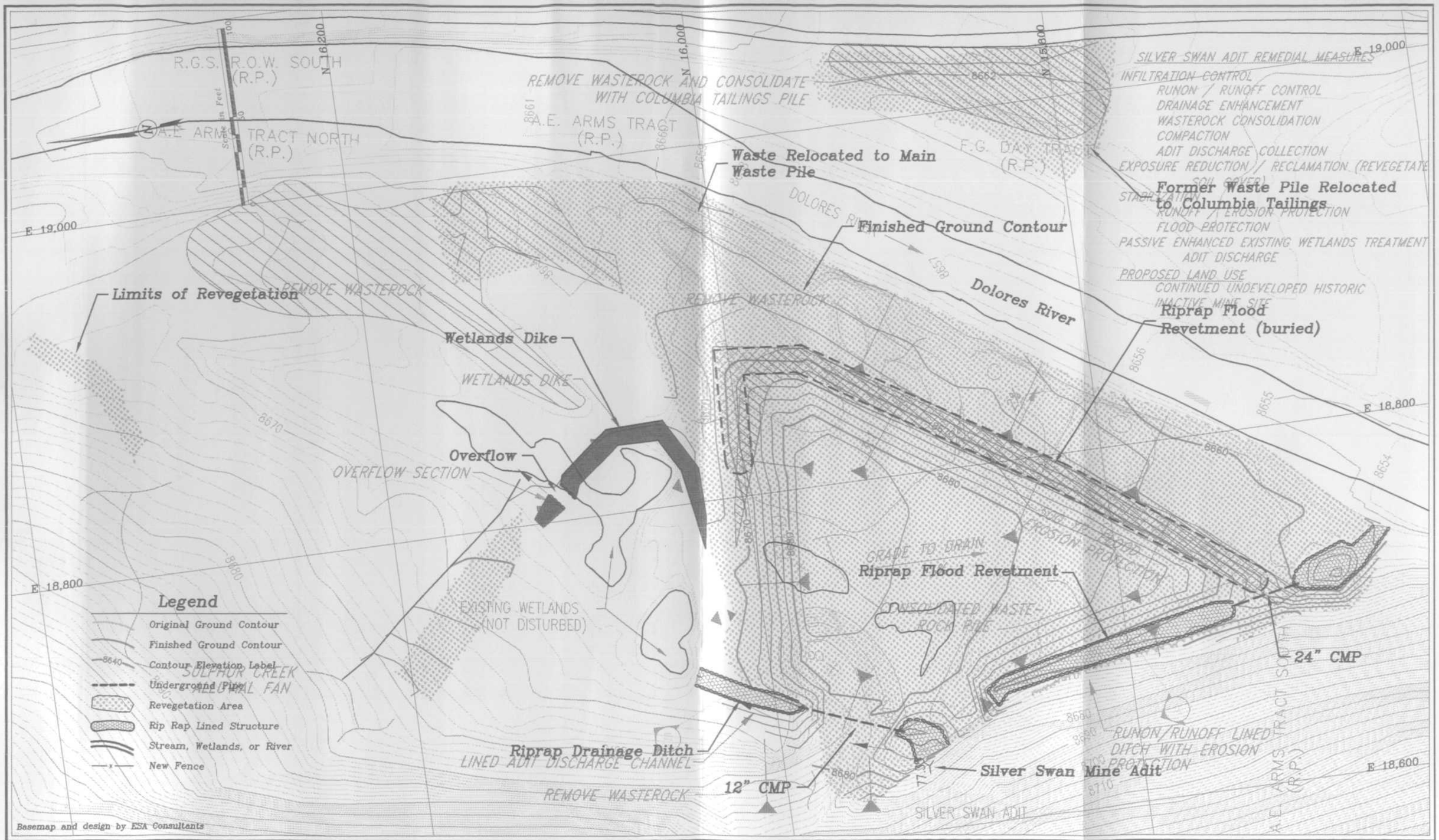
### 4.11.2 Confirmatory Testing

Confirmatory testing was performed at each location where specific removal of mine waste rock or mill tailings was specified in the Voluntary Cleanup Plan (VCUP). Based on soil investigations within and surrounding the Town of Rico, Zinc levels range from 200 to 4720 ppm. The cleanup level was set at a maximum of 4720 ppm for testing of subgrade after the removal of materials. Sample results above the limit resulted in further removal and sampling. Table 4.7 summarizes the confirmatory sampling results. Final samples indicate the cleanup was successful. The comprehensive report of confirmatory testing on the Rico Project is contained in the Appendix.

**Table 4.7**
**Silver Swan Mine Area**
**Confirmatory Testing**

| Removal Site | Sample ID | Zinc (ppm) | Sample Type |
|---|---|---|---|
| Silver Swan east bank | EX-SSE-01 | 2,030 | Composite |
| Silver Swan west bank | EX-SSW-01 | 788 | Composite |
| Silver Swan west bank | EX-SSW-02 | 1,640 | Composite |

## 4.12 As Built Drawings

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| NO. | REVISION/DESCRIPTION | DATE |
|---|---|---|
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| | |
|---|---|
| DRAWN BY: | R. TATE |
| CHECKED BY: | S. ANDERSON |
| CLIENT CONTACT: | R. ELLIOTT |
| SCALE: | 1" = 50' |
| OTHER REFS: | . |

# SILVER SWAN MINE AREA FINAL CONFIGURATION PLAN VIEW

References: ss-econt.dwg, ssconcep.dwg

FIG. 4-1

File: SLVRSWN.DWG view (plan)

## 4.13 Photographs

Dozer and Trackhoe Reconfiguring Mine Waste

Reconfigured Waste Pile with Wetlands Dike in Foreground

# 5.0 Santa Cruz Mine Area

## 5.1 General

The Santa Cruz Mine Area and adit are located on the west side of the Dolores River south of Rico, Colorado. The Santa Cruz, Iron Clad and Rico Boy Mines are all former underground operations. This Site occupies approximately five acres and consists of mine openings, waste rock piles and some scattered debris. The Site is adjacent to a wetland area associated with the Dolores River.

The Site is made up of waste rock piles produced from the mines. Debris associated with the former mining activity and several buildings exist in the northern position of the Site. The southwestern portion of the waste rock was placed against the nearby hillside slope. Mine water from the Santa Cruz, Iron Clad and Rico Boy adits and was flowing on the surface onto the nearby waste materials and eventually into the adjacent wetlands.

## 5.2 Permit

The VCRA application dated March 8, 1996 and supplements to the application dated April 16, 1996 were approved by the CDPHE on April 19, 1996. The CDPHE approval stated that the VCUP would meet a degree of clean up and control of hazardous substances such that the property does not present an unacceptable risk to human health and the environment based on the property's proposed use as an open space. The approved VCUP remedial design for the Santa Cruz Mine Area involves reconfiguring the existing waste pile, relocation of wastes for stabilization along the Dolores River construction runon and runoff control features, and compaction and treatment of waste materials to reduce infiltration. Erosion protection of the Site is addressed in the VCUP by providing a reclamation cover consisting of plant growth medium with amendments and seeding. The adit discharge waters are to be captured and directed through the mine area by a lined interception ditch. A wetlands dike was constructed to enhance the existing system for passive treatment of discharge waters.

## 5.3 Geohazards

As expected in the VCUP application, no substantive engineering geologic or geotechnical issues were encountered during the work to implement the remedial design for the Santa Cruz Mine. No slope failure problems were experienced during the materials movement and waste pile grading and contouring. The dikes

constructed across the wetlands area did possess saturated weak foundation conditions, however, soil was placed until the wet area materials were displaced and a firm working surface was obtained. The Dolores River flows did not constitute any excavation problems above those expected.

## 5.4 Site Access

Access to the Santa Cruz was by existing roads that pass through west Rico. An existing USFS bridge was used to access the Site with light equipment and service vehicles. A Road Use Permit and a Special Use Permit were obtained from the USFS and upgrades were made to the bridge during usage. Both approaches to the bridge were paved. Roads used for access were maintained and left in as good or better condition than existed prior to their use on this project. Road access use information was recorded and maintained as required by the USFS permits.

## 5.5 Construction Site Controls

Controls were implemented during construction to address requirements of applicable federal, state or local permits, codes or regulations. Work was completed to comply with COE notice requirements for wetlands and State of Colorado Discharge Permit System for Stormwater. The beaver pond on the east side of the main pile was drained prior to construction in compliance with Colorado Discharge Permit System Minimal Discharge Permit. All construction work and specifications employed appropriate Best Management Practices to protect the Dolores River and wetlands from sedimentation during remedial activities. The Dolores River banks were protected as needed for control of erosional losses during work near the Dolores River. Silt fencing and hay bales were used as barriers to sediment migration to the Dolores River during excavation activities. Sediment traps and ponds existing in the area were used to also control sediment movement. Also, construction activities were conducted in a manner to preserve existing vegetation buffers in the work area in compliance with the Stormwater Management Plan.

Water was retained from disturbed areas prior to allowing discharge into the Dolores River. Strict precautions to avoid dust and excavation spillage during operations were followed by the use of water spray and control of load heaping on haul units.

The onsite construction activities were conducted in strict compliance with the Site Specific Safety and Health Plan and the Site Pre-Excavation Construction Plan.

## 5.6 Hydraulic Controls

### 5.6.1 Runon

Runon controls include the installation of a lined ditch about 200 ft. long to intercept upgradient rainfall runoff and snowmelt. The lined ditches, drop structures, and energy dissipation features have been placed to direct expected flows away from the reshaped waste rock pile. The runon interception ditch was constructed between the reconfigured waste pile and the natural hillside west of the mine area. The alignment of the runon ditch is shown in Figure 5-1. The runon ditch is constructed of a combination of corrugated metal half pipe, a riprap lined stilling basin and a full pipe beneath the relocated access road. The main portion of the runon ditch is lined with 18 inch diameter, 16 gauge CMP half pipe. The CMP was anchored by 2" x 2" x 1/4" angle iron set into the graded fill. The grade of the ditch is about 33% and spills into a riprap stilling basin composed of 2 ft. of Type A riprap over 6 inches of Type D and 6 inches of Type E riprap. The stilling basin is drained under the relocated access road by a 15 inch diameter reinforced concrete pile for a distance of approximately 30 feet. Type C riprap was placed 4 feet on each side of the ditch at the end of the drainage. Water is retained in the bermed area of the wetlands to allow for settling. An overflow spillway was constructed to allow water to pass from the retention area to the existing wetlands along the Dolores River corridor. The overflow is constructed of 2.4 ft. of Type A riprap, underlayed by 6 inches of Type D and 6 inches of Type E bedding.

Some runon will be captured by the adit interception ditch that drains the Rico Boy and Santa Cruz adit from the hill area to the west. The construction of the adit interception ditch consists of an open "v" notch design channel with 12 inches of soil bedding with an intermediate textured liner. A 6 inch layer of Type B riprap was placed as the uppermost portion within the ditch. The adit interception ditch drains from north to south and passes along the toe of the reshaped waste rock pile. Runon resulting from the west enters the adit interception ditch and is directed into the existing wetlands.

### 5.6.2 Runoff

The surface of the consolidated waste rock has been contoured and graded to drain precipitation and not retain runoff on the pile surface. The waste rock reconfiguration blends into the adjacent land form. The outslopes of the

waste rock have been graded to 3h:1v. The slope configuration and adit interception ditch convey runoff flows away from the Site in a controlled manner. The adit interception ditch drains runoff from the mine waste pile area at between 1% and 8% within a riprap lined channel. Figure 5-1 depicts the runoff patterns and runoff ditch locations and spillway areas.

### 5.6.3 Infiltration

Infiltration of water into the waste rock pile at the Santa Cruz Mine is controlled by rerouting of adit discharge away from the reclaimed pile, reducing the surface area of the pile itself, regrading of the waste rock pile to not pond water and compaction of the waste rock top surface. A new access road embankment was constructed of clean fill installed along the east toe of the consolidated waste rock pile to prevent direct contact of the wetland surface water with waste rock.

The discharge from the Santa Cruz adit and the Rico Boy adit is estimated at an average 60 gpm from the mine openings. This discharge is collected by a constructed adit interception channel that transfers the discharge waters away from the waste pile and into the adjacent existing wetlands. The channel is constructed as described in Section 5.6.1. The rerouting of the discharge away from the waste rock pile will be of significant impact for reducing infiltration of mine water. The adit discharge to the waste rock in the mine area has been directly eliminated.

The surface area of the waste rock pile has been reduced by 73% and thereby reducing the infiltration surface available. The waste rock was consolidated by removal of mining waste rock from the area directly east of the mine adits. This material occupied about 1.6 acres and was placed on the main mining waste pile existing south of the adits. This reduction in surface area will decrease the total infiltration from snowmelt and direct rainfall into the waste rock. The surface of the consolidated waste was contoured to drain precipitation occurring on the waste pile and avoid impeding flow and retention and ponding of water on the reconfigured pile.

The upper 12 inches of top surface and 3h:1v outslopes of the Santa Cruz waste rock pile were compacted prior to placement of growth medium. The compaction of this material will aid in prohibiting infiltration into the waste pile. With the material types encountered in the waste dumps, the density that is achieved by this compaction will reduce the hydraulic conductivity at

the surface of the waste pile. Moisture was controlled to ± 2 % during the compactive effort.

The results of compaction testing conducted on the Santa Cruz Mine reconfigured surface are summarized in Section 5.11.1.

### 5.6.4 Drainage Stabilization

Approximately 5,200 cubic yards of mine waste rock material were removed from the Dolores River corridor area near the mine. This removal extended for the length of the waste pile, approximately 500 feet and was 100 feet wide on average. The removal of waste rock cleared this material from contact with the Dolores River during peak flood stage resulting from 100 year flood events. The removal of this material was in compliance with ARCO's Army Corps of Engineers Nationwide Permit No. 38 Notification, the Colorado Stormwater Permit in addition to the VCUP. The removal of this waste creates an added 0.6 acres of area available for wetlands adjacent to the reclaimed mine area. Figure 5-1 is a plan view of the completed work and shows the newly created surface in the drainage area.

## 5.7 Waste Materials

### 5.7.1 Consolidation

The waste rock material at the Santa Cruz Mine extended around the Site and down into the Dolores River wetlands area. A total of 2.2 acres were occupied by the existing waste rock piles and reduced by 0.6 acres after consolidation activities. In order to achieve the VCUP goals of controlled infiltration, runoff and runon control and stabilization of the drainage in this area the pile was reshaped and the waste rock consolidated. Approximately 5,200 cubic yards of waste rock was relocated and shaped to meet the lines and grades required by the VCUP. This work was accomplished using bulldozers, wheel loaders and highway type haul trucks. The removal location of the waste rock and final graded surface of the removal areas are shown on Figure 5-1.

Waste rock was removed in layers of about 12 inches in thickness. Following removal, confirmatory sampling was conducted to detect if all waste material had been removed. This process was repeated until

conformation sampling showed that no additional material removal was required.

Verification of waste rock removal was accomplished by collecting confirmatory samples of the underlying Dolores River alluvium. Waste rock excavation was considered completed, as defined in the VCUP, when the Zinc content of underlying soils within fell within or below the range of local natural bedrock and surficial materials. This range is 200 to 4720 ppm Zinc. The sampling of the removal areas confirms that the majority of waste rock was excavated from the areas of concern. Sampling results and summaries are contained in Section 5.11.

The relocated waste rock was placed onto the main pile in lifts not exceeding 12 inches in depth and compacted. The compactive effort was accomplished by placement equipment making a minimum of one pass over the entire surface of each 12 inch lift.

### 5.7.2 Surface Shaping and Slopes

The small area of top surface on the consolidated waste rock pile drains to the south at 3%. The pile has been reconfigured for drainage erosion control and to blend adjacent land forms. The outslopes vary in length from about 50 ft. to 140 ft., all are constructed to a 3h:1v geometry. The reconfigured Santa Cruz waste rock pile is graded to a tolerance of $\pm$ 0.3 ft. of construction drawings and free of irregularities. Surface shaping was accomplished using the same type of heavy equipment as the waste rock consolidation. Figure 5-1 shows the pre-existing conditions, VCUP configuration and the as built conditions of the Santa Cruz Mine waste rock pile. One foot of unprocessed borrow from the St. Louis Borrow was placed at the wetlands areas where waste rock was removed as shown on Figure 5-1.

The upper 12 inches of the waste rock on the surface of the waste pile was compacted. The compact test summary and field tests are contained in Section 5.11.1 of this report.

## 5.8 Erosion Protection

### 5.8.1 Growth Medium

The top surface material of the reshaped Santa Cruz was sampled to evaluate agricultural lime requirements. Areas requiring lime amendments were identified in the field. Over the compacted one foot of waste material, a 12 inch layer of loose waste amended with lime was placed to provide a suitable growth medium. Over the top of the lime amended layer is a 12 inch layer of soil resulting in total vegetation growth zone of approximately 2 feet deep. The lime was applied at a rate of 80 tons/acre for the main pile and 280 tons/acre for the northeast area of the pile in the upper 12 inches of waste. No lime was required in the northeast removal area or the access road. Table 5.1 shows the lime application rates for the Santa Cruz Mine Area. The lime was spread evenly over the Site by mechanical methods then incorporated. Multiple tillage passes were made to insure complete mixing of the lime into the material. The liming process was accomplished immediately following waste pile shaping to provide the greatest reaction time prior to revegetation.

Borrow soil used for plant growth was tested and identified prior to excavation. The borrow soil was obtained from the St. Louis borrow area 2 miles from the Santa Cruz Mine. The soil was transported by truck to the Santa Cruz and placed over the top of the lime amended material to a depth 12 inches. This soil was placed on the top surface and slopes and covered the entire areal extent of the regraded waste pile. The removal area northeast of the waste rock pile was covered with approximately 12 inches of unprocessed borrow. The traffic over the soil was kept to a minimum to avoid unnecessary compaction of the seed bed. The finished grade for the soil growth medium is $\pm$ 0.3 ft. of design and does not contain irregularities.

**Table 5.1**
**Santa Cruz Mine Site**
**Lime Application Rates**

| SITE | LIME APPLICATION RATE FOR WASTE ROCK | SOIL COVER APPLICATION RATE |
|---|---|---|
| Santa Cruz | | |
| Northeast removal area | No lime | 12" unprocessed borrow soil. |
| Access road slope on east side. | No lime | 12" of unprocessed borrow soil. |
| Main Pile | 80 tons/acre (0.46 in. thick) Amend 12" | 12" processed soil (-3/4").. |
| Small isolated area | 280 tons/acre (1.6 in. thick) Amended 12" on N.E. area of pile (as directed by ARCO) | 12" processed soil (-3/4"). |

### 5.8.2 Revegetation

All seed was applied by hydrology methods due to wet surface conditions and time constraints. Table 5.2 contains seed mixtures and applications used at the Santa Cruz Mine Site. The hydroseeding and fertilization sequence of activity completed is as shown on Table 5.3. Mulch was also spread by hydro application methods and held in place by tacking agents.

## Table 5.2
## Santa Cruz Mine Area
## Seed Mixtures and Application Rates

| Type A (1) General Seed Mixture | | | |
|---|---|---|---|
| Species | Preferred Variety(s) | Rate (lbs./acre) Planted (broadcast) | PLS (seeded/acre) |
| Big bluegrass<br>Poa ampla | Sherman | 0.50 | 458,500 |
| Mountain brome<br>Bromus carinatus | Bromar | 8.00 | 496,000 |
| Slender wheatgrass<br>Agropyron trachycaulum | Primar, San Luis | 3.00 | 480,000 |
| Streambank wheatgrass<br>Agropyron riparium | Sodar | 3.00 | 480,000 |
| Birdsfoot trefoil<br>Lotus corniculatus | Empire | 1.00 | 410,000 |
| Lewis flax<br>Linum lewisii | Apar | 2.00 | 570,000 |
| Rocky Mountain penstemon<br>Penstemon strictus | Bandera | 1.00 | 592,000 |
| Cicer milkvetch<br>Astragalus cicer | Lutana, Monarch | 1.50 | 290,000 |
| | ***Totals*** | **20.00** | **3,776,500 (approx. 87 seeds per square foot)** |

(1) Type A applied on waste rock pile area.

**Type B (2)**
**Sideslope Stabilization Mixture**

| Species | Preferred Variety(s) | Rate (lbs./acre) Planted (broadcast) | PLS (seeded/acre) |
|---|---|---|---|
| Big bluegrass<br>Poa ampla | Park | 0.50 | 1,100,000 |
| Mountain brome<br>Bromus carinatus | Bromar | 15.00 | 975,000 |
| Slender wheatgrass<br>Agropyron trachycaulum | Primar, San Luis | 6.00 | 960,000 |
| Streambank wheatgrass<br>Agropyron riparium | Sodar | 6.00 | 960,000 |
| Cicer milkvetch<br>Astragalus cicer | Lutana, Monarch | 1.50 | 290,000 |
| | **Totals** | **29.00** | **4,285,000 (approx. 98 seeds per square foot)** |

(2) Type B applied on hillsides slopes along the runon interception ditch, disturbed hillside above Santa Cruz portal, and the outslope of the new access road embankment.

**Table 5.3**
**Santa Cruz Mine Site**
**Revegetation Sequence**

| Item | Seed Bed Preparation | Fertilizer | Seed | Mulch |
|---|---|---|---|---|
| **Period** | Prior to fertilization and seeding. | Concurrent with seeding. | After September 30th, immediately following final seed bed preparation. | Immediately following seeding. |
| **Method** | Mechanical scarification of soil. | Combined with hydroseeding equipment. | Hydroseeding on all areas. | Hydromulch - 1500 lbs./acre, all slope areas.<br>Slurry pH>3.5. |
| Equipment | Disc or rippers pulled by tractor. | | Mobile hydroseeding with spray and tank equipment. | |
| **Discing/Raking** | Disc or rip to 12 inch depth maximum. | | | |
| **Other** | Insure adequate seed bed without hard surface resistant to seed placement. | Nutrient application applies to all sites:<br>Nitrogen (lb./acre) 40<br>Phosphate (lb./acre) 60<br>Potash (lb./acre) 40 | Type<br>A General seed mix (<3:1)<br>B Side slope mix (>3:1)<br>D Wetland mix | Purpose: twofold:<br>1. Conserve water<br>2. Deter erosion |

### 5.8.3 Riprap

Riprap erosion protection was placed where runoff and runon drainage occurs. Riprap types, rock covers and bedding are shown on Table 5.4.

**Table 5.4**
**Santa Cruz Mine Site**
**Riprap and Bedding**

| | | Percent Passing | | | | | |
|---|---|---|---|---|---|---|---|
| **Type** | **Description** | **100** | **85** | **50** | **30** | **15** | **0** |
| A | Riprap | 1.7-2.4' | - | 1.4'-1.6' | 1.2' | 0.9' | 0.8' |
| B | Riprap | Larger Rock Material Generated By Borrow Processing | | | | | |
| C | Riprap | 0.9-1.2' | - | 0.7-0.8' | 0.6' | 0.5-0.65' | 0.4 |
| D | Riprap/Bedding | 3.0-8.0" | 3.0-6.0" | - | - | 0.75"-1.5" | 0"-0.5" |
| E | Filter Material | 2.0" | 0.5-1.5" | - | - | 0.5-0.65mm | 0.6mm |

The runon and runoff ditch designs and erosion protection riprap are shown in plan view on Figure 5-1. These ditches contain bedding, textured liner and riprap to handle flows resulting from a 100 year precipitation event. These designs are discussed in detail under Section 5.6.

## 5.9 Passive Treatment of Mine Drainage

Drainage from the Santa Cruz and the Rico Boy mine adits is captured by the adit interception ditch. The ditch conveys adit flows around the consolidated waste rock pile to the south into the existing wetlands. The existing wetlands' conditions are conducive to some natural attenuation of metals. Only minor modifications of the existing wetlands in the area were made. A dike 5 ft. in height and 5 ft. wide (top) was built to the south of the waste rock and utilizes a small pond area to provide for sufficient retention capacity for settling of precipitates. The wetlands ponded water was isolated from the consolidated waste rock pile by the construction of a clean fill access road embankment around the east and south sides of the pile. Approximately 0.5 acres of retention area pond was enclosed by the dike. A riprap lined overflow was constructed to regulate flow out of the pond maintaining the 5 day retention time specified in the VCUP. The dike extends about 400 ft. and was constructed over the wetlands floor of unprocessed borrow material. Two overflow areas were

constructed in the dike with a 2 ft. layer of Type A riprap placed over two 6 inch bedding layers of Types D and E material. The core of the dike consisted of 2 ft. of unprocessed borrow. Figure 5-1 shows a plan view of the dike location and overflow spillways.

The wetlands layout provides for an aerobic treatment step in an up gradient pond to enable oxidation precipitation of dissolved iron and to serve as a sludge storage area. The assumptions, calculations and further description of the wetlands passive treatment is contained in the Santa Cruz VCRA application.

## 5.10 Quantity Summary

The quantities moved for remedial action for the Santa Cruz Mine Area involved ten categories of materials. The total volume of material moved was 7,606 cubic yards. Table 5.5 contains the volume of materials moved by category for earthwork at the Santa Cruz Mine Site.

**Table 5.5**
**Santa Cruz Mine Area**
**Relocated Materials, Riprap and Bedding**

| Activity | Material Type | Units | Quantities |
|---|---|---|---|
| Relocated Waste Rock | *** | CY | 5,200 |
| Unprocessed Cover Soil | Borrow Soil | CY | 1,100 |
| Processed Cover Soil | -3/4" Borrow Soil | CY | 2,273 |
| Riprap | A | CY | 119 |
| Riprap | B | CY | 133 |
| Riprap | C | CY | 10 |
| Riprap Bedding | D | CY | 22 |
| Riprap Bedding | E | CY | 22 |
| Textured Liner | | $Yd.^2$ | 794 |
| Soil Amendment | Agricultural Lime | Tons | 53 |

## 5.11 Soil Testing Summary

### 5.11.1 Geotechnical Testing

Field soil density testing was conducted to determine compliance with the technical specifications of the construction contract. The technical specifications relating to compaction were selected to achieve various engineering objectives relating to infiltration and enhancing stability in fill materials. The applicable technical specifications required that the upper 12 inches of the waste pile below the lime amended material be of a compactable gradation, and attain 95% of Standard Proctor maximum dry density (or 90% of maximum Providence index density for soils with little or no fines). Table 5.6 summarizes the field soil moisture/density tests conducted for the Argentine Tailings. Nuclear density gauges were used to obtain in-place densities for comparison to laboratory generated Proctor or Providence mold laboratory density tests as appropriate for a given soil. Where moisture/density tests were deficient, footnotes in Table 5.6 indicates the action taken by the field engineer, e.g. - recompaction of the affected area or in cases where additional compaction or replacement of fill materials would not have provided any additional benefits to the long-term performance of the fill with respect to design objectives, no action was directed. Laboratory and field tests were performed and results approved by ARCO. Tests were conducted according to the following standards:

| ASTM Method | Description: |
|---|---|
| Field Tests: | |
| D-2922 | Density of Soil and Soil-Aggregate in Place by Nuclear Methods |
| Laboratory Tests: | |
| D-422 | Sieve Analysis |
| D-698 | Moisture Density Relationships (5.5 lb. hammer) |
| D-4253 | Modified Providence Moisture Density Relationships |

Table 5.6 summarizes the results of field tests.

**Table 5.6**
**Santa Cruz Mine**
**Field Soil Testing Summary**

| Date | Test No. | Location | Density | Moisture | Proctor No. | Maximum Density | Optimum Moisture | Percent Compaction | Notes | % Compaction Required | Percent +\- Moisture |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 9-Aug-96 | SC-NU-01 | Main Pile | 119.8 | 12.9% | EF-07-MP-01 | 122.7 | *** | 98% | | 90% | |
| " | SC-NU-02 | Pre-Amendment | 125.6 | 13.0% | " | 122.7 | *** | 102% | | 90% | |
| " | SC-NU-03 | | 113.8 | 12.3% | " | 122.7 | *** | 93% | | 90% | |
| 16-Aug-96 | SC-NU-04 | Main Pile | 111.3 | 10.2% | Estimate | 125 | *** | 89% | (1) | 90% | |
| " | SC-NU-05 | Pre-Amendment | 123.7 | 9.9% | " | 125 | *** | 99% | | 90% | |
| " | SC-NU-06 | | 119.0 | 11.2% | " | 125 | *** | 95% | | 90% | |
| " | SC-NU-07 | | 118.6 | 9.5% | " | 125 | *** | 95% | | 90% | |
| " | SC-NU-08 | | 123.8 | 7.5% | " | 125 | *** | 99% | | 90% | |
| " | SC-NU-09 | | 112.9 | 9.2% | " | 125 | *** | 90% | | 90% | |
| 16-Sep-96 | SC-NU-10 | Runon Ditch | 104.2 | 22.2% | EF-10-SP-01 | 129 | 12% | 81% | (2) | 90% | 10.2% |
| " | SC-NU-11 | Bedding | 118.5 | 17.0% | " | 129 | 12% | 92% | | 90% | 5.0% |
| " | SC-NU-12 | | 112.8 | 19.0% | " | 129 | 12% | 87% | (2) | 90% | 7.0% |
| " | SC-NU-13 | | 115.3 | 18.4% | " | 129 | 12% | 89% | (2) | 90% | 6.4% |
| " | SC-NU-14 | | 114.1 | 15.8% | " | 129 | 12% | 88% | (2) | 90% | 3.8% |
| 20-Sep-96 | SC-NU-15 | Adit Ditch | 118.9 | 17.0% | EF-10-SP-01 | 129 | 12% | 92% | | 90% | 5.0% |
| " | SC-NU-16 | Liner Bedding | 120.8 | 16.9% | " | 129 | 12% | 94% | | 90% | 4.9% |

*** Modified Providence Tests and estimated maximum densities did not generate an optimum moisture.

(1.) The slightly substandard result was not representative of the general area and did not warrant additional compactive effort.

(2.) Low densities were the result of saturated fill materials from recent precipitation. Subgrade was reworked and additional compaction effort was completed.

* Soil testing provided by ESA, Inc., Fort Collins, CO.

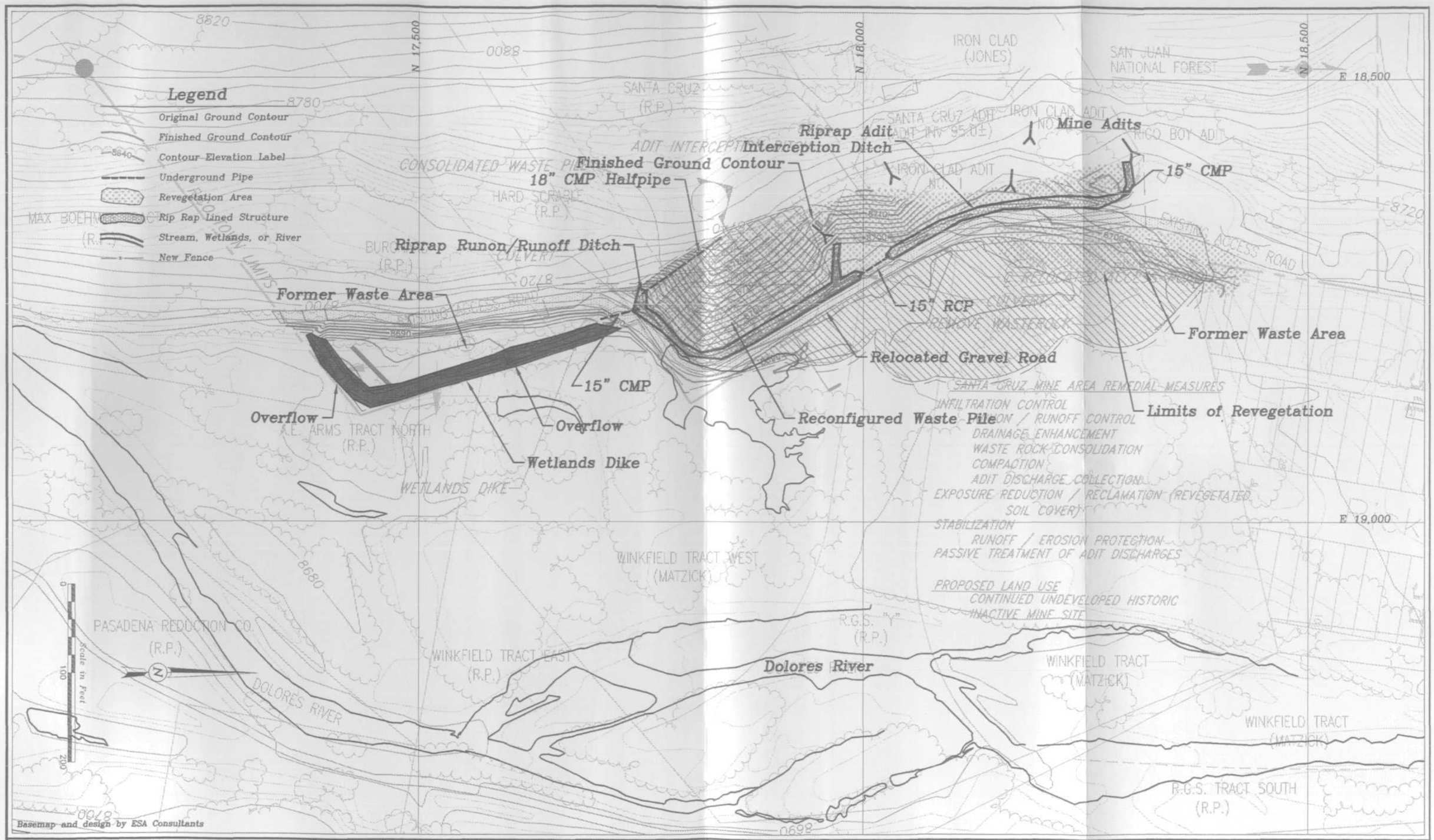
### 5.11.2 Confirmatory Testing

Confirmatory testing was performed at each location where specific removal of mine waste rock or mill tailings was specified in the Voluntary Cleanup Plans (VCUP). Based on soil investigations within and surrounding the Town of Rico, zinc levels range from 200 to 4720 ppm. The cleanup level was set at a maximum of 4720 ppm for testing of subgrade after the removal of materials. Sample results above the limit resulted in further removal and sampling. Final samples indicate the cleanup was successful. Table 5.7 summarizes the confirmatory sampling results. The comprehensive report of confirmatory testing on the Rico Project is contained in the Appendix.

**Table 5.7**
**Santa Cruz Mine Site**
**Confirmatory Testing**

| Removal Site | Sample ID | Zinc (ppm) | Sample Type |
|---|---|---|---|
| Santa Cruz | EX-SC-02 | 1,440 | Composite |
| | EX-SC-03 | 2,640 | Single sample |
| | EX-SC-04 | 422 | Single sample |

## 5.12 As Built Drawings




| NO. | REVISION/DESCRIPTION | DATE |
|---|---|---|
| | | |

ATLANTIC RICHFIELD COMPANY
RICO MINING AREA
CONSTRUCTION COMPLETION REPORT

ANDERSON ENGINEERING CO., INC.
375 West 2100 South Street Suite 100
Salt Lake City, UT 84115
Tel. (801) 972-5222

| | |
|---|---|
| DRAWN BY: | R. TATE |
| CHECKED BY: | S. ANDERSON |
| CLIENT CONTACT: | R. ELLIOTT |
| SCALE: | 1" = 100' |
| OTHER REFS: | sc_prop.dwg, sc_plan.dwg |

# SANTA CRUZ MINE AREA FINAL CONFIGURATION PLAN VIEW

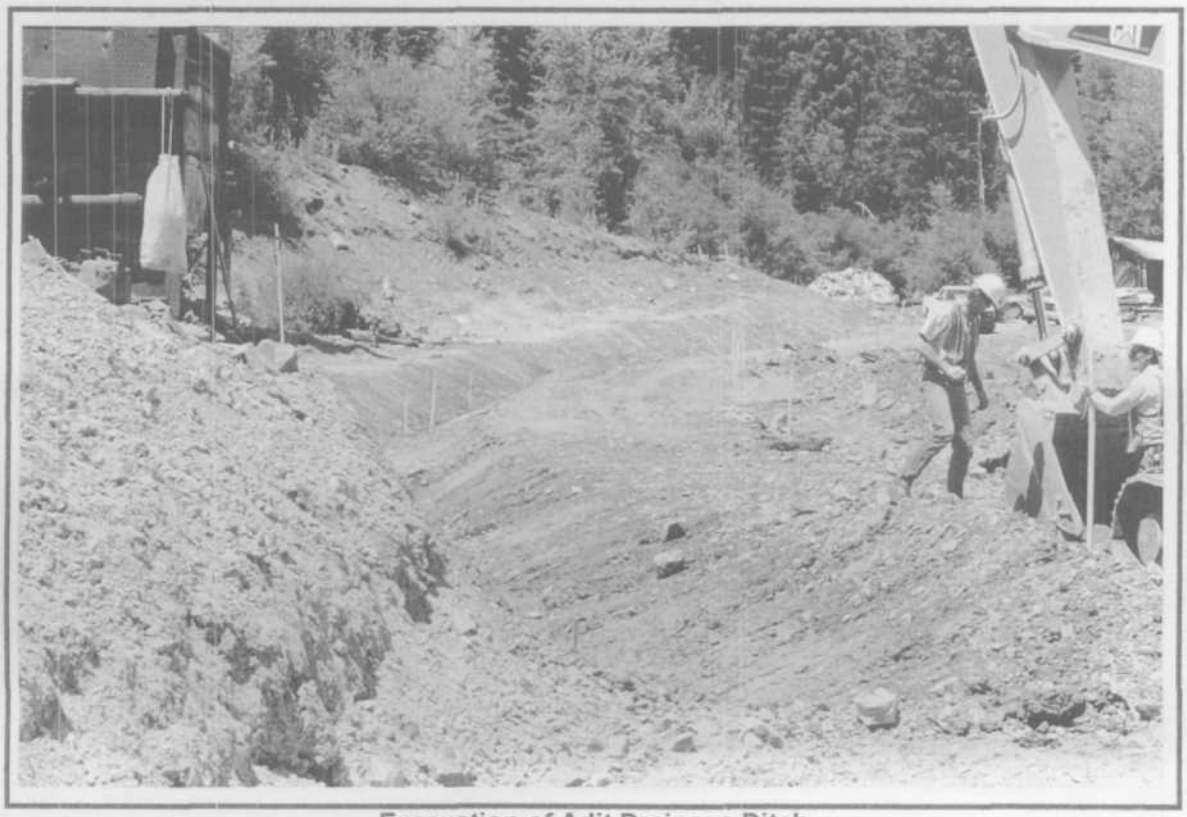
References: scconcep.dwg, sc_econt.dwg

FIG. 5-1

File: S_CRUZ.DWG view (plan)

## 5.13 Photographs

D-8 Dozer and Trackhoe Reconfiguring Waste Rock Pile



Excavation of Adit Drainage Ditch

# 6.0 Grand View Smelter Site

## 6.1 General

The Grand View Smelter Site is located on the east side of State Highway 145 at the north end of the Town of Rico. This Site contains approximately 1.7 acres and was originally used as a smelter facility. The Site consists of waste materials over a natural ground surface. Slopes are moderate and two dirt roads traverse the area.

## 6.2 Permit

The VCRA application dated April 12, 1996 and supplements to the application dated June 17, 1996 were approved by the CDPHE on June 21, 1996. The CDPHE approval stated that the VCUP would meet a degree of clean up and control of hazardous substances such that the property does not present an unacceptable risk to human health or the environment based on the property's proposed use as an open space. The approved VCUP remedial design for the Grand View Smelter Site involves removal of a small waste pile, construction of drainage control features, placing a reclamation cover over a portion of the Site which consists of plant growth medium and amendments and revegetation.

## 6.3 Geohazards

No natural engineering or geotechnical hazards were encountered during construction activities at the Grand View Smelter Site. No preconstruction hazard control measures were required due to the limited activity associated with the work at the Site.

## 6.4 Site Access

Access to the Site is through existing public roads at the north end of the Town of Rico. Access to the Columbia where the removed waste was stabilized is on State Road 145 and through the newly constructed access road from State Highway 145 to the Columbia. All roads were maintained and left in as good or better condition than existed prior to their use on this project.

## 6.5 Construction Site Controls

Controls were implemented during construction to address requirements of applicable federal, state or local permits, codes or regulations. All construction and

specifications employed appropriate Best Management Practices to protect the Dolores River from sedimentation during remedial activities. Temporary grading to control runoff to the Dolores River were constructed in work or active traffic areas. Construction activities were conducted in a manner to preserve existing vegetation buffers in the work areas. Strict precautions to avoid dust and excavation spillage during operations were followed by the use of water spray and control of load heaping on haul units.

The onsite construction activities were conducted in strict compliance with the VCUP Site Specific Safety and Health Plan and Site Pre-Excavation Construction Plans as well as Stormwater and COE Permits obtained for the specific work area.

## 6.6 Hydraulic Controls

### 6.6.1 Runon

Runon generated from rainfall or snowmelt upland of the Site is of a very minor quantity and the existing slopes were maintained and are sufficient to promote controlled flow of stormwater. The two roads existing on Site also contribute to reducing runoff velocities at peak flow and direct runon away from the site. The newly constructed road entering the Grand View area was constructed with a small "v" notch diversion ditch on the west side of the road. Figure 6-1 shows the road alignment and the location of the adjacent drainage.

### 6.6.2 Runoff

The slopes and general flow pattern of the Site was maintained after removal activities. The existing slopes are sufficient to promote controlled runoff. Flow across the Site enters existing drainages along the west side of the highway and flows from the Site. Final shaping of the Site, the road fill and parallel drainage ditch, and also cover materials placed on this area contribute to adequate drainage of runoff.

### 6.6.3 Infiltration

Reclamation cover was placed over the Grand View area consisting of 1 ft. of plant growth medium. The combination of growth medium and Site drainage provides adequate removal of stormwater.

### 6.6.4 Drainage Stabilization

The northwest embankment slope of the Grand View Site adjacent to the Dolores River was protected from potential flood flows by the construction of flood protection revetment. The revetment consists of riprap and bedding materials. Type A riprap was placed as a scour toe. Type A riprap was also placed on the prepared river bank. Riprap was bedded with 6 inches of Type D and 6 inches of Type E material. Figure 6-1 contains the revetment location at the Grand View Site. Riprap materials existing in this river area were reused and pushed adjacent to the constructed revetment.

## 6.7 Waste Materials

### 6.7.1 Surface Shaping and Slopes

A small area occupied by waste was graded to conform to the adjacent land shape.

The area of grading occupies about 0.25 acres. The majority of the surface at the Grand View Site is adequately drained with stormwater draining.

## 6.8 Erosion Protection

### 6.8.1 Growth Medium

A small amount of borrow soil was placed at the Grand View area to promote vegetation growth for erosion control. Approximately 800 cubic yards of material were spread adjacent to the road and over the area where the waste material was removed. No lime amendments were required at the Grand View Site.

### 6.8.2 Revegetation

The seed mix used at the Grand View Site was Type A and is as shown on Table 6.1.

**Table 6.1**
**Grand View Smelter Site**
**Seed Mixtures and Application Rates**

| Type A General Seed Mixture | | | |
|---|---|---|---|
| **Species** | **Preferred Variety(s)** | **Rate (lbs./acre) Planted (broadcast)** | **PLS (seeded/acre)** |
| Big bluegrass<br>Poa ampla | Sherman | 0.50 | 458,500 |
| Mountain brome<br>Bromus carinatus | Bromar | 8.00 | 496,000 |
| Slender wheatgrass<br>Agropyron trachycaulum | Primar, San Luis | 3.00 | 480,000 |
| Streambank wheatgrass<br>Agropyron riparium | Sodar | 3.00 | 480,000 |
| Birdsfoot trefoil<br>Lotus corniculatus | Empire | 1.00 | 410,000 |
| Lewis flax<br>Linum lewisii | Apar | 2.00 | 570,000 |
| Rocky Mountain penstemon<br>Penstemon strictus | Bandera | 1.00 | 592,000 |
| Cicer milkvetch<br>Astragalus cicer | Lutana, Monarch | 1.50 | 290,000 |
| | **Totals** | **20.00** | **3,776,500 (approx. 87 seeds per square foot)** |

All seed was applied using hydroseeding methods due to wet surface conditions and seasonal constraints. The hydroseeding and fertilization sequence of activity completed is as shown on Table 6.2. Mulch was also spread by hydro application methods and held in place by tacking agents.

**Table 6.2**
**Grand View Smelter Site**
**Revegetation Sequence**

| Item | Seed Bed Preparation | Fertilizer | Seed | Mulch |
|---|---|---|---|---|
| **Period** | Prior to fertilization and seeding. | Concurrent with hydroseeding. | After September 30th, immediately following final seed bed preparation. | Immediately following seeding. |
| **Method** | Mechanical scarification of soil. | Combined with hydroseeding, liquid fertilizer mixture. | Hydroseeding on all areas. | Hydromulch - 1500 lbs./acre, slopes 2:1 and steeper.<br>Slurry pH>3.5. |
| **Equipment** | Disc or rippers pulled by tractor. | Mobile hydroseeding equipment. | Mobile hydroseeding with spray and tank equipment. | |
| **Discing/Raking** | Disc or rip to 12 inch depth maximum. | | | |
| **Other** | Insure adequate seed bed without hard surface resistant to seed placement. | Nutrient application applies to all sites:<br>Nitrogen (lb./acre) 40<br>Phosphate (lb./acre) 60<br>Potash (lb./acre) 40 | Type<br>A General seed mix (<3:1) | Purpose: twofold:<br>1. Conserve water<br>2. Deter erosion |
| Note: Ripping of final graded surface completed prior to broadcasting fertilizer. Ripped to a maximum depth of 12 inches. | | | | |

### 6.8.3 Riprap

Riprap was placed along the Dolores River Bank for flood protection of the Grand View area. The riprap involved placement of a scour protective toe consisting of Type A riprap approximately 3.6 ft. thick below average water level. Additional Type A riprap about 2 ft. thick was placed over the outslope to protect against flood waters. The riprap materials were underlaid by Type D and Type E bedding. The riprap materials and bedding are shown on Table 6.3. Riprap material existing in this river area was released and pushed adjacent to the constructed revetment.

**Table 6.3**
**Grand View Smelter Site, Riprap and Bedding**

| | | Percent Passing | | | | | |
|---|---|---|---|---|---|---|---|
| **Type** | **Description** | **100** | **85** | **50** | **30** | **15** | **0** |
| A | Riprap | 1.7-2.4' | - | 1.4'-1.6' | 1.2' | 0.9' | 0.8' |
| B | Riprap | Larger Rock Material Generated By Borrow Processing | | | | | |
| C | Riprap | 0.9-1.2' | - | 0.7-0.8' | 0.6' | 0.5-0.65' | 0.4 |
| D | Riprap/Bedding | 3.0-8.0" | 3.0-6.0" | - | - | 0.75"-1.5" | 0"-0.5" |
| E | Filter Material | 2.0" | 0.5-1.5" | - | - | 0.5-0.65mm | 0.6mm |

## 6.9 Quantity Summary

The quantities moved for implementation of the VCUP for the Grand View Tailings involves four categories of materials. The total volume of material moved was 900 cubic yards. Table 6.4 contains the volume of material moved by category for earthwork at the Grand View Site.

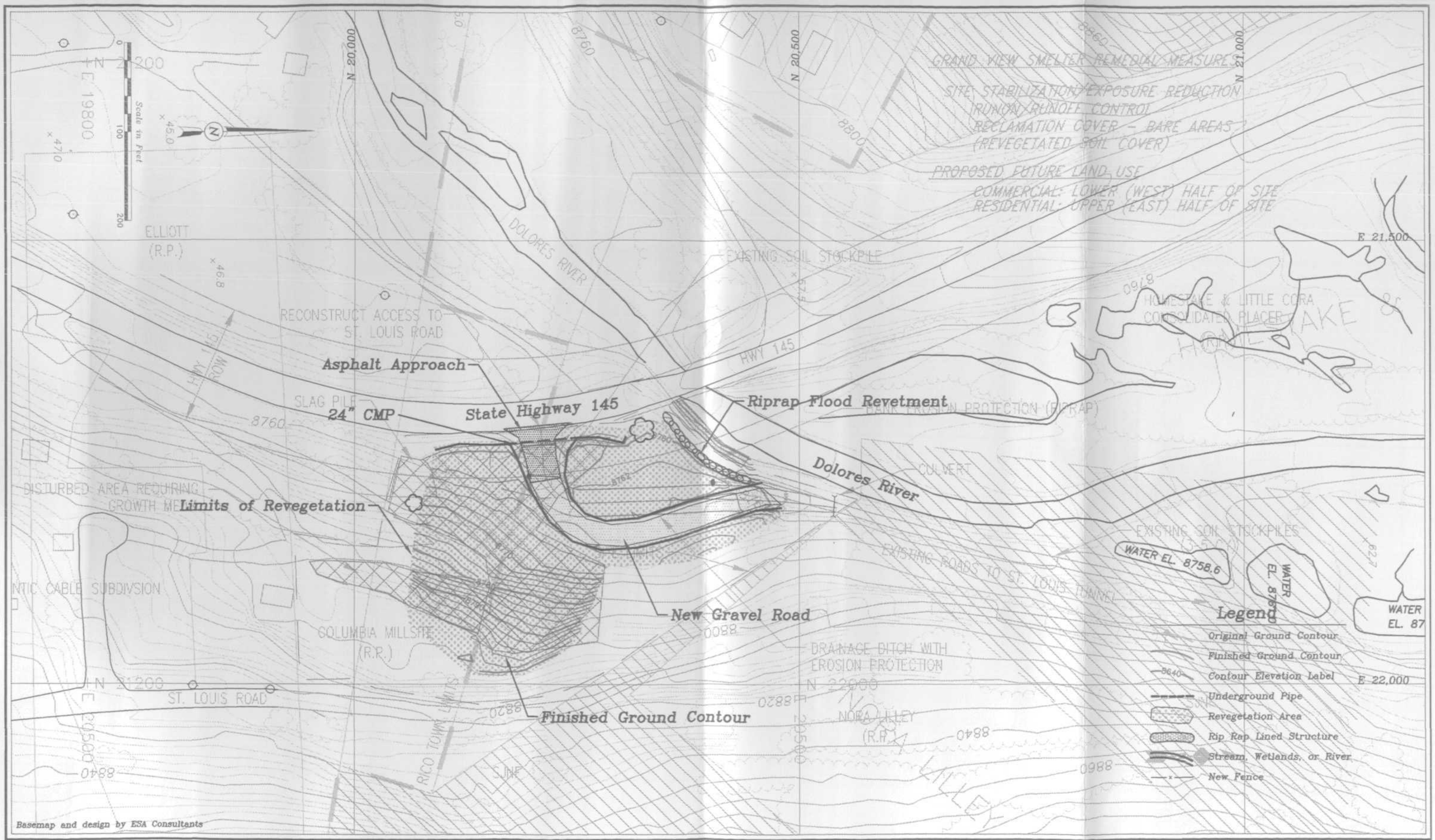
**Table 6.4**
**Grand View Smelter Site**
**Relocated Material Quantities**

| Activity | Material Type | Units | Quantities |
|---|---|---|---|
| Growth Medium | | CY | 800 |
| Revetment | Type A | CY | 128 |
| Revetment | Type D | CY | 22 |
| Revetment | Type E | CY | 22 |

## 6.10 Soil Testing Summary

No soil testing was required at the Grand View Site.

## 6.11 As Built Drawings




**ATLANTIC RICHFIELD COMPANY**
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|---|---|
| DRAWN BY: | R. TATE |
| CHECKED BY: | S. ANDERSON |
| CLIENT CONTACT: | R. ELLIOTT |
| SCALE: | 1" = 100' |
| OTHER REFS: | gv-econt.dwg, gv-prop.dwg |

# GRAND VIEW SMELTER AREA FINAL CONFIGURATION PLAN VIEW

References: gv-concep.dwg, gv-plan

FIG. 6-1

File: G_VIEW.DWG view (plan)

## 6.12 Photographs

Material Removal Area (Colorado Route 145 at Left)

Closeup of North Cleanup Area

# 7.0 Borrow Sites

## 7.1 St. Louis Borrow

The St. Louis Borrow Site is located adjacent to the St. Louis Tunnel approximately 3/4 mile north of the Town of Rico. The borrow area is situated against the hill east of the Dolores River and occupies just under 3 acres. A screening plant was set up to produce the various types of riprap products and processed growth medium. The riprap materials are described in earlier sections. Processed growth medium material is 3/4 inch minus. Access to the Site was by a combination of private roads and USFS. A Special Use Permit with the USFS was obtained for activities related to transport of this borrow material over USFS access roads. The conditions of this permit were totally complied with.

A total of 25,784 cubic yards was extracted from the St. Louis borrow area. The various riprap and growth medium products were processed and transported to the reclamation areas primarily along the Dolores River corridor. No stockpiles of produced materials remained at the Site after work completion.

The area in the immediate vicinity of the borrow site operations was graded to promote drainage and comply with the pre-construction Work Plan. The slopes were configured to a 3h:1v geometry with an intermediate 10 ft. wide bench. Figure 7-1 shows the final surface topography of the Site.

Following land shaping, the borrow area was seeded. The seed bed soil was in a loose condition and ready for seeding. Fertilizer was broadcast at a rate of 40 lbs. N, 60 lbs. $P_20_5$ and 40 lbs. $K_20$ per acre. All seed was applied using hydroseeding methods. Mulch was applied using hydromulching equipment. Tacking agents were also applied to secure the mulch on the seeded area. Table 7.1 shows the seed mix used for the St. Louis Borrow Site.

**Table 7.1**
**St. Louis Borrow**

| Type B Sideslope Stabilization Mixture | | | |
|---|---|---|---|
| **Species** | **Preferred Variety(s)** | **Rate (lbs./acre) Planted (broadcast)** | **PLS (seeded/acre)** |
| Big bluegrass<br>Poa ampla | Park | 0.50 | 1,100,000 |
| Mountain brome<br>Bromus carinatus | Bromar | 15.00 | 975,000 |
| Slender wheatgrass<br>Agropyron trachycaulum | Primar, San Luis | 6.00 | 960,000 |
| Streambank wheatgrass<br>Agropyron riparium | Sodar | 6.00 | 960,000 |
| Cicer milkvetch<br>Astragalus cicer | Lutana, Monarch | 1.50 | 290,000 |
| | **Totals** | **29.00** | **4,285,000 (approx. 98 seeds per square foot)** |

## 7.2 Argentine Borrow

The Argentine Borrow Site is located approximately 0.2 miles northeast of the Argentine Tailings Site. The borrow area is situated in a sloping area north of Silver Creek and occupies about 2 acres. A screening plant was set up to produce the various types of riprap products and processed growth medium. The riprap materials are described in earlier sections. Processed growth medium material is 3/4 inch. Access to the Site was by a combination of private roads and by a USFS roads. A Special Use Permit with the USFS was obtained for activities related to transport of this borrow material over USFS access roads. The conditions of this permit were totally complied with.

A total of 23,700 cubic yards was extracted from the Argentine borrow area. The unprocessed borrow was extracted and transported to the reclamation areas mainly at the Argentine Tailings. No stockpiles of produced materials remained at the Site after completion of the work.

The area in the immediate vicinity of the borrow site operations was graded to promote drainage and comply with the pre-construction Work Plan. The slopes were configured to a 3h:1v geometry with two intermediate 10 ft. wide bench. Figure 7-1 shows the final surface topography of the Site.

Following land shaping, the borrow area was seeded. The seed bed soil was in a loose condition and ready for seeding. Fertilizer was broadcast at a rate of 40 lbs. N, 60 lbs. $P_2O_5$ and 40 lbs. $K_2O$ per acre. All seed was applied using hydroseeding methods. Mulch was applied using hydromulching equipment. Tacking agents were also applied to secure the mulch on the seeded area. Table 7.2 shows the seed mix used for the Argentine Borrow Site.

**Table 7.2**
**Argentine Borrow**

**Type B**
**Sideslope Stabilization Mixture**

| Species | Preferred Variety(s) | Rate (lbs./acre) Planted (broadcast) | PLS (seeded/acre) |
|---|---|---|---|
| Big bluegrass<br>Poa ampla | Park | 0.50 | 1,100,000 |
| Mountain brome<br>Bromus carinatus | Bromar | 15.00 | 975,000 |
| Slender wheatgrass<br>Agropyron trachycaulum | Primar, San Luis | 6.00 | 960,000 |
| Streambank wheatgrass<br>Agropyron riparium | Sodar | 6.00 | 960,000 |
| Cicer milkvetch<br>Astragalus cicer | Lutana, Monarch | 1.50 | 290,000 |
| | **Totals** | **29.00** | **4,285,000 (approx. 98 seeds per square foot)** |

## 7.3 Cayton Borrow

The Cayton borrow area is located near the Cayton Campground on USFS land approximately 6 miles north of Rico, Colorado. An estimated 2500 cubic yards of borrow material exists at this borrow area. This material was made available to the VCRA application for reclamation use on sites near Rico. The Cayton borrow

occupied less than ½ acre. The material was unscreened and primarily used for fill purposes and removed by a daytime (8:00 a.m. to 5:00 p.m.) loader and truck operation. In order to obtain and haul this material, a Road Use and Special Use Permit were obtained from the USFS. These permits were totally complied with during removal of the fill material from the Cayton borrow area. Figure 7-3 shows final surface topography of the Site.

Under the terms of the USFS Permit the following procedures were observed to stabilize the Site after removal of the fill. The Site was graded to drain without concentration of flow. The seed bed soils were analyzed for fertility. Fertilizer was broadcast into the roughed seed bed at a rate of 40 lbs. of N, 60 lbs. of P205, and 40 lbs. of K20 per acre.

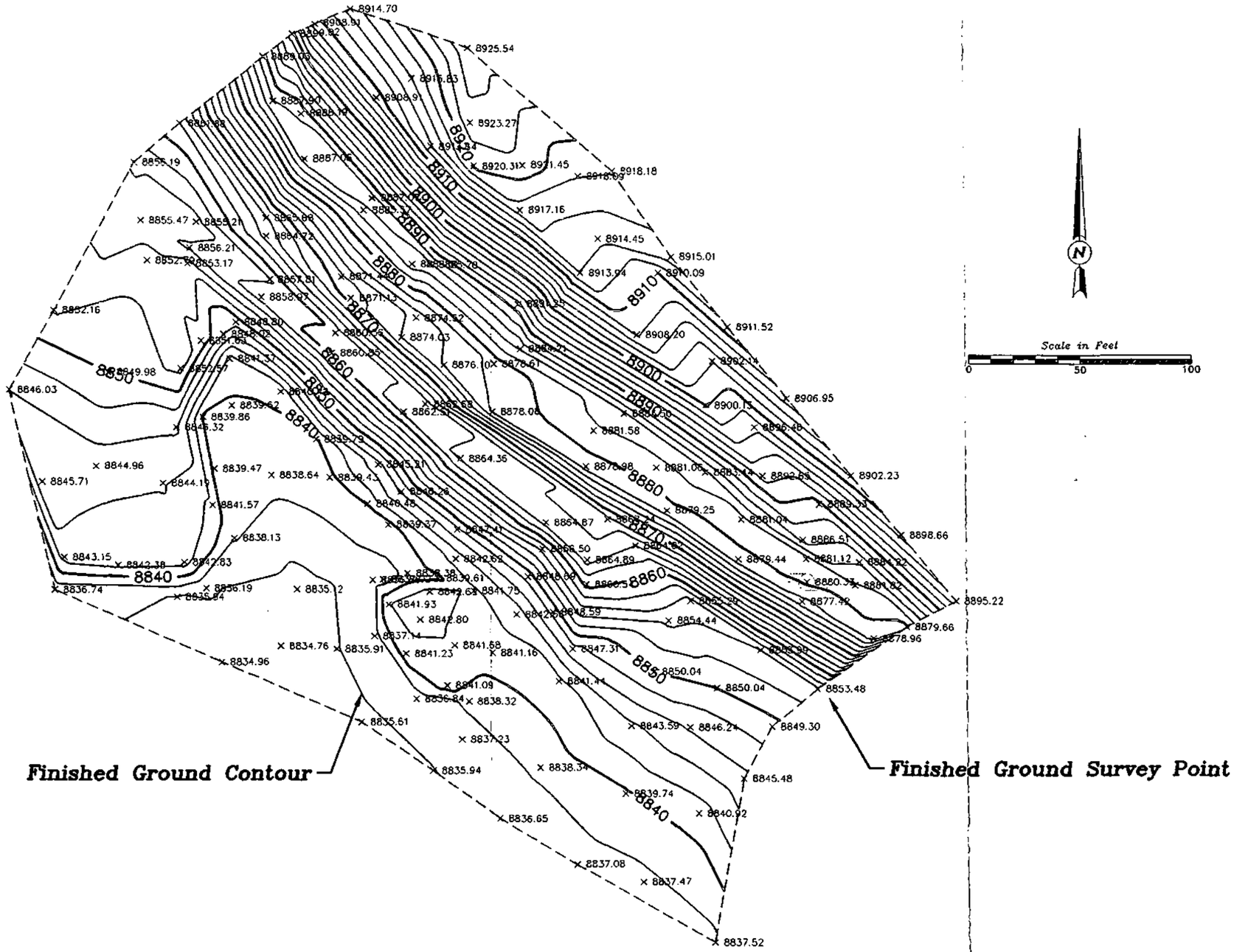
Seeding of disturbed areas will be with the following seed mixture (Table 7.3). Seed was certified weed free and included the following. This mixture was applied by hydroseeding methods.

**Table 7.3**
**Cayton Borrow**
**Stabilization Mixture**

| **Species** | **Rate (lbs./acre)** |
|---|---|
| Annual ryegrass | 3 lbs./acre |
| Mountain brome | 10 lbs./acre |
| Canadian wildrye | 9 lbs./acre |
| Tuffted hairgrass | 3 lbs./acre |
| **Totals** | **25 lbs./acre** |

Mulch was applied to all disturbed areas following seeding. The disturbed area was hydromulched at a rate of 2,000 lbs. per acre. A rate of 1,500 lbs. per acre was used on slopes of 3:1 or less steep. Mulch anchoring was accomplished through the addition of a tackifier included with the mulch slurry.

## 7.4 As Built Drawings

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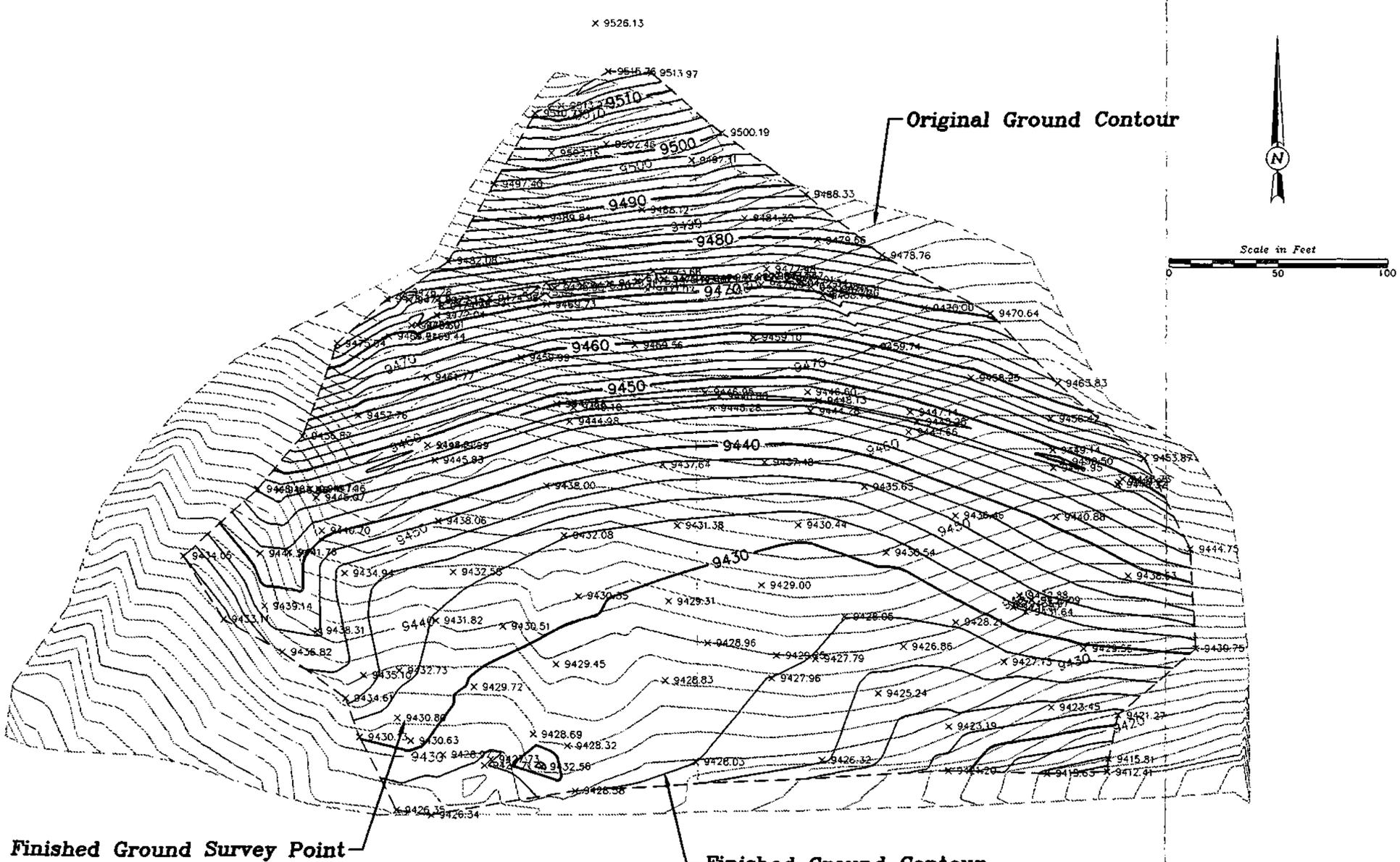
| DRAWN BY: | R. TATE |
| CHECKED BY: | S. ANDERSON |
| CLIENT CONTACT: | R. ELLIOTT |
| SCALE: | 1" = 50' |
| OTHER REFS: | . |

# ST. LOUIS BORROW AREA FINAL CONFIGURATION PLAN VIEW

References: .

FIG. 7-1

File: STLOUIS.DWG view (plan)

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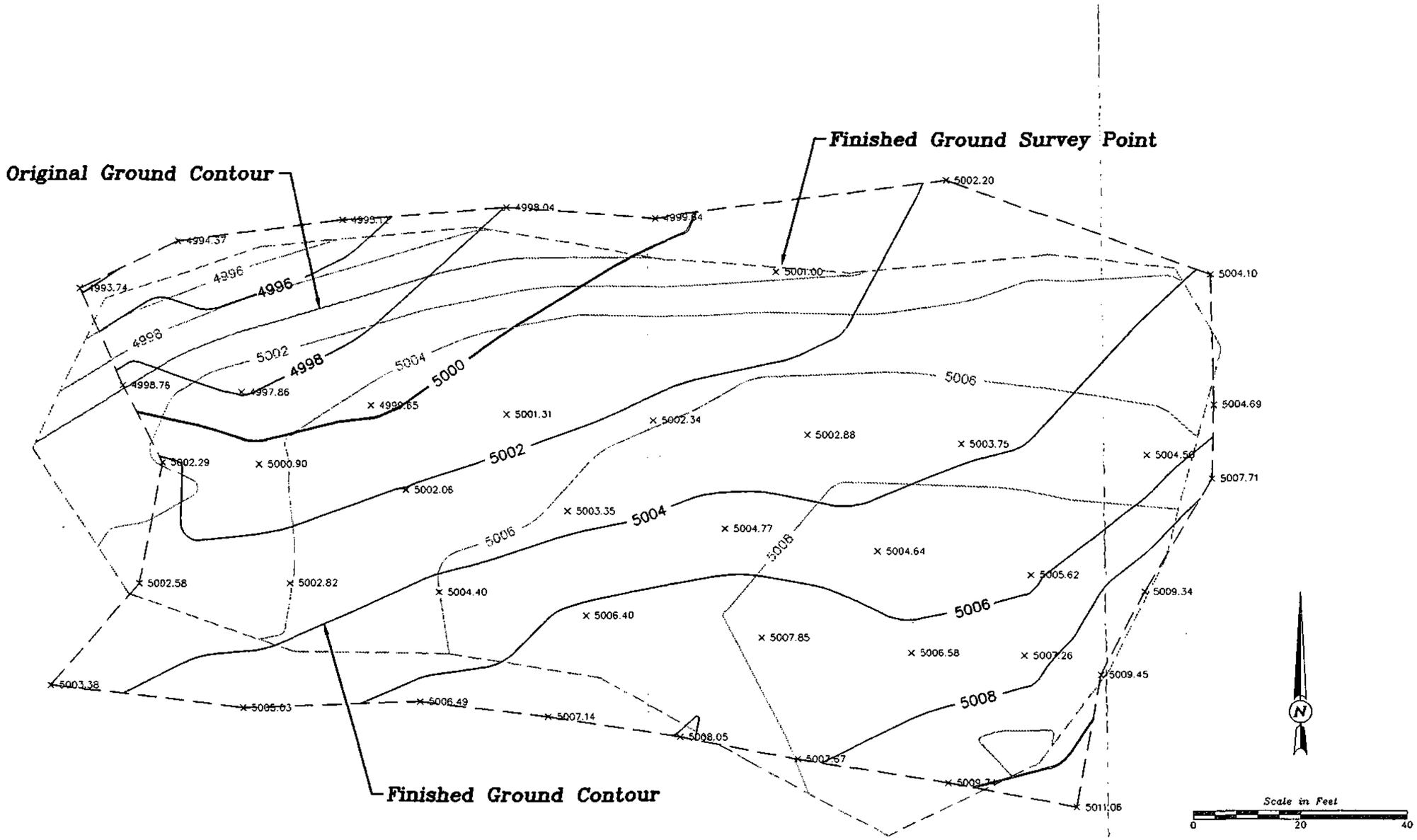
**ARGENTINE BORROW AREA**
**FINAL CONFIGURATION PLAN VIEW**

References: .

FIG. 7-2

File: ARGBORRO.DWG view (plan)

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| SCALE: | 1" = 20' |
| OTHER REFS: | . |

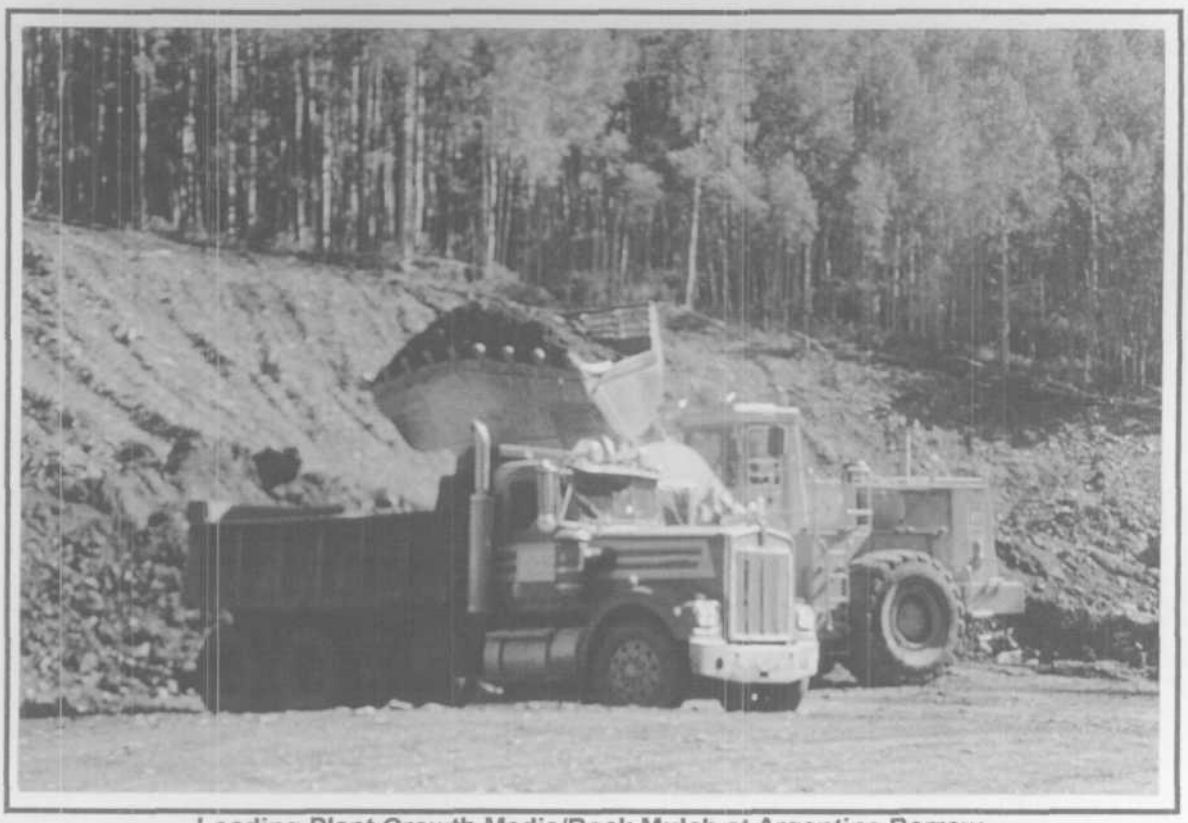
# CAYTON BORROW AREA FINAL CONFIGURATION PLAN VIEW

References:

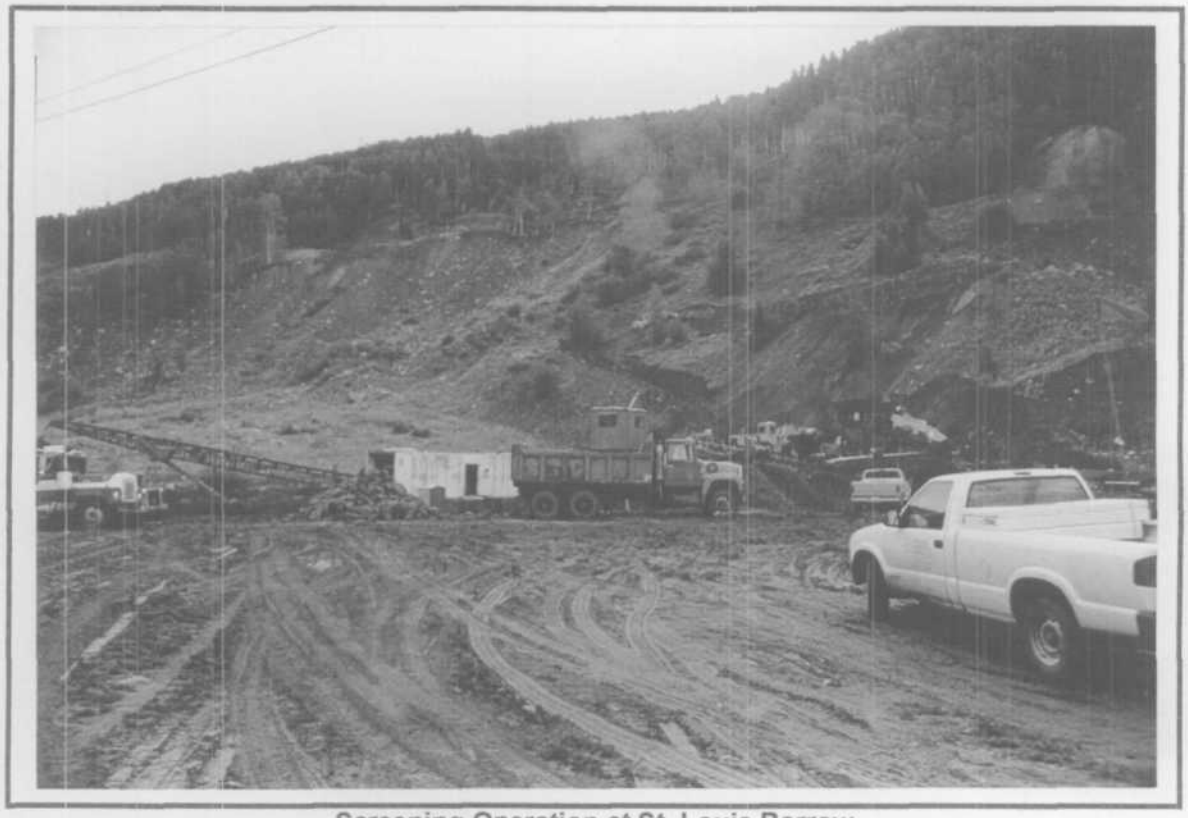
FIG. 7-3

File: CAYTON.DWG view (plan)

## 7.5 Photographs



Loading Plant Growth Media/Rock Mulch at Argentine Borrow



Screening Operation at St. Louis Borrow

# TECHNICAL MEMORANDUM
# on
# CONFIRMATION SOIL SAMPLING AND ANALYSIS RESULTS
# for
# RICO SITE REMEDIATION PROJECT

*Prepared for:*

**ATLANTIC RICHFIELD COMPANY**
444 South Flower Street
Los Angeles, California 90071

*Prepared by:*

**ESA CONSULTANTS INC.**
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525

November 7, 1996

ESA Consultants Inc.
2637 Midpoint Drive, Suite F, Fort Collins, Colorado 80525
Telephone: (970) 484-3611 ◆ FAX: (970) 484-4118

November 8, 1996
101.9601.051

Richard A. Elliott
Atlantic Richfield Company
444 South Flower Street
Los Angeles, CA 90071

RE: Technical Memorandum - Confirmation Soil Sampling and Analysis Results
Rico Site Remediation Project

Dear Richard:

This Technical Memorandum provides documentation of confirmation soil sampling performed as proposed for the Rico site remediation project implemented under the Colorado Voluntary Cleanup and Redevelopment Act. Confirmatory sampling verified the successful removal of either mine waste rock or mill tailings from the areas specified in the voluntary cleanup design plans for the following sites:

- Argentine tailings
- Columbia tailings
- Silver Swan mine
- Santa Cruz mine
- Pro Patria tailings
- Shamrock waste rock pile

A reproducible copy for preparation of the project construction completion report has been provided to Anderson Engineering.

Sincerely,
ESA Consultants Inc.

Edmund J. Schneider
Project Manager

Enclosures

cc: Anderson Engineering (2)

G:\PROJECTS\RICO\96CORRES\NOV1996\1108ARCO.LTR

# TECHNICAL MEMORANDUM
# on
# CONFIRMATION SOIL SAMPLING AND ANALYSIS RESULTS
# for
# RICO SITE REMEDIATION PROJECT

*Prepared for:*

**ATLANTIC RICHFIELD COMPANY**
444 South Flower Street
Los Angeles, California 90071

*Prepared by:*

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November 7, 1996

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4.0 SAMPLE ANALYSIS METHOD . . . . . 3

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Appendix B Analytical Report Ashe Analytics, Inc.

# TECHNICAL MEMORANDUM
on
# CONFIRMATION SOIL SAMPLING AND ANALYSIS RESULTS
for
# RICO SITE REMEDIATION PROJECT

Prepared by ESA Consultants Inc.
November 7, 1996

## 1.0 SUMMARY

This memorandum summarizes the methods and results for confirmation soil sampling performed subsequent to the removal of mine waste rock or mill tailings in accordance with Voluntary Cleanup Plans implemented in July 1996 at the following sites in Rico, Colorado:

- Argentine tailings (Pond 4)
- Silver Swan mine (river banks)
- Shamrock mine (east river bank)
- Columbia tailings (southwest corner)
- Santa Cruz mine (Winkfield & RGS "Y" tracts)
- Pro Patria tailings (entire site)

Confirmatory sampling was performed to verify the removal of mine waste rock or mill tailings from the areas designated for removal in the site-specific Voluntary Cleanup Plans and construction drawings. Soil investigations indicate the zinc content of natural bedrock and surficial materials (i.e., native soil, alluvium and colluvium) within the Town of Rico ranges from 200 ppm to 4,720 ppm. Verification of waste rock or tailings removal from specified areas was accomplished by sampling and analyzing the underlying soil. Removal work was considered successful if the post removal zinc content of the soil was less than 4,720 ppm. Additional material was removed and soil re-sampled where confirmatory sampling results indicated a zinc content greater than 4,720 ppm.

Final post-removal confirmatory analytical results for zinc are summarized by site as follows:

| Site Removal Area | Sample ID. | Zinc (ppm) | Remarks |
|---|---|---|---|
| Shamrock east bank | EX-SH-01 | 3,740 | Composite |
| Pro Patria | EX-PP-02 | 3,840 | Composite |
| Santa Cruz | EX-SC-02 | 1,440 | Single check |
| | EX-SC-03 | 2,640 | Single check |
| | EX-SC-04 | 422 | Composite |
| Silver Swan east bank | EX-SSE-01 | 2,030 | Composite |
| Silver Swan west bank | EX-SSW-01 | 788 | Composite |
| | EX-SSW-02 | 1,640 | Composite |
| Columbia tailings south | EX-CO-01 | 651 | Composite |
| Argentine tailings Pond 4 | EX-AR-01 | 1,130 | Composite |
| | EX-AR-02 | 1,120 | Composite |

These results confirm the removal actions were successful in the meeting the post-removal maximum concentration criterion of 4,720 ppm for zinc.

The following sections summarize waste removal and soil sampling and analysis methods. Appendix A includes copies of the sampling location maps by site, soil sampling field data and custody/shipping records. The analytical report for the soil samples prepared by Ashe Analytics, Inc. is included as Appendix B.

## 2.0 WASTE REMOVAL AND CONSOLIDATION OPERATIONS

Mine waste rock and mill tailings removal and consolidation operations were implemented in July and fully completed in August 1996 in accordance with site remediation technical specifications. A combination of conventional excavation methods were used for the removal of mine waste rock and tailings, including bulldozer, front end loader and tracked hoe/excavator operations. Haul trucks were used for transport and placement of waste materials consolidated at either the Columbia site or Argentine site.

The amount of material removed was determined primarily by visual identification by material type within the approximate boundaries of known waste materials delineated on construction drawings. The construction contractor was notified of final removal area boundaries during the course of removal operations. Removal activities were inspected to ensure removal of all visually identifiable waste material.

Approximately 10,200 c.y. of tailings and mixed tailings and soil material were removed from Argentine tailings Pond 4 and consolidated with Pond 3 tailings. A combined total of about 23,200 c.y. of waste materials removed from the Columbia (south side), Santa Cruz, Silver Swan, Pro Patria, and Shamrock sites were consolidated at the Columbia site. In addition, about 7,500 c.y. of material was removed from within 50 feet of the Dolores River and consolidated at the Silver Swan site.

## 3.0 SAMPLING LOCATIONS AND METHODS

A total of 11 final confirmation soil samples were collected from the six (6) sites where either mine waste or tailings removal operations were specified in the cleanup plans and prior to placement of growth media material. The location of the soil sampling locations are identified on Sheets AT-3, CT-2, SC-2, SS-2, and OS-1 (see Appendix A). Sample analysis results are listed in Section 1.0. In addition, two check samples were taken at the Santa Cruz (EX-SC-01) and Pro Patria (EX-PP-01) to confirm visual indications that excavation of additional material would be necessary in order to complete removal operations at these sites. The zinc content of both check samples exceeded the criterion for successful removal.

All except two of the final soil samples were collected as an aliquot of a composite of grab samples of equal proportions sampled from a depth interval of 0-6 inches. Two of the three Santa Cruz site samples were single point samples of soil from a depth interval of 0-6 inches. The composite samples consisted of five sub-samples: one sub-sample from the center of the sampling

location and four more sub-samples from discrete points 10 to 20 feet from the center point in a box pattern. Each sub-sample was sieved through a No. 4 (4.76 mm) stainless steel sieve to remove coarse materials and debris. Each of the composite sub-samples and single point samples were throughly mixed in a stainless steel bowl using a stainless steel spoon. After mixing, the sample composite was quartered and a sample aliquot from one of the quarters was placed in a certified contaminant-free 8 ounce high density polyethylene sample bottle. Each sample bottle was sealed, labeled and stored in a shipping box. All bottled samples remained in the custody of the sampler until shipped to the analytical laboratory. Custody was maintained by the sampler and the analytical laboratory according to standard chain-of-custody procedures and documentation. Chain-of-Custody and shipping records are provided in Appendix A.

## 4.0 SAMPLE ANALYSIS METHOD

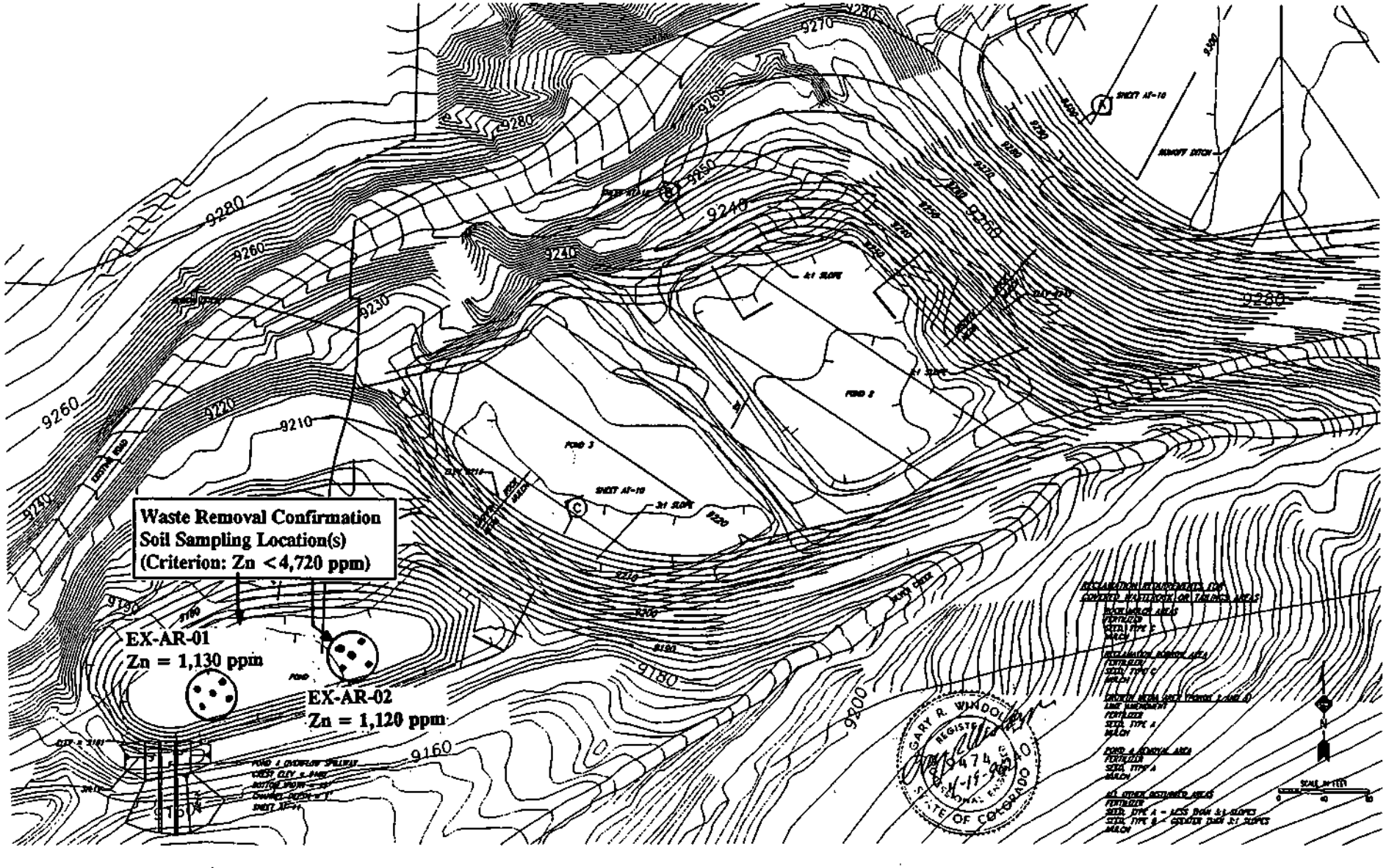
All confirmatory soil sample analyses for total zinc concentration were analyzed by x-ray fluorescence (XRF) spectroscopy using the laboratory-grade instrumentation and sample preparation methods developed by Ashe Analytics, Inc. and approved for Clark Fork River Superfund site investigations (Montana). Analyses were performed by Ashe Analytics, Inc. under the protocol defined in the following document:

> "Clark Fork River Superfund Site Investigations Laboratory Analytical Procedure for X-Ray Fluorescence Analysis of Solid Media: I. Laboratory-Grade Instrumentation method. Prepared for ARCO, Anaconda, Montana. Ashe Analytics, Inc., Butte, Montana. October 1995."

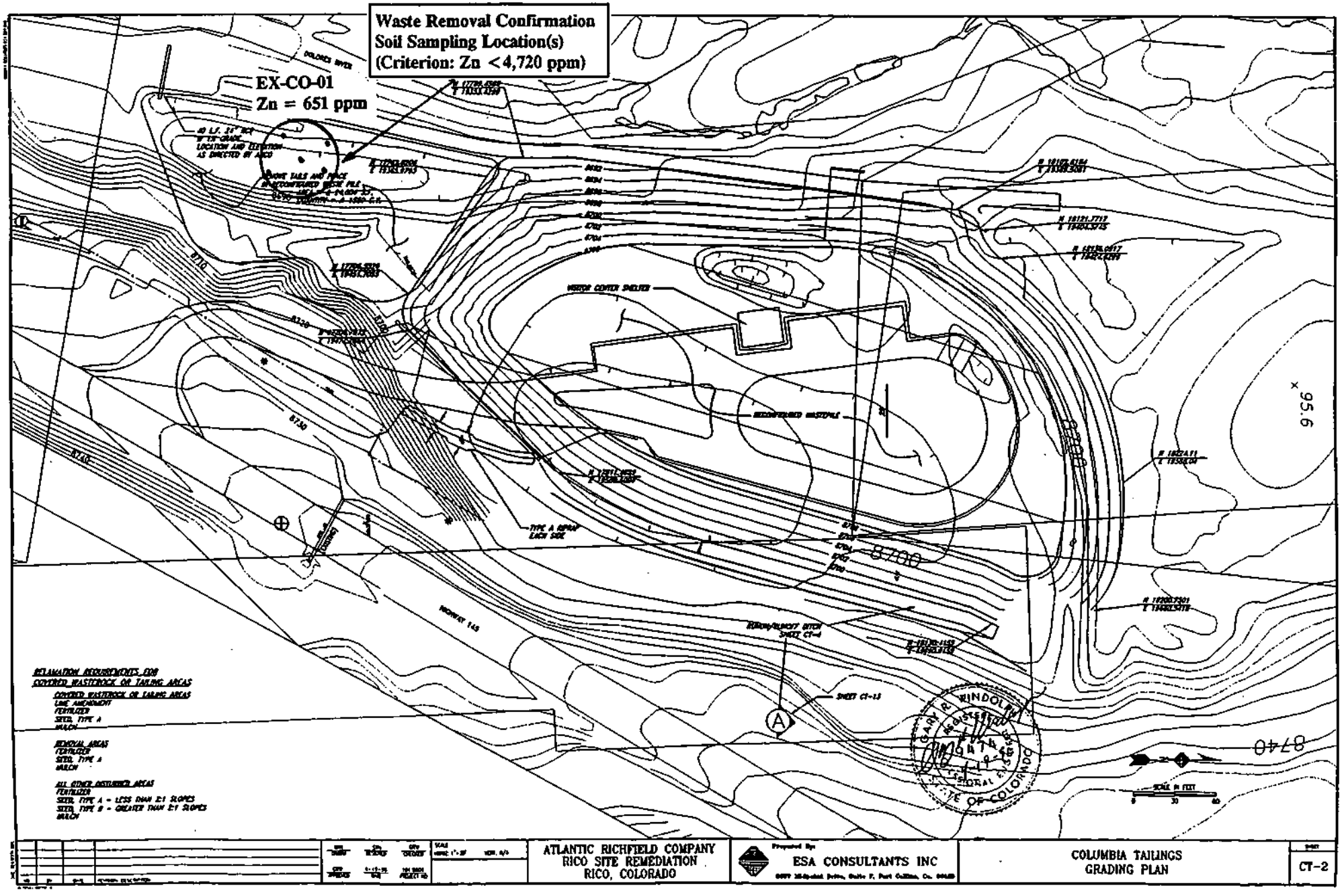
The Ashe analytical report for the Rico sample analyses is provided as Appendix B. The report includes analytical results, QA/QC information, method detection limits, raw data output, and sample log, sample preparation and chain-of-custody records.

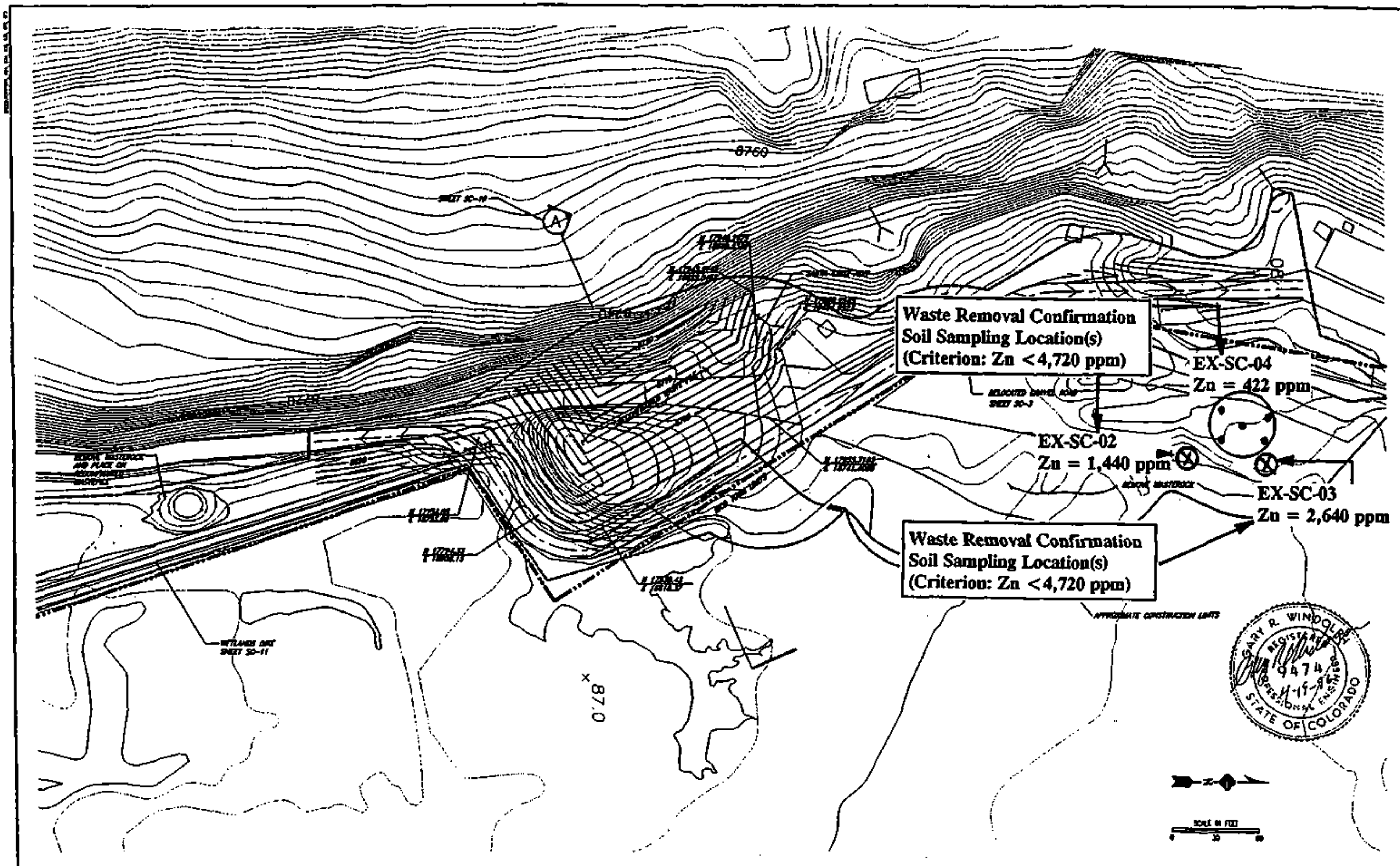
# APPENDIX A

## SOIL SAMPLING LOCATION MAPS AND FIELD RECORDS




| | | | |
|---|---|---|---|
| ATLANTIC RICHFIELD COMPANY<br>RICO SITE REMEDIATION<br>RICO, COLORADO | Prepared By:<br>ESA CONSULTANTS INC | ARGENTINE TAILINGS<br>GRADING PLAN - PONDS 2, 3 AND 4 | SHEET<br>AT-3 |


Waste Removal Confirmation
Soil Sampling Location(s)
(Criterion: Zn <4,720 ppm)
EX-CO-01
Zn = 651 ppm
DOLORES RIVER
VISITOR CENTER SHELTER
RECONFIGURED WASTEPILE
TYPE A RIPRAP EACH SIDE
HIGHWAY 145
8700
8740
95.6
RELAMATION REQUIREMENTS FOR
COVERED WASTEROCK OR TAILING AREAS
COVERED WASTEROCK OR TAILING AREAS
LIME AMENDMENT
FERTILIZER
SEED, TYPE A
MULCH
REMOVAL AREAS
FERTILIZER
SEED, TYPE A
MULCH
ALL OTHER DISTURBED AREAS
FERTILIZER
SEED, TYPE A - LESS THAN 3:1 SLOPES
SEED, TYPE B - GREATER THAN 3:1 SLOPES
MULCH
SCALE IN FEET
0 30 60
ATLANTIC RICHFIELD COMPANY
RICO SITE REMEDIATION
RICO, COLORADO
Prepared By:
ESA CONSULTANTS INC
COLUMBIA TAILINGS
GRADING PLAN
CT-2

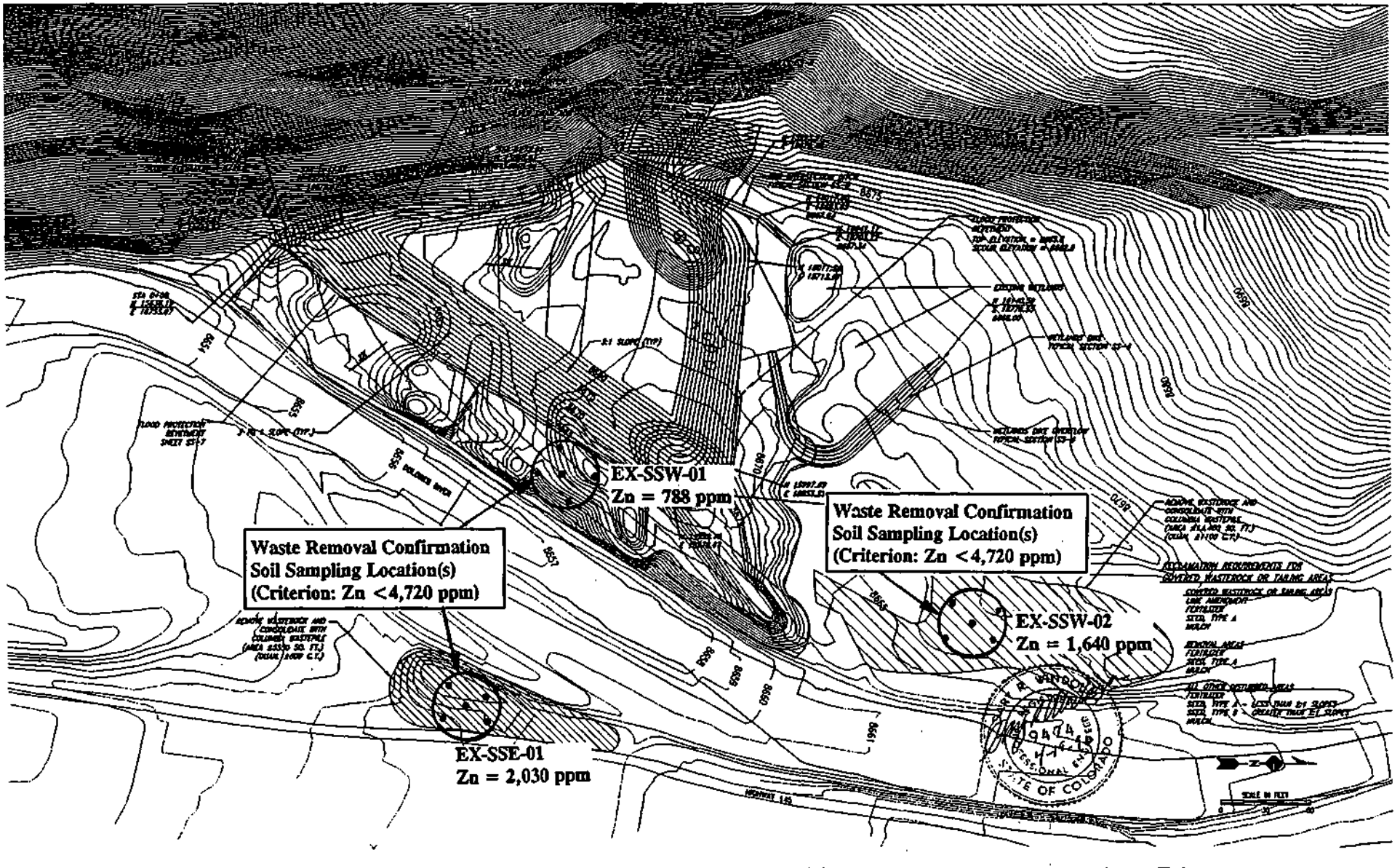



ATLANTIC RICHFIELD COMPANY
RICO SITE REMEDIATION
RICO, COLORADO

ESA CONSULTANTS INC

SANTA CRUZ MINE AREA
GRADING PLAN

SC-2




ATLANTIC RICHFIELD COMPANY
RICO SITE REMEDIATION
RICO, COLORADO

Prepared By
ESA CONSULTANTS INC

SILVER SWAN
GRADING PLAN

SS-2

ATLANTIC RICHFIELD COMPANY
RICO SITE REMEDIATION
RICO, COLORADO

ESA CONSULTANTS INC

RICO SITE REMEDIATION
SURFICIAL WASTE REMOVAL

03-1

ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, CO 80525
(970) 484-3611 (970) 484-4118 FAX

# SOIL SAMPLING
## FIELD DATA FORM

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Date: 7/16/96 Tues.
Weather Conditions: Cloudcover, Warm. Temperature: 72°F

Sampling Personnel (Signatures): [signature] Photo. Roll #: R2

*Tie picture numbers to samples below, if any

## SOIL SAMPLES

| | Tag Number | Sample Number | Sample Type | Depth Below Grade/Depth Interval | Time | Laboratory Analysis | Location | |
|---|---|---|---|---|---|---|---|---|
| 1. | 00123 | EX-SH-01 | Excavation Soil | 0-6" | 1330 | Zinc-XRF | Shamrock | Photo # 14 and # 15 |
| 2. | | | | | | | | |
| 3. | | | | | | | | |
| 4. | | | | | | | | |
| 5. | | | | | | | | |
| 6. | | | | | | | | |
| 7. | | | | | | | | |
| 8. | | | | | | | | |
| 9. | | | | | | | | |
| 10. | | | | | | | | |

# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

**Samples sent to:**
ASHE Analytics, Inc.
1309 Kaw Ave.
Butte, MT. 59701
(406) 723-2080

FOR LAB USE
LAB ID_____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Tag · 00123 Sample · EX·SH·01 | Soil | Zinc · X·Ray fluorescence |
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| SAMPLES RELINQUISHED BY | SAMPLES RECEIVED BY | FORM NO. |
|---|---|---|
| Signature: [signature] Date: 7/16/96 Time: 1445 | Signature: Date: Time: | 1 |
| Signature: Date: Time: | Signature: Date: Time: | |

ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, CO 80525
(970) 484-3611 (970) 484-4118 FAX

# SOIL SAMPLING
## FIELD DATA FORM

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Date: 7/19/96 , 1130
Weather Conditions: Clear, Warm
Temperature: 75°F

Sampling Personnel (Signatures): [signature]
Photo. Roll #: R2

*Tie picture numbers to samples below, if any

## SOIL SAMPLES

| | Tag Number | Sample Number | Sample Type | Depth Below Grade/Depth Interval | Time | Laboratory Analysis | Location |
|---|---|---|---|---|---|---|---|
| 1. | 00125 | EX-AR-01 | Soil | 0-6" | 1130 | Zinc-XRF | Argentine - Pond 4 (SW Area) ☒ Photos R2, #1, #2 |
| 2. | | | | | | | Station Plotted on drawing AT-3 |
| 3. | | | | | | | |
| 4. | | | | | | | |
| 5. | | | | | | | |
| 6. | | | | | | | |
| 7. | | | | | | | |
| 8. | | | | | | | |
| 9. | | | | | | | |
| 10. | | | | | | | |

# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

**Samples sent to:**
Asha Analytics, Inc.
1309 Kaw Ave.
Butte, MT. 59701
(406) 723-2080

FOR LAB USE
LAB ID_____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # EX-AR-01 Tag # 00125 | Soil | Zinc - XRF |
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| SAMPLES RELINQUISHED BY | SAMPLES RECEIVED BY | FORM NO. |
|---|---|---|
| Signature: [signature] Date: 7/19/96 Time: 1400 | Signature: Date: Time: | 2 |
| Signature: Date: Time: | Signature: Date: Time: | |

SAMPLE EX-AR-01

**UPS Next Day Air®**
**UPS Worldwide Express**
**Shipping Document**

See instructions on back. Call 1-800-PICK-UPS (800-742-5877) for additional information.

TRACKING NUMBER: 0090965210008 10

**1 SHIPMENT FROM**

SHIPPER'S UPS ACCOUNT NO.: UPS SHIPPER NO. / UPS BILLING NO.: 9907223326 | FOR UPS USE: 800X99

REFERENCE NUMBER: 101.9601.052

NAME: Steve Story | TELEPHONE: 970-484-3611

COMPANY: ESA CONSULTANTS

STREET ADDRESS: 2637 MIDPOINT DR STE F

CITY AND STATE: FORT COLLINS CO | ZIP CODE: 80525

PLEASE PRESS HARD
YOU ARE MAKING 3 COPIES

**2 EXTREMELY URGENT DELIVERY TO**

NAME: John Ashe | TELEPHONE: (406) 723-2080

COMPANY: Ashe Analytics ~~Ave~~

177

168 STREET ADDRESS: 1309 Kaw Avenue | DEPT./FLOOR:

135 CITY AND STATE (INCLUDE COUNTRY IF INTERNATIONAL): Butte, MT. | ZIP CODE: 59701

**3 WEIGHT AND ZONE**

| WEIGHT ENTER "LTR" IF LETTER | DIMENSIONAL WEIGHT (If Applicable) | ZONE |
|---|---|---|
| 1.14 lbs. | | |

SHIPPER'S COPY

**4 TYPE OF SERVICE**

- [X] NEXT DAY AIR
- [ ] WORLDWIDE EXPRESS (INTERNATIONAL)

FOR WORLDWIDE EXPRESS SHIPMENTS Mark an "X" in this box if shipment only contains documents of no commercial value. [ ] DOCUMENTS ONLY

**5 OPTIONAL SERVICES**

- [ ] SATURDAY PICKUP (See instructions)
- [ ] SATURDAY DELIVERY (See instructions)
- [ ] DECLARED VALUE (Contents are automatically protected up to $100. For declared value over $100, see instructions.) $ AMOUNT
- [ ] C.O.D. (If C.O.D., enter amount to be collected and attach completed UPS C.O.D. tag to package.) $ AMOUNT

**6 ADDITIONAL HANDLING CHARGE**

- [ ] An Additional Handling Charge applies for certain items. See instructions.

**TOTAL CHARGES**

**7 METHOD OF PAYMENT**

| BILL SHIPPER | BILL RECEIVER (Next Day Air Only) | BILL THIRD PARTY | AMERICAN EXPRESS | MASTER CARD | VISA | CHECK | UPS USE CASH |
|---|---|---|---|---|---|---|---|
| X | | | | | | | |

Receive Account No. in Section 8

**8 RECEIVER'S / THIRD PARTY'S UPS ACCT. NO. OR MAJOR CREDIT CARD NO.** | EXPIRATION DATE

THIRD PARTY'S COMPANY NAME

STREET ADDRESS

CITY AND STATE | ZIP CODE

**9 SHIPPER'S SIGNATURE** X [signature] | DATE OF SHIPMENT 7/19/96

010191120 9/95 W

ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, CO 80525
(970) 484-3611 (970) 484-4118 FAX

# SOIL SAMPLING
## FIELD DATA FORM

Project Name: Rico Site Remediation
Project Number: 101.9601 ~~032~~ 052
Date: 7/22/96 0930
Weather Conditions: Clear, Warm
Temperature: 65°F

Sampling Personnel (Signatures): [signature]
Photo. Roll #: R3

*Tie picture numbers to samples below, if any

## SOIL SAMPLES

| | Tag Number | Sample Number | Sample Type | Depth Below Grade/Depth Interval | Time | Laboratory Analysis | Location |
|---|---|---|---|---|---|---|---|
| 1. | 00124 | EX-SC-01 | Soil | 0-6" | 0930 | Zinc-XRF | Santa Cruz (NW Area). R3, #3, #4 |
| 2. | | | | | | | Sample Plotted on drawing SC-2 |
| 3. | | | | | | | |
| 4. | | | | | | | |
| 5. | | | | | | | |
| 6. | | | | | | | |
| 7. | | | | | | | |
| 8. | | | | | | | |
| 9. | | | | | | | |
| 10. | | | | | | | |

# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

**Samples sent to:**
John Ashe
Ashe Analytics, Inc.
1309 Kaw Ave.
Butte, MT. 59701

FOR LAB USE
LAB ID _____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~-052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # EX-SC-01 Tag # 00134 | Soil | Zinc - XRF |
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| SAMPLES RELINQUISHED BY | SAMPLES RECEIVED BY | FORM NO. |
|---|---|---|
| Signature [signature] Date 7/22/96 Time 1400 | Signature Date Time | 3 |
| Signature Date Time | Signature Date Time | |

**UPS Next Day Air®**
**UPS Worldwide Express**
Shipping Document

See instructions on back. Call 1-800-PICK-UPS (800-742-5877) for additional information.

TRACKING NUMBER: 0909 521 009 9

**1 SHIPMENT FROM**

SHIPPER'S UPS ACCOUNT NO.: 5907223326
UPS SHIPPER NO. / UPS BILLING NO.
FOR UPS USE: 800X99

REFERENCE NUMBER: 101.9601.052

NAME: Steve Story
TELEPHONE: 970-484-3611

COMPANY: ESA CONSULTANTS

STREET ADDRESS: 2637 MIDPOINT DR STE F

CITY AND STATE: FORT COLLINS CO
ZIP CODE: 80525

**2 EXTREMELY URGENT DELIVERY TO**

NAME: John Ashe
TELEPHONE: (406) 723-2080

COMPANY: Ashe Analytics, Inc.

STREET ADDRESS: 1309 Kaw Avenue
DEPT./FLOOR:

CITY AND STATE (INCLUDE COUNTRY IF INTERNATIONAL): Butte, MT.
ZIP CODE: 59701

**3 WEIGHT AND ZONE**

| WEIGHT (ENTER "LTR" IF LETTER) | DIMENSIONAL WEIGHT (If Applicable) | ZONE |
|---|---|---|
| 1.08 lb. | | |

SHIPPER'S COPY

**4 TYPE OF SERVICE** — CHARGES

- [X] NEXT DAY AIR
- [ ] WORLDWIDE EXPRESS (INTERNATIONAL)
- For Worldwide Express Shipments: [ ] DOCUMENTS ONLY (Mark an "X" in this box if shipment only contains documents of no commercial value.) $

**5 OPTIONAL SERVICES**

- [ ] SATURDAY PICKUP (See instructions.)
- [ ] SATURDAY DELIVERY (See instructions.) $
- [ ] DECLARED VALUE (Consignments are automatically protected up to $100. For declared value over $100, see instructions.) $ AMOUNT $
- [ ] C.O.D. (If C.O.D., enter amount to be collected and attach completed UPS C.O.D. tag to package.) $ AMOUNT $

**6 ADDITIONAL HANDLING CHARGE**

- [ ] An Additional Handling Charge applies for certain items. See Instructions. $

**TOTAL CHARGES** $

**7 METHOD OF PAYMENT**

- [X] BILL SHIPPER
- [ ] BILL RECEIVER (Next Day Air Only)
- [ ] BILL THIRD PARTY (Next Day Air Only)
- [ ] AMERICAN EXPRESS
- [ ] MASTER CARD
- [ ] VISA
- [ ] CHECK
- [ ] UPS USE (CASH)

Provide Account No. in Section 8

**8** RECEIVER'S / THIRD PARTY'S UPS ACCT. NO. OR MAJOR CREDIT CARD NO.
EXPIRATION DATE /

THIRD PARTY'S COMPANY NAME

STREET ADDRESS

CITY AND STATE
ZIP CODE

**9** SHIPPER'S SIGNATURE X [signature]
DATE OF SHIPMENT 7/22/96

010191120 9/95 W

SAMPLE EX-SC-01

ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, CO 80525
(970) 484-3611 (970) 484-4118 FAX

# SOIL SAMPLING
## FIELD DATA FORM

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Date: 7/23/96 0830
Weather Conditions: Clear, warm
Temperature: 100°F

Sampling Personnel (Signatures): [signature]
Photo. Roll #: R3

*Tie picture numbers to samples below, if any

## SOIL SAMPLES

| | Tag Number | Sample Number | Sample Type | Depth Below Grade/Depth Interval | Time | Laboratory Analysis | Location |
|---|---|---|---|---|---|---|---|
| 1. | 00126 | EX-PP-01 | Soil | 0-12" | 0830 | Zinc-XRF | Pro. Pantria. Center East Side. Photos R3 #13, 14. |
| 2. | | | | | | | Plotted on drawing OS-1 |
| 3. | | | | | | | |
| 4. | | | | | | | |
| 5. | | | | | | | |
| 6. | | | | | | | |
| 7. | | | | | | | |
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| 10. | | | | | | | |

# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

Samples sent to:
John Ashe
Ashe Analytics, Inc.
1309 Kaw Ave.
Butte, MT. 59701

FOR LAB USE
LAB ID _____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601 ~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # EX-PP-01 Tag # 00126 | Soil | Zinc - XRF |
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| SAMPLES RELINQUISHED BY | SAMPLES RECEIVED BY | FORM NO. |
|---|---|---|
| Signature [signature] Date 7/23/96 Time 1400 | Signature Date Time | 4 |
| Signature Date Time | Signature Date Time | |

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SAMPLE EX-PP-01

**UPS Next Day Air®**
**UPS Worldwide Express**
Shipping Document

See instructions on back. Call 1-800-PICK-UPS (800-742-5877) for additional information.

TRACKING NUMBER: 0909 521 010 6

**1 SHIPMENT FROM**

SHIPPER'S UPS ACCOUNT NO.: UPS SHIPPER NO. / UPS BILLING NO.: 5907223326

FOR UPS USE: A00X99

REFERENCE NUMBER: 101.9(001).052 RICO

NAME: Steve Story

TELEPHONE: 970-484-3611

COMPANY: ESA CONSULTANTS

STREET ADDRESS: 2637 MIDPOINT DR STE F

CITY AND STATE: FORT COLLINS

ZIP CODE: CO 80525

**2 EXTREMELY URGENT DELIVERY TO**

NAME: John Ashe

TELEPHONE: (406) 723-2080

COMPANY: Ashe Analytics, Inc.

STREET ADDRESS: 309 Kaw Ave.

DEPT./FLOOR:

CITY AND STATE (INCLUDE COUNTRY IF INTERNATIONAL): Butte, MT

ZIP CODE: 59701

**3 WEIGHT AND ZONE**

| WEIGHT (ENTER "LTR" IF LETTER) | DIMENSIONAL WEIGHT (If Applicable) | ZONE |
|---|---|---|
| 1.02 lbs. | | |

SHIPPER'S COPY

**4 TYPE OF SERVICE**

| | CHARGES |
|---|---|
| [X] NEXT DAY AIR [ ] WORLDWIDE EXPRESS (INTERNATIONAL) | $ |
| FOR WORLDWIDE EXPRESS SHIPMENTS Mark an "X" in this box if shipment only contains documents of no commercial value. [ ] DOCUMENTS ONLY | |

**5 OPTIONAL SERVICES**

| | |
|---|---|
| [ ] SATURDAY PICKUP (See instructions.) [ ] SATURDAY DELIVERY (See instructions.) | $ |
| [ ] DECLARED VALUE (Carriers are automatically indemnified up to $100. For declared value over $100, see instructions.) $ _____ AMOUNT | $ |
| [ ] C.O.D. (If C.O.D., enter amount to be collected and attach completed UPS C.O.D. tag or package.) $ _____ AMOUNT | $ |

**6 ADDITIONAL HANDLING CHARGE**

[ ] An Additional Handling Charge applies for certain items. See instructions. $

**TOTAL CHARGES** $

**7 METHOD OF PAYMENT**

[X] BILL SHIPPER [ ] BILL RECEIVER [ ] BILL THIRD PARTY (Next Day Air Only) [ ] AMERICAN EXPRESS [ ] MASTER CARD [ ] VISA [ ] CHECK [ ] UPS USE ONLY (CASH)

Respond Account No. in Section 8

**8 RECEIVER'S / THIRD PARTY'S UPS ACCT. NO. OR MAJOR CREDIT CARD NO.** EXPIRATION DATE /

THIRD PARTY'S COMPANY NAME

STREET ADDRESS

CITY AND STATE

ZIP CODE

**9 SHIPPER'S SIGNATURE** X

DATE OF SHIPMENT 7/23/96

010191120 9/95 W

ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, CO 80525
(970) 484-3611 (970) 484-4118 FAX

# SOIL SAMPLING
## FIELD DATA FORM

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Date: 7/25/96
Weather Conditions: Overcast, Warm. Temperature: 68°F

Sampling Personnel (Signatures): Photo. Roll #: R4

*Tie picture numbers to samples below, if any

## SOIL SAMPLES

| | Tag Number | Sample Number | Sample Type | Depth Below Grade/Depth Interval | Time | Laboratory Analysis | Location |
|---|---|---|---|---|---|---|---|
| 1. | 00127 | EX-PP-02 | Soil | 0-6" | 1000 | Zinc-XRF | Pro Patria: Center West side · ☒ R4, #9, 10. Plotted 03-1 |
| 2. | 00128 | EX-AR-02 | Soil | 0-6" | 1040 | Zinc-XRF | Argentine: Pond 4 · East side · ☒ R4, #11, 12. Plotted AT-3 |
| 3. | | | | | | | |
| 4. | | | | | | | |
| 5. | | | | | | | |
| 6. | | | | | | | |
| 7. | | | | | | | |
| 8. | | | | | | | |
| 9. | | | | | | | |
| 10. | | | | | | | |

# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

**Samples sent to:**
John Ashe
Ashe Analytics, Inc.
1309 Kaw Ave.
Butte, MT. 59701
(406) 723-2080

FOR LAB USE
LAB ID_____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~002~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # EX-PP-02 Tag# 00127 | Soil | Zinc - XRF |
| Sample # EX-AR-02 Tag# 00128 | Soil | Zinc - XRF |
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| SAMPLES RELINQUISHED BY | SAMPLES RECEIVED BY | FORM NO. |
|---|---|---|
| Signature [signature] Date 7/25/96 Time 1400 | Signature Date Time | 5 |
| Signature Date Time | Signature Date Time | |

G:\USERS\TYNAS\FORMS\FIELD\SMPLANAL.FRM

SAMPLES EX-PP-02 & EX-AR-02

# UPS Next Day Air® UPS Worldwide Express
## Shipping Document

See instructions on back. Call 1-800-PICK-UPS (800-742-5877) for additional information.

TRACKING NUMBER: 0909 521 011 5

**1 SHIPMENT FROM**

SHIPPER'S UPS ACCOUNT NO.: UPS SHIPPER NO. / UPS BILLING NO.: 5907223326 — FOR UPS USE: 800X99

REFERENCE NUMBER: 101.9601.052 Rico

NAME: Steve Story — TELEPHONE: 970-484-3611

COMPANY: ESA CONSULTANTS

STREET ADDRESS: 2637 MIDPOINT DR STE F

CITY AND STATE: FORT COLLINS CO — ZIP CODE: 80525

**2 EXTREMELY URGENT DELIVERY TO**

NAME: John Ashe — TELEPHONE: (406)723-2080

COMPANY: Ashe Analytics, Inc.

STREET ADDRESS: 1309 Kaw Ave. — DEPT./FLOOR:

CITY AND STATE (INCLUDE COUNTRY IF INTERNATIONAL): Butte, MT. — ZIP CODE: 59701

177
168
135

**3 WEIGHT AND ZONE**

WEIGHT ENTER "LTR" IF LETTER: 2.2 lbs. — DIMENSIONAL WEIGHT (If Applicable): — ZONE:

SHIPPER'S COPY

**4 TYPE OF SERVICE**

- [X] NEXT DAY AIR
- [ ] WORLDWIDE EXPRESS (INTERNATIONAL)
- FOR WORLDWIDE EXPRESS SHIPMENTS Mark an "X" in this box if shipment only contains documents of no commercial value. [ ] DOCUMENTS ONLY

**5 OPTIONAL SERVICES**

- [ ] SATURDAY PICKUP See instructions.
- [ ] SATURDAY DELIVERY See instructions.
- [ ] DECLARED VALUE Contents are automatically protected up to $100. For declared value over $100, see instructions. $ AMOUNT
- [ ] C.O.D. If C.O.D., enter amount to be collected and attach completed UPS C.O.D. tag to package. $ AMOUNT

**6 ADDITIONAL HANDLING CHARGE**

- [ ] An Additional Handling Charge applies for certain items. See instructions.

TOTAL CHARGES: $

CHARGES: $ / $ / $ / $

**7 METHOD OF PAYMENT**

- [X] BILL SHIPPER
- BILL RECEIVER (NEXT DAY AIR ONLY) [ ]
- BILL THIRD PARTY (NEXT DAY AIR ONLY) [ ]
- AMERICAN EXPRESS [ ]
- MASTER CARD [ ]
- VISA [ ]
- CHECK [ ]
- UPS USE (CASH) [ ]

RECORD ACCOUNT NO. IN SECTION 8

**8 RECEIVER'S / THIRD PARTY'S UPS ACCT. NO. OR MAJOR CREDIT CARD NO.** — EXPIRATION DATE /

THIRD PARTY'S COMPANY NAME

STREET ADDRESS

CITY AND STATE — ZIP CODE

**9 SHIPPER'S SIGNATURE** X [signature] — DATE OF SHIPMENT 7/25/96

010191120 9/95 W

ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, CO 80525
(970) 484-3611 (970) 484-4118 FAX

# SOIL SAMPLING
## FIELD DATA FORM

Project Name: Rico Site Remediation
Project Number: 101.9601.~~052~~ 052
Date: 7/26/96
Weather Conditions: Overcast
Temperature: 70°F

Sampling Personnel (Signatures): [signature]
Photo. Roll #: R4

*Tie picture numbers to samples below, if any

## SOIL SAMPLES

| | Tag Number | Sample Number | Sample Type | Depth Below Grade/Depth Interval | Time | Laboratory Analysis | Location |
|---|---|---|---|---|---|---|---|
| 1. | 00130 | EX-SC-02 | Soil-Organic | 0-6" | 1700 | Zinc-XRF | Santa Cruz: N.E. Area ID 23, 24. Plotted on SC-2 |
| 2. | 00131 | EX-SC-03 | Soil-Organic | 0-6" | 1700 | Zinc-XRF | Santa Cruz: N.E. Area ID 23, 24. Plotted on SC-2 |
| 3. | 00129 | LM-SC-01 | Soil-Organic | 0-6" | 1700 | Lime Application | Santa Cruz: N.E. Area ID 23, 24. Plotted on SC-2 |
| 4. | | | | | | | |
| 5. | | | | | | | |
| 6. | | | | | | | |
| 7. | | | | | | | |
| 8. | | | | | | | |
| 9. | | | | | | | |
| 10. | | | | | | | |

# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

**Samples sent to:**
John Ashe
Ashe Analytics, Inc.
1309 Kaw Ave.
Butte, MT 59701
(406) 723-2080

FOR LAB USE
LAB ID_____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # EX-SL-02 Tag # 00130 | Soil | Zinc · XRF |
| | | |
| Sample # EX-SL-03 Tag # 00131 | Soil | Zinc · XRF |
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| SAMPLES RELINQUISHED BY | SAMPLES RECEIVED BY | FORM NO. |
|---|---|---|
| Signature [signature] Date 7/29/96 Time 1400 | Signature Date Time | 6 |
| Signature Date Time | Signature Date Time | |

G:\USERS\TYNAS\FORMS\FIELD\SMPLANAL.FRM

SAMPLES EX-SC-02 & EX-SC-03

**UPS Next Day Air®**
**UPS Worldwide Express**
Shipping Document

See instructions on back. Call 1-800-PICK-UPS (800-742-5877) for additional information.

TRACKING NUMBER 0909 521 012 4

**1 SHIPMENT FROM**

SHIPPER'S UPS ACCOUNT NO. 5907223326

UPS SHIPPER NO. / UPS BILLING NO.

FOR UPS USE 800X99

REFERENCE NUMBER 101.9601.052

NAME Steve Story

TELEPHONE 970-484-3611

COMPANY ESA CONSULTANTS

STREET ADDRESS 2637 MIDPOINT DR STE F

CITY AND STATE FORT COLLINS CO

ZIP CODE 80525

**2 EXTREMELY URGENT DELIVERY TO**

NAME John Ashe

TELEPHONE (406)723-2080

COMPANY Ashe Analytics, Inc.

STREET ADDRESS 1309 Kaw Ave.

DEPT./FLOOR

CITY AND STATE (INCLUDE COUNTRY IF INTERNATIONAL) Butte, MT.

ZIP CODE 59701

**3 WEIGHT AND ZONE**

WEIGHT (ENTER "LTR" IF LETTER): 1.9 lbs.

DIMENSIONAL WEIGHT (If Applicable)

ZONE

SHIPPER'S COPY

**4 TYPE OF SERVICE**

[X] NEXT DAY AIR [ ] WORLDWIDE EXPRESS (INTERNATIONAL)

FOR WORLDWIDE EXPRESS SHIPMENTS Mark an "X" in this box if shipment only contains documents of no commercial value. [ ] DOCUMENTS ONLY

CHARGES

**5 OPTIONAL SERVICES**

[ ] SATURDAY PICKUP (See Instructions) [ ] SATURDAY DELIVERY (See Instructions) $

[ ] DECLARED VALUE Contents are automatically protected up to $100. For declared value over $100, see instructions. $ _____ AMOUNT $

[ ] C.O.D. If C.O.D., enter amount to be collected and attach completed UPS C.O.D. tag to package. $ _____ AMOUNT $

**6 ADDITIONAL HANDLING CHARGE**

[ ] An Additional Handling Charge applies for certain items. See Instructions. $

TOTAL CHARGES $

**7 METHOD OF PAYMENT**

[X] BILL SHIPPER [ ] BILL RECEIVER [ ] BILL THIRD PARTY (Next Day Air Only) [ ] AMERICAN EXPRESS [ ] MASTER CARD [ ] VISA [ ] CHECK [ ] UPS USE CARD

Record Account No. in Section 8

**8 RECEIVER'S / THIRD PARTY'S UPS ACCT. NO. OR MAJOR CREDIT CARD NO.** EXPIRATION DATE

THIRD PARTY'S COMPANY NAME

STREET ADDRESS

CITY AND STATE

ZIP CODE

**9 SHIPPER'S SIGNATURE** X

DATE OF SHIPMENT 7/29/96

010191120 9/95 W

PRESS HOLD COPIES FOR PRINTING

ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, CO 80525
(970) 484-3611 (970) 484-4118 FAX

# SOIL SAMPLING
## FIELD DATA FORM

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Date: 7/31/96
Weather Conditions: Cloud Cover, COOL.
Temperature: 60°F

Sampling Personnel (Signatures): [signature]

Photo. Roll #: R5

*Tie picture numbers to samples below, if any

## SOIL SAMPLES

| | Tag Number | Sample Number | Sample Type | Depth Below Grade/Depth Interval | Time | Laboratory Analysis | Location |
|---|---|---|---|---|---|---|---|
| 1. | 00132 | EX-SC-04 | Soil | 0-6" | 0910 | Zinc-XRF | Santa Cruz · N.E. Area · Ⓒ # 11, 12. |
| 2. | | | | | | | Plotted on sheet Sc-2 |
| 3. | | | | | | | |
| 4. | | | | | | | |
| 5. | | | | | | | |
| 6. | | | | | | | |
| 7. | | | | | | | |
| 8. | | | | | | | |
| 9. | | | | | | | |
| 10. | | | | | | | |

# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

**Samples sent to:**
John Ashe
Ashe Analytics, Inc.
1309 Kaw Ave
Butte, MT. 59701
(406) 723-2080

FOR LAB USE
LAB ID_____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # EX-SC-04 Tag # 00132 | Soil | Zinc - XRF |
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| SAMPLES RELINQUISHED BY | SAMPLES RECEIVED BY | FORM NO. |
|---|---|---|
| Signature [signature] Date 7/31/96 Time 1400 | Signature Date Time | 7. |
| Signature Date Time | Signature Date Time | |

SAMPLE EX-SC-04

# UPS Next Day Air® UPS Worldwide Express Shipping Document

See instructions on back. Call 1-800-PICK-UPS (800-742-5877) for additional information.

TRACKING NUMBER: 0909 521 013 3

**1 SHIPMENT FROM**

SHIPPER'S UPS ACCOUNT NO: UPS SHIPPER NO. / UPS BILLING NO.: 5907223326 — FOR UPS USE: 800X99

REFERENCE NUMBER: 101.9601.052

NAME: Steve Story — TELEPHONE: 970-484-3611

COMPANY: ESA CONSULTANTS

STREET ADDRESS: 2637 MIDPOINT DR STE E

CITY AND STATE: FORT COLLINS — ZIP CODE: CO 80525

PLEASE PRESS HARD YOU ARE MAKING 3 COPIES

**2 EXTREMELY URGENT DELIVERY TO**

NAME: John Ashe — TELEPHONE: (406)723-2080

COMPANY: Ashe Analytics, Inc.

STREET ADDRESS: 1309 Kaw Ave. — DEPT./FLOOR:

CITY AND STATE (INCLUDE COUNTRY IF INTERNATIONAL): Butte, MT. — ZIP CODE: 59701

177

168

135

**3 WEIGHT AND ZONE**

| WEIGHT ENTER "LTR" IF LETTER | DIMENSIONAL WEIGHT If Applicable | ZONE |
|---|---|---|
| 1.1 lb. | | |

SHIPPER'S COPY

**4 TYPE OF SERVICE**

- [X] NEXT DAY AIR
- [ ] WORLDWIDE EXPRESS (INTERNATIONAL)
- FOR WORLDWIDE EXPRESS SHIPMENTS Mark an "X" in this box if shipment only contains documents of no commercial value. [ ] DOCUMENTS ONLY

**5 OPTIONAL SERVICES**

- [ ] SATURDAY PICKUP See instructions.
- [ ] SATURDAY DELIVERY See instructions.
- [ ] DECLARED VALUE Contents are automatically protected up to $100. For declared value over $100, see instructions. $ AMOUNT
- [ ] C.O.D. If C.O.D., enter amount to be collected and attach completed UPS C.O.D. tag to package. $ AMOUNT

**6 ADDITIONAL HANDLING CHARGE**

- [ ] An Additional Handling Charge applies for certain items. See instructions.

**TOTAL CHARGES**

CHARGES: $ / $ / $ / $ / $

**7 METHOD OF PAYMENT**

BILL SHIPPER [X] — BILL RECEIVER [ ] — BILL THIRD PARTY [ ] — AMERICAN EXPRESS [ ] — MASTER CARD [ ] — VISA [ ] — CHECK [ ] — UPS USE (CASH) [ ]

NEXT DAY AIR ONLY — RECORD ACCOUNT NO. IN SECTION 8

**8 RECEIVER'S / THIRD PARTY'S UPS ACCT. NO. OR MAJOR CREDIT CARD NO.** — EXPIRATION DATE

THIRD PARTY'S COMPANY NAME

STREET ADDRESS

CITY AND STATE — ZIP CODE

**9 SHIPPER'S SIGNATURE** X [signature] — DATE OF SHIPMENT 7/31/96

010191120 9/95 W

ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, CO 80525
(970) 484-3611 (970) 484-4118 FAX

# SOIL SAMPLING
## FIELD DATA FORM

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Date: 8/2/96
Weather Conditions: Clear, Calm, Warm
Temperature: 70°F

Sampling Personnel (Signatures):
Photo. Roll #: R5

*Tie picture numbers to samples below, if any

## SOIL SAMPLES

| | Tag Number | Sample Number | Sample Type | Depth Below Grade/Depth Interval | Time | Laboratory Analysis | Location |
|---|---|---|---|---|---|---|---|
| 1. | 00133 | EX-SSE-01 | Soil | 0-6" | 1245 | Zinc-XRF | ~~Sonic~~ Silver Swan East. ~~[illegible]~~ R5, # 18, 19. |
| 2. | | | | | | | Plotted on Sheet SS-2 |
| 3. | | | | | | | |
| 4. | | | | | | | |
| 5. | | | | | | | |
| 6. | | | | | | | |
| 7. | | | | | | | |
| 8. | | | | | | | |
| 9. | | | | | | | |
| 10. | | | | | | | |

# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

**Samples sent to:**
John Ashe
Ashe Analytics, Inc.
1309 Kaw Ave.
Butte, MT. 59701
(406) 723-2080

FOR LAB USE
LAB ID _____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values; Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # EX-65E-01 Tag # 00133 | Soil | Zinc - XRF |
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| SAMPLES RELINQUISHED BY | SAMPLES RECEIVED BY | FORM NO. |
|---|---|---|
| Signature: [signature] Date: 8/2/96 Time: 1400 | Signature: Date: Time: | 8 |
| Signature: Date: Time: | Signature: Date: Time: | |

SAMPLE EX-SSE-01

**UPS Next Day Air®**
**UPS Worldwide Express**
Shipping Document

See Instructions on back. Call 1-800-PICK-UPS (800-742-5877) for additional information.

TRACKING NUMBER 0909 521 014 2

**1 SHIPMENT FROM**

SHIPPER'S UPS ACCOUNT NO: 5907223326 | UPS SHIPPER NO. / UPS BILLING NO. | FOR UPS USE: 800X99

REFERENCE NUMBER: 101.9601.052

NAME: Steve Story | TELEPHONE: 970-484-3611

COMPANY: ESA CONSULTANTS

STREET ADDRESS: 2637 MIDPOINT DR STE E

CITY AND STATE: FORT COLLINS CO | ZIP CODE: 80525

PLEASE PRESS HARD YOU'RE MAKING 3 COPIES

**2 EXTREMELY URGENT DELIVERY TO**

NAME: John Ashe | TELEPHONE: (406) 723-2080

COMPANY: Ashe Analytics, Inc.

177 STREET ADDRESS: 1309 Kaw Ave. | DEPT./FLOOR

168

135 CITY AND STATE (INCLUDE COUNTRY IF INTERNATIONAL): Butte, MT. | ZIP CODE: 59701

**3 WEIGHT AND ZONE**

| WEIGHT (ENTER "LTR" IF LETTER) | DIMENSIONAL WEIGHT (If Applicable) | ZONE |
|---|---|---|
| 1.1 lb. | | |

SHIPPER'S COPY

**4 TYPE OF SERVICE** — CHARGES

- [X] NEXT DAY AIR
- [ ] WORLDWIDE EXPRESS (INTERNATIONAL)
- FOR WORLDWIDE EXPRESS SHIPMENTS Mark an "X" in the box if shipment only contains documents of no commercial value. [ ] DOCUMENTS ONLY — $

**5 OPTIONAL SERVICES**

- [ ] SATURDAY PICKUP (See instructions.) [ ] SATURDAY DELIVERY (See instructions.) — $
- [ ] DECLARED VALUE — Contents are automatically protected up to $100. For declared value over $100, see instructions. $ AMOUNT — $
- [ ] C.O.D. — If C.O.D., enter amount to be collected and attach completed UPS C.O.D. tag to package. $ AMOUNT — $

**6 ADDITIONAL HANDLING CHARGE**

- [ ] An Additional Handling Charge applies for certain items. See instructions. — $

TOTAL CHARGES — $

**7 METHOD OF PAYMENT**

- [X] BILL SHIPPER
- BILL RECEIVER [ ] (Next Day Air Only)
- BILL THIRD PARTY [ ] (Next Day Air Only)
- AMERICAN EXPRESS [ ]
- MASTER CARD [ ]
- VISA [ ]
- CHECK [ ]
- UPS USE CASH [ ]

Receiver Account No. in Section 8

**8 RECEIVER'S / THIRD PARTY'S UPS ACCT. NO. OR MAJOR CREDIT CARD NO.** | EXPIRATION DATE

THIRD PARTY'S COMPANY NAME

STREET ADDRESS

CITY AND STATE | ZIP CODE

**9 SHIPPER'S SIGNATURE** X [signature] | DATE OF SHIPMENT 8/2/96

010191120 9/95 W

ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, CO 80525
(970) 484-3611 (970) 484-4118 FAX

# SOIL SAMPLING
## FIELD DATA FORM

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Date: 8/20/96
Weather Conditions: Partly Cloudy, Sprinkling Rain
Temperature: 68°F

Sampling Personnel (Signatures): [signature]

Photo. Roll #: 7

*Tie picture numbers to samples below, if any

## SOIL SAMPLES

| | Tag Number | Sample Number | Sample Type | Depth Below Grade/Depth Interval | Time | Laboratory Analysis | Location |
|---|---|---|---|---|---|---|---|
| 1. | 00134 | EX-SSW-01 | Soil | 0-6" | 1340 | Zinc-XRF | Silver Swan West. Between Main Pile (on East side) |
| 2. | x | x | x | x | x | x | and Dolores River. Photo # 24, 25. Plotted on Sheet SS-2 |
| 3. | 00135 | EX-SSW-02 | Soil | 0-6" | 1410 | Zinc-XRF | Silver Swan West. Stripped Area North of Main Pile. |
| 4. | | | | | | | Photo # 29, 30. Plotted on Sheet SS-2 |
| 5. | | | | | | | |
| 6. | | | | | | | |
| 7. | | | | | | | |
| 8. | | | | | | | |
| 9. | | | | | | | |
| 10. | | | | | | | |

# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

**Samples sent to:**
Ashe Analytics, Inc.
1309 Kaw Ave.
Butte, MT. 59701
(406) 723-2080

FOR LAB USE
LAB ID _____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # EX-SSW-01 Tag # 00134 | Soil | Zinc - XRF |
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| Sample # EX-SSW-02 Tag # 00135 | Soil | Zinc - XRF |
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| SAMPLES RELINQUISHED BY | SAMPLES RECEIVED BY | FORM NO. |
|---|---|---|
| Signature [signature] Date 8/21/96 Time 1400 | Signature Date Time | 9. |
| Signature Date Time | Signature Date Time | |

SAMPLES EX-SSW-01 & EX-SSW-02

**UPS Next Day Air®**
**UPS Worldwide Express**
Shipping Document

See instructions on back. Call 1-800-PICK-UPS (800-742-5877) for additional information.

TRACKING NUMBER: 0909 521 021 3

**1 SHIPMENT FROM**

SHIPPER'S UPS ACCOUNT NO.: 5907223326
UPS SHIPPER NO. / UPS BILLING NO.:
FOR UPS USE: 800X99

REFERENCE NUMBER: Rico 101.9601.052

NAME: Steve Story
TELEPHONE: 970-484-3611

COMPANY: ESA CONSULTANTS

STREET ADDRESS: 2637 MIDPOINT DR STE F

CITY AND STATE: FORT COLLINS CO
ZIP CODE: 80525

**2 EXTREMELY URGENT DELIVERY TO**

NAME: John Ashe
TELEPHONE: (406) 723-2080

COMPANY: Ashe Analytics, Inc.

STREET ADDRESS: 1309 Kaw Ave.
DEPT./FLOOR:

CITY AND STATE (INCLUDE COUNTRY IF INTERNATIONAL): Butte, MT.
ZIP CODE: 59701

**3 WEIGHT AND ZONE**

| WEIGHT (ENTER "LTR" IF LETTER) | DIMENSIONAL WEIGHT (If Applicable) | ZONE |
|---|---|---|
| 1.9 lb. | | |

SHIPPER'S COPY

**4 TYPE OF SERVICE** — CHARGES

- [X] NEXT DAY AIR
- [ ] WORLDWIDE EXPRESS (INTERNATIONAL)
- FOR WORLDWIDE EXPRESS SHIPMENTS Mark an "X" in this box if shipment only contains documents of no commercial value. [ ] DOCUMENTS ONLY — $

**5 OPTIONAL SERVICES**

- [ ] SATURDAY PICKUP (See Instructions) — $
- [ ] SATURDAY DELIVERY (See Instructions) — $
- [ ] DECLARED VALUE (Contents are automatically protected up to $100. For declared value over $100, see instructions.) $ _____ AMOUNT — $
- [ ] C.O.D. (If C.O.D., enter amount to be collected and attach completed UPS C.O.D. tag to package.) $ _____ AMOUNT — $

**6 ADDITIONAL HANDLING CHARGE**

- [ ] An Additional Handling Charge applies for certain items. See instructions. — $

TOTAL CHARGES — $

**7 METHOD OF PAYMENT**

- [X] BILL SHIPPER
- BILL RECEIVER (Next Day Air Only) [ ]
- BILL THIRD PARTY (Next Day Air Only) [ ]
- AMERICAN EXPRESS [ ]
- MASTER CARD [ ]
- VISA [ ]
- CHECK [ ]
- UPS USE CARD [ ]

(Receiver Account No. in Section 8)

**8 RECEIVER'S / THIRD PARTY'S UPS ACCT. NO. OR MAJOR CREDIT CARD NO.**
EXPIRATION DATE

THIRD PARTY'S COMPANY NAME

STREET ADDRESS

CITY AND STATE
ZIP CODE

**9 SHIPPER'S SIGNATURE** X
DATE OF SHIPMENT: 8/21/96

010191120 9/95 W

ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, CO 80525
(970) 484-3611 (970) 484-4118 FAX

# SOIL SAMPLING
## FIELD DATA FORM

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Date: 8/26/96
Weather Conditions: Overcast, Calm. Temperature: 60°F

Sampling Personnel (Signatures): [signature]

Photo. Roll #: ~~R8~~ R9

*Tie picture numbers to samples below, if any

## SOIL SAMPLES

| | Tag Number | Sample Number | Sample Type | Depth Below Grade/Depth Interval | Time | Laboratory Analysis | Location |
|---|---|---|---|---|---|---|---|
| 1. | 00137 | EX-CO-01 | Soil | 0-6" | 1115 | Zinc-XRF | Stripped Area South of Columbia Pile |
| 2. | | | | | | | Photos # 2, #3. Plotted on Sheet CT-2. |
| 3. | | | | | | | |
| 4. | | | | | | | |
| 5. | | | | | | | |
| 6. | | | | | | | |
| 7. | | | | | | | |
| 8. | | | | | | | |
| 9. | | | | | | | |
| 10. | | | | | | | |

# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

**Samples sent to:**
John Ashe
ASHE Analytics, INC.
1309 Kaw Ave.
Butte, MT- 59701
(406) 723-2080

FOR LAB USE
LAB ID_____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Tag # 00137 Sample # EX-60-01 | Soil | Zinc: XRF |
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| SAMPLES RELINQUISHED BY | SAMPLES RECEIVED BY | FORM NO. |
|---|---|---|
| Signature [signature] Date 8/26/96 Time 1400 | Signature Date Time | 10. |
| Signature Date Time | Signature Date Time | |

SAMPLE EX-CO-01

# UPS Next Day Air
# UPS Worldwide Express
## Shipping Document

See instructions on back. Call 1-800-PICK-UPS (800-742-5877) for additional information.

TRACKING NUMBER: 0909 521 022 2

**1 SHIPMENT FROM**

SHIPPER'S UPS ACCOUNT NO.: UPS SHIPPER NO. / UPS BILLING NO.: 5907223326 — FOR UPS USE: 800X99

REFERENCE NUMBER: Rico 101.9601.052

NAME: Steve Story — TELEPHONE: 970-484-3611

COMPANY: ESA CONSULTANTS

STREET ADDRESS: 2637 MIDPOINT DR STE F

CITY AND STATE: FORT COLLINS — ZIP CODE: CO 80525

PLEASE PRESS HARD YOU ARE MAKING 3 COPIES

**2 EXTREMELY URGENT DELIVERY TO**

NAME: John Ashe — TELEPHONE: (406)723-2080

COMPANY: Ashe Analytics, Inc.

177

168 STREET ADDRESS: 1309 Kaw Ave. — DEPT./FLOOR:

135 CITY AND STATE (INCLUDE COUNTRY IF INTERNATIONAL): Butte, MT. — ZIP CODE: 59701

**3 WEIGHT AND ZONE**

| WEIGHT (ENTER "LTR" IF LETTER) | DIMENSIONAL WEIGHT | ZONE |
|---|---|---|
| 1.25 lb. | | |

SHIPPER'S COPY

**4 TYPE OF SERVICE**

- [X] NEXT DAY AIR
- [ ] WORLDWIDE EXPRESS (INTERNATIONAL)
- FOR WORLDWIDE EXPRESS SHIPMENTS: Mark an "X" in this box if shipment only contains documents of no commercial value. [ ] DOCUMENTS ONLY

**5 OPTIONAL SERVICES**

- [ ] SATURDAY PICKUP — See instructions.
- [ ] SATURDAY DELIVERY — See instructions.
- [ ] DECLARED VALUE — Contents are automatically protected up to $100. For declared value over $100, see instructions. $ AMOUNT
- [ ] C.O.D. — If C.O.D., enter amount to be collected and attach completed UPS C.O.D. tag to package. $ AMOUNT

**6 ADDITIONAL HANDLING CHARGE**

- [ ] An Additional Handling Charge applies for certain items. See instructions.

**TOTAL CHARGES**

CHARGES: $ / $ / $ / $ / $

**7 METHOD OF PAYMENT**

| BILL SHIPPER | BILL RECEIVER (NOT ON AIR ONLY) | BILL THIRD PARTY | AMERICAN EXPRESS | MASTER CARD | VISA | CHECK | UPS USE (CASH) |
|---|---|---|---|---|---|---|---|
| [X] | [ ] | [ ] | [ ] | [ ] | [ ] | [ ] | [ ] |

Record Account No. in Section 8

**8 RECEIVER'S / THIRD PARTY'S UPS ACCT. NO. OR MAJOR CREDIT CARD NO.** — EXPIRATION DATE

THIRD PARTY'S COMPANY NAME

STREET ADDRESS

CITY AND STATE — ZIP CODE

**9 SHIPPER'S SIGNATURE** X [signature] — DATE OF SHIPMENT 8/26/96

010191120 9/95 W

# APPENDIX B

## ANALYTICAL REPORT
## ASHE ANALYTICS, INC.

Ashe
Analytics, Inc.
P.O. Box 4172 • Butte, Montana 59701
(406) 723-2080

RECEIVED
SEP 16 1996

September 12, 1996

Mr. Ed Schneider
ESA CONSULTANTS, INC.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525

RE: RICO SITE REMEDIATION Analytical Report
Project 101.9601.052

Dear Mr. Schneider:

Attached is the analytical report for samples relating to the Rico site remediation (Project 101.9601.052).

Samples were received in good condition. They are being held, in ambient laboratory conditions, for final disposition instructions. The laboratory is locked and secured when not occupied.

Analyses were performed under the protocol defined in the "Laboratory Analytical Procedures for x-ray fluorescence analysis of solid media. I: Laboratory-grade instrumentation method" dated October, 1995. A copy is attached for information. No violations of the QA/QC standards occurred to cause any re-analyses.

No unusual events which could affect the analytical results occurred during the analysis period.

Sincerely,

John B. Ashe, PhD
President

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John B. Ashe, PhD
President

ANALYTICAL RESULTS
RICO SITE REMEDIATION
PROJECT NO. 101.9601.052

| LABORATORY SAMPLE NUMBER | SAMPLE I.D. | Zinc (mg/kg) | SAMPLE PREP GROUP |
|---|---|---|---|
| 6-0882.1 | EX-SH-01 | 3740 | 999242 |
| 6-0897 | EX-AR-01 | 1130 | 999242 |
| 6-0910 | EX-SC-01 | 6330 | 999243 |
| 6-0911 | EX-PP-01 | 16600 | 999243 |
| 6-0914 | EX-PP-02 | 3840 | 999243 |
| 6-0915 | EX-AR-02 | 1120 | 999243 |
| 6-0918 | EX-SC-02 | 1440 | 999243 |
| 6-0919 | EX-SC-03 | 2640 | 999243 |
| 6-0939 | EX-SC-04 | 422 | 999243 |
| 6-0944 | EX-SSE-01 | 2030 | 999243 |
| 6-0968 | EX-SSW-01 | 788 | 999244 |
| 6-0969 | EX-SSW-02 | 1640 | 999244 |
| 6-0978.1 | EX-C~~B~~O-01 | 651 | 999244 |

QA/QC SAMPLES
RICO SITE REMEDIATION
PROJECT NO. 101.9601.052

| SAMPLE LABEL | REMARKS | ZN PPM |
|---|---|---|
| N-2710/A | ICV, 7/17/96 | 6975.96 |
| CERTIFIED | | 6952 |
| RECOVERY | | 100.3 |
| | | |
| N-2711/A | ICV, 7/17/96 | 374.641 |
| CERTIFIED | | 350.4 |
| RECOVERY | | 106.9 |
| | | |
| 6-0882.1 | | 3739.73 |
| 6-0882.2 | LAB DUP | 3708.9 |
| 6-0882R | LAB REP | 3919.32 |
| RPD, LAB DUP | | 0.83 |
| RPD, LAB REP | | 4.69 |
| | | |
| 999242 | XCS | 2.538 |
| 990242 | BLANK | 1.159 |

THE ABOVE BLANKS ARE ASSOCIATED WITH SPG 999242.

| | | |
|---|---|---|
| N-2710/A | LCS, 7/17/96 | 7006.04 |
| CERTIFIED | | 6952 |
| RECOVERY | | 100.8 |

THE ABOVE LCS ASSOCIATED WITH SAMPLE 6-0882.

| | | |
|---|---|---|
| N-2710/A | ICV, 7/22/96 | 6936.09 |
| CERTIFIED | | 6952 |
| RECOVERY | | 99.8 |
| | | |
| N-2711/A | ICV, 7/22/96 | 357.606 |
| CERTIFIED | | 350.4 |
| RECOVERY | | 102.1 |
| | | |
| N-2710/A | LCS, 7/22/96 | 6994.95 |
| CERTIFIED | | 6952 |
| RECOVERY | | 100.6 |

THE ABOVE LCS ASSOCIATED WITH SAMPLE 6-0897.

| | | |
|---|---|---|
| N-2710/A | ICV, 7/24/96 | 6897.21 |
| CERTIFIED | | 6952 |
| RECOVERY | | 99.2 |

3rd QUARTER, 1996

(Measured on July 24 through July 27, 1996)

| | MDL (mg/kg) | LOQ (mg/kg) |
|---|---|---|
| Copper | 11.6 | 38.7 |
| Zinc | 13.8 | 46.0 |
| Arsenic | 7.8 | 26.0 |
| Cadmium | 2.9 | 9.5 |
| Lead | 6.2 | 20.7 |

| SAMPLE LABEL | REMARKS | ZN PPM |
|---|---|---|
| N-2711/A | ICV, 7/24/96 | 351.872 |
| CERTIFIED | | 350.4 |
| RECOVERY | | 100.4 |
| 999243 | XCS | 2.722 |
| 990243 | BLANK | |

THE ABOVE BLANKS ARE ASSOCIATED WITH SPG 999243.

| | | |
|---|---|---|
| N-2710/A | LCS, 7/24/96 | 7052.99 |
| CERTIFIED | | 6952 |
| RECOVERY | | 101.5 |

THE ABOVE LCS ASSOCIATED WITH SAMPLES 6-0910 & 6-0911.

| | | |
|---|---|---|
| N-2710/A | ICV, 7/26/96 | 7002.29 |
| CERTIFIED | | 6952 |
| RECOVERY | | 100.7 |
| N-2711/A | ICV, 7/26/96 | 361.461 |
| CERTIFIED | | 350.4 |
| RECOVERY | | 103.2 |
| N-2710/A | LCS, 7/26/96 | 7071.51 |
| CERTIFIED | | 6952 |
| RECOVERY | | 101.7 |

THE ABOVE LCS ASSOCIATED WITH SAMPLES 6-0914 & 6-0915.

| | | |
|---|---|---|
| N-2710/A | ICV, 7/30/96 | 6882.92 |
| CERTIFIED | | 6952 |
| RECOVERY | | 99.0 |
| N-2711/A | ICV, 7/30/96 | 345.565 |
| CERTIFIED | | 350.4 |
| RECOVERY | | 98.6 |
| N-2710/A | LCS, 7/30/96 | 6858.85 |
| CERTIFIED | | 6952 |
| RECOVERY | | 98.7 |

THE ABOVE LCS ASSOCIATED WITH SAMPLES 6-0918 & 6-0919.

| | | |
|---|---|---|
| N-2710/A | ICV, 8/01/96 | 6983.7 |
| CERTIFIED | | 6952 |
| RECOVERY | | 100.5 |
| N-2710/A | LCS, 8/01/96 | 6898.98 |
| CERTIFIED | | 6952 |
| RECOVERY | | 99.2 |

THE ABOVE LCS ASSOCIATED WITH SAMPLE 6-0939.

| SAMPLE LABEL | REMARKS | ZN PPM |
|---|---|---|
| N-2710/A | ICV, 8/05/96 | 6975.17 |
| CERTIFIED | | 6952 |
| RECOVERY | | 100.3 |
| N-2711/A | ICV, 8/05/96 | 347.641 |
| CERTIFIED | | 350.4 |
| RECOVERY | | 99.2 |
| N-2710/A | LCS, 8/05/96 | 7077.06 |
| CERTIFIED | | 6952 |
| RECOVERY | | 101.8 |

THE ABOVE LCS ASSOCIATED WITH SAMPLE 6-0944.

| | | |
|---|---|---|
| 999244 | XCS | 5.276 |
| 990244 | BLANK | 3.362 |

THE ABOVE BLANKS ARE ASSOCIATED WITH SPG 999244.

| | | |
|---|---|---|
| N-2710/A | ICV, 8/22/96 | 6775.14 |
| CERTIFIED | | 6952 |
| RECOVERY | | 97.5 |
| N-2710/A | LCS, 8/22/96 | 6916.29 |
| CERTIFIED | | 6952 |
| RECOVERY | | 99.5 |

THE ABOVE LCS ASSOCIATED WITH SAMPLES 6-0968 & 6-0969.

| | | |
|---|---|---|
| N-2710/A | ICV, 8/27/96 | 6839.84 |
| CERTIFIED | | 6952 |
| RECOVERY | | 98.4 |
| N-2711/A | ICV, 8/27/96 | 356.75 |
| CERTIFIED | | 350.4 |
| RECOVERY | | 101.8 |
| 6-0978.1 | | 651.497 |
| 6-0978.2 | LAB DUP | 689.11 |
| 6-0978R | LAB REP | 669.177 |
| RPD, LAB DUP | | 5.61 |
| RPD, LAB REP | | 2.68 |
| N-2710/A | LCS, 8/27/96 | 6875.42 |
| CERTIFIED | | 6952 |
| RECOVERY | | 98.9 |

THE ABOVE LCS ASSOCIATED WITH SAMPLE 6-0978.

RAW DATA PRINTOUT (QA SAMPLES ANNOTATED)
RICO SITE REMEDIATION
PROJECT NO. 101.9601.052

| SAMPLE LABEL | ZN PPM | REMARKS |
|---|---|---|
| N-2710/A | 6975.957 | ICV, 7/17/96 |
| N-2711/A | 374.641 | ICV, 7/17/96 |
| 6-0882.1 | 3739.734 | |
| 6-0882.2 | 3708.899 | LAB DUP |
| 6-0882R | 3919.324 | LAB REP |
| 999242 | 2.538 | XCS |
| 990242 | 1.159 | BLANK |
| N-2710/A | 7006.042 | LCS, 7/17/96 |
| N-2710/A | 6936.087 | ICV, 7/22/96 |
| N-2711/A | 357.606 | ICV, 7/22/96 |
| 6-0897 | 1133.828 | |
| N-2710/A | 6994.953 | LCS, 7/22/96 |
| N-2710/A | 6897.206 | ICV, 7/24/96 |
| N-2711/A | 351.872 | ICV, 7/24/96 |
| 999243 | 2.722 | XCS |
| 990243 | | BLANK |
| 6-0910 | 6334.604 | |
| 6-0911 | 16624.346 | |
| N-2710/A | 7052.988 | LCS, 7/24/96 |
| N-2710/A | 7002.286 | ICV, 7/26/96 |
| N-2711/A | 361.461 | ICV, 7/26/96 |
| 6-0914 | 3836.429 | |
| 6-0915 | 1116.985 | |
| N-2710/A | 7071.514 | LCS, 7/26/96 |
| N-2710/A | 6882.916 | ICV, 7/30/96 |
| N-2711/A | 345.565 | ICV, 7/30/96 |
| 6-0918 | 1439.337 | |
| 6-0919 | 2637.194 | |
| N-2710/A | 6858.851 | LCS, 7/30/96 |
| N-2710/A | 6983.695 | ICV, 8/01/96 |
| 6-0939 | 422.489 | |
| N-2710/A | 6898.981 | LCS, 8/01/96 |
| N-2710/A | 6975.166 | ICV, 8/05/96 |
| N-2711/A | 347.641 | ICV, 8/05/96 |
| 6-0944.1 | 2026.085 | |
| N-2710/A | 7077.059 | LCS, 8/05/96 |
| 999244 | 5.276 | XCS |
| 990244 | 3.362 | BLANK |
| N-2710/A | 6775.142 | ICV, 8/22/96 |
| 6-0968 | 788.068 | |
| 6-0969 | 1643.174 | |
| N-2710/A | 6916.293 | LCS, 8/22/96 |
| N-2710/A | 6839.839 | ICV, 8/27/96 |
| N-2711/A | 356.75 | ICV, 8/27/96 |
| 6-0978.1 | 651.497 | |
| 6-0978.2 | 689.11 | LAB DUP |
| 6-0978R | 669.177 | LAB REP |
| N-2710/A | 6875.422 | LCS, 8/27/96 |

| Job Number | Sample I.D. | | | Date Rcvd | |
|---|---|---|---|---|---|
| 6-0862 | LL | 0100 | 7/11/96 | 7/15/96 | |
| 6-0863 | TL | 1400 | 7/11/96 | | |
| 6-0864 | TR | 1400 | 7/11/96 | | |
| 6-0865 | LR | 1400 | 7/11/96 | | |
| 6-0866 | LL | 1400 | 7/11/96 | | |
| 6-0867 | Cement In | 22:00 | 7/11/96 | | |
| 6-0868 | Cement In | 22:00 | 7/11/96 | | |
| 6-0869 | 2nd Thickener | 22:00 | 7/11/96 | | |
| 6-0870 | D009 | 07:00 | 7/12/96 | 7/15/96 | |
| 6-0871 | ~~7/13/96 #1~~ | 7 136 | #1 | 7/15/96 | |
| 6-0872 | 7/ | 7146 | #5 | 7/15/96 | |
| 6-0873 | RBSH-COMP | | | 7/15/96 | |
| 6-0874 | RBSH-COMP | | | 7/15/96 | |
| 6-0875 | #1 | | | 7/15/96 | |
| 6-0876 | #2 | | | | |
| 6-0877 | #3 | | | | |
| 6-0878 | #4 | | | | |
| 6-0879 | #5 | | | | |
| ~~6-0880~~ | ~~Sluice~~ | ~~Delete~~ | | ~~7/16/96~~ | 6.0880 A Run |
| ~~6-0881~~ | ~~Sugar Tank~~ | ~~Delete~~ | | ~~7/16/96~~ | |
| 6-0882 | EX-SH-01 | | | 7/17/96 | |

| Lab Number | Sample I.D. | | Date Rcvd |
|---|---|---|---|
| 6-0883 | #1 CD (red) | | 8/17/96 |
| 6-0884 | #2 CD (grey) | | 8/17/96 |
| 6-0885 | Cement. In | 02:30 7/15/96 | 7/19/96 |
| 6-0886 | Cement. Out | 02:30 7/15/96 | |
| 6-0887 | 2nd Thickener | 02:30 7/15/96 | |
| 6-0888 | Cement. Inlet | 15:45 7/16/96 | |
| 6-0889 | Cement. Outlet | 15:45 7/16/96 | |
| 6-0890 | 2nd Thickener | 15:40 7/16/96 | |
| 6-0891 | Cement. Inlet | 22:30 7/16/96 | |
| 6-0892 | Cement. Outlet | 22:30 7/16/96 | |
| 6-0893 | 2nd Thickener | 22:30 7/16/96 | |
| 6-0894 | Cement. Inlet | 19:30 7/17/96 | |
| 6-0895 | Cement Outlet | 19:30 7/17/96 | |
| ~~6-0896~~ | ~~2nd Underflow~~ | ~~19:30 7/17/96~~ | ~~7/19/96~~ |
| 6-0897 | EX-AR-01 | | 7/24/96 |
| ~~6-0898~~ | ~~UN Numbered~~ | | ~~7/24/96~~ |
| 6-0899 | Drainage ditch Bell St | | 7/23/96 |
| 6-0900 | SW Quadrant Bell St | | |
| 6-0901 | NW Quadrant Bell St | | |
| 6-0902 | NE Quadrant Bell St | | |
| 6-0903 | SE Quad Bell St | | 7/23/96 |

| Lab Number | Sample I.D. | Date Rec'd |
|---|---|---|
| 6-0904 | CM-0723-5S | 7/23/96 |
| 6-0905 | CM-0723-9S | |
| 6-0906 | CM-0723-10S | |
| 6-0907 | CM-0723-11S | |
| 6-0908 | CM-RINSATE | 7/23/96 |
| ~~6-0909~~ | ~~Kelly Stafford~~ | ~~7/24/96~~ |
| 6-0910 | EX-SC-01 | 7/24/96 |
| 6-0911 | EX-PP-01 | 7/24/96 |
| ~~6-0912~~ | ~~DWTP-1~~ | ~~7/24/96~~ |
| ~~6-0913~~ | ~~DWTP-2~~ | ~~7/24/96~~ |
| 6-0914 | EX-PP-02 | 7/26/96 |
| 6-0915 | EX-AR-02 | 7/26/96 |
| ~~6-0916~~ | ~~Buffalo/Sumner St~~ | ~~7/26/96~~ |
| ~~6-0917~~ | ~~Corner of Buffalo St & Sumner~~ | ~~7/26/96~~ |
| 6-0918 | EX-SC-02 | 7/30/96 |
| 6-0919 | EX-SC-03 | 7/30/96 |
| ~~6-0920~~ | ~~SHRIVER COMP 7/18/96~~ | ~~7/30/96~~ |
| 6-0921 | ~~Cement Inlet 20:00 7/18/96~~ | |
| 6-0922 | ~~Cement Outlet 20:00 7/18/96~~ | |
| 6-0923 | ~~2nd M/F 20:00 7/18/96~~ | |
| 6-0924 | SHRIVER 7/22/96 | 7/30/96 |

| Lab Number | Sample I.D. | | Date Rcvd |
|---|---|---|---|
| 6-0925 | Cement Inlet | 02:45 7/22/96 | 7/30/96 |
| 6-0926 | Cement Outlet | 02:45 7/22/96 | |
| 6-0927 | 2nd U/F | 02:45 7/22/96 | |
| 6-0928 | Cement Inlet | 7/24/96 | |
| 6-0929 | Cement Outlet | 7/24/96 | |
| 6-0930 | 2nd Thickener | 7/24/96 | |
| 6-0931 | SHRIVER | 03:00 7/25/96 | |
| 6-0932 | SHRIVER | 7/25/96 | |
| 6-0933 | Cement Inlet | 7/25/96 | |
| 6-0934 | Cement Outlet | 7/25/96 | |
| 6-0935 | 2nd Thickener | 7/25/96 | 7/30/96 |
| 6-0936 | BB-1 | | 7/30/96 |
| 6-0937 | BB-2 | | |
| ~~6-0938~~ | ~~BB-3~~ | | ~~7/31/96~~ |
| 6-0939 | EX-SC-04 | | 8/01/96 |
| ~~6-0940~~ | ~~Cement Inlet~~ | ~~7/29/96~~ | ~~8/01/96~~ |
| 6-0941 | Cement Out | 7/29/96 | |
| 6-0942 | 2nd Thickener | 7/29/96 | |
| ~~6-0943~~ | ~~Cement Inlet~~ | ~~7/30/96~~ | ~~8/01/96~~ |
| 6-0944 | EX-SSE-01 | | 8/05/96 |
| ~~6-0945~~ | ~~Shriver~~ | ~~02:30 7/26/96~~ | ~~8/07/96~~ |

A

000012

| Lab Number | Sample I.D. | Date Rcvd. |
|---|---|---|
| ~~6-0967~~ | ~~TPC-4~~ | ~~8/14/96~~ |
| 6-0968 | Ex-SSW-01 | 8/22/96 |
| 6-0969 | Ex-SSW-02 | 8/22/96 |
| ~~6-0970~~ | ~~DK-1 0-18"~~ | ~~8/22/96~~ |
| 6-0971 | DK-2 0-24" | |
| 6-0972 | DK-3 0-18" | |
| 6-0973 | ~~TPC-1 Pits 3 & 4~~ | |
| 6-0974 | TPC-2 Pits 1 & 2 | |
| 6-0975 | WDPC-1 Pits 1, 4, 5, 8 | |
| 6-0976 | WDPC-2 Pits 3 & 6 | |
| ~~6-0977~~ | ~~WDPC-3 Pits 2 & 7~~ | ~~8/22/96~~ |
| 6-0978 | Ex-CD-01 | 8/27/96 |
| ~~6-0979~~ | | |
| ~~6-0980~~ | | |
| 6-0981 | | |
| 6-0982 | | |
| 6-0983 | | |
| 6-0984 | | |
| 6-0985 | | |
| 6-0986 | | |
| 6-0987 | | |

July 17, 1996

Scale Calibration

| Weight | Reading |
|---|---|
| 5g | |
| 10g | |
| 20g | |
| 50g | |

Lot # 4 Cleaning Sand

| Sample I.D. | Grinding Vessel | Sample Wt (gms) |
|---|---|---|
| 6-0882 | 1 | 15.7 |
| 6-0882R | 2 | 16.7 |
| 7/17/96 ~~999228~~ | | ~~13.9, 1~~ |
| 999242, 990242 | 3 | 13.9, 14.1 |

[signature] 7/17/96

July 22, 1996

| Scale Weight | Calibration Reading |
|---|---|
| 5g | 5.0g |
| 10g | 10.0g |
| 20g | 20.0g |
| 50g | 50.0g |

Lot # 4 Clemmy Sand

| Sample I.D. | Grinding Vessel | Sample Wt (gm) |
|---|---|---|
| 6-0897 | 1 | 15.7g |

J. W. [illegible] 7/22/96

July 24, 1996

Scale Calibration

| Weight | Reading |
|---|---|
| 5g | 5.0g |
| 10g | 10.0g |
| 20g | 20.0g |
| 50g | 50.0g |

Lot # 4 cleaning Sand

| Sample I.D. | Grinding Vessel | Sample Wt (grams) |
|---|---|---|
| ~~6-0909~~ | ~~1~~ | ~~16.7~~ |
| 6-0910 | 2 | 17.3 |
| ~~6-0911~~ | 3 | 17.3 |
| ~~6-0901~~ 999, 243, 990243 | 1 | 13.3, 13.2 |
| ~~6-0902~~ | 2 | 16.3 |
| 6-0903 | 3 | 16.5 |
| 6-0901 | 1 | 16.1 |
| ~~6-0909~~ | ~~1~~ | ~~16.7~~ |
| 6-0910 | 2 | 16.8 |
| 6-0911 | 3 | 16.6 |

John Black
7/24/96

July 26, 1996

| Scale Weight | Calibration Reading |
|---|---|
| 5g | 5.0g |
| 10g | 10.0g |
| 20g | 20.0g |
| 50g | 50.0g |

(gms)

Tot #4 Cleaning Sand

| Sample I.D. | Grinding Vessel | Sample wt (gms) |
|---|---|---|
| ~~6-0912~~ | ~~1~~ | ~~16.3~~ |
| ~~6-0913~~ | ~~2~~ | ~~16.4~~ |
| 6-0914 | 3 | 16.1 |
| 6-0915 | 1 | 16.5 |
| ~~6-0916~~ | ~~2~~ | ~~16.7~~ |
| ~~6-0917~~ | ~~3~~ | ~~15.8~~ |

[signature]
7/26/96

7/30/96

Scale Calibration

| Weight | Reading |
|---|---|
| 5g | 5.0g |
| 10g | 10.0g |
| 20g | 20.0g |
| 50g | 50.0g |

Lot #4 Cleaning Sand

| Sample I.D. | Grinding Vial | Sample Wt. (gm) |
|---|---|---|
| 6-0918 | 1 | 16.7 |
| 6-0919 | 2 | 16.3 |
| ~~6-0926~~ | ~~3~~ | ~~17.1~~ |
| ~~6-0927~~ | ~~1~~ | ~~16.4~~ |
| ~~6-0938~~ | ~~2~~ | ~~16.4~~ |

7/30/96

8/01/96

Scale Calibration

| Weight | Reading |
|---|---|
| 5g | 5.0g |
| 10g | 10.0g |
| 20g | 20.0g |
| 50g | 50.1g |

Lot # 4 Cleaning Sand

| Sample I.D. | Grading Vessel | Sample wt. (gms) |
|---|---|---|
| 6-0939 | 1 | 16.6 g |

8/01/96

August 05, 1996

| Scale Weight | Calibration Reading |
|---|---|
| 5g | 5.0g |
| 10g | 10.0g |
| 20g | 20.0g |
| 50g | 50.0g |

For # 4 Cleaning Sand

| Sample I.D. | Grinding Vessel | Sample Wt (gm) |
|---|---|---|
| 6-0944 | 1 | 16.6 |

August 05, 1996

8/22/96

Scale Calibration

| Weight | Reading |
|---|---|
| 5g | 5.0g |
| 10g | 10.0g |
| 20g | 20.0g |
| 50g | 50.0g |

Lot #4 Cleaning Sand

| Sample I.D. | Grinding Vessel | Sample Wt (gms) |
|---|---|---|
| 6-0968 | 1 | 16.6 |
| 6-0969 | 2 | 16.4 |

Joh Eberhard
8/22/96

Aug. 23, 1996

Scale Calibration

| Sample Weight | Reading |
|---|---|
| 5g | 5.0g |
| 10g | 10.0g |
| 20g | 20.0g |
| 50g | 50.0g |

Lot #4 Cleaning Sand

| Sample I.D. | Grinding Time | Sample Wt (gms) |
|---|---|---|
| 6-0978 | 1 | 17.4 |
| 6-0978R | 2 | 12.4 |

(gms)
.6
.9
6.5
.8
6.7
.4
.5
7.3
23

000022

# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

**Samples sent to:**
ASHE Analytics, Inc.
1309 Kaw Ave.
Butte, MT. 59701
(406) 723-2080

FOR LAB USE
LAB ID_____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Tag: 00123 Sample: EX-SH-01 | Soil | Zinc - X-Ray fluorescence |
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| Signature Date Time | Signature Date Time | |

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# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

000023

**Samples sent to:**
Asha Analytics, Inc.
1309 Kaw Ave.
Butte, MT. 59701
(406) 723-2080

FOR LAB USE
LAB ID_____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601 ~~.032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # EX-AR-01 Tag # 00125 | Soil | Zinc - XRF |
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| Signature Date Time | Signature Date Time | |

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# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM 000024

**Samples sent to:**
John Ashe
Ashe Analytics, Inc.
1309 Kaw Ave.
Butte, MT. 59701

FOR LAB USE
LAB ID_____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~-052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # EX-SC-01 Tag # 00124 | Soil - Santa Cruz Site | Zinc - XRF |
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| Signature Date Time | Signature Date Time | |

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# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

000025

**Samples sent to:**
John Ashe
Ashe Analytics, Inc.
1309 Kaw Ave.
Butte, MT 59701

FOR LAB USE
LAB ID

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # EX-PP-01 Tag # 00126 | Soil | Zinc - XRF |
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| Date Time | Date Time | |

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# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM 000020

**Samples sent to:**
John Ashe
Ashe Analytics, Inc.
1309 Kaw Ave.
Butte, MT. 59701
(406) 723-2080

**FOR LAB USE**
LAB ID _____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| pk # EX-PP-02 Tag # 00127 | Soil | Zinc - XRF |
| Sample # EX-AR-02 Tag # 00128 | Soil | Zinc - XRF |

| SAMPLES RELINQUISHED BY | SAMPLES RECEIVED BY | FORM NO. |
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| Signature [signature] Date 7/25/96 Time 1400 | Signature [signature] Date 7/26/96 Time 10:25 | 5 |
| Signature Date Time | Signature Date Time | |

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# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

**Samples sent to:**
John Ashe
Ashe Analytics, Inc.
1309 Kaw Ave.
Butte, MT. 59701
(406) 723-2080

FOR LAB USE
LAB ID

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # EX-SC-02 Tag # 00130 | Soil | Zinc · XRF |
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| Sample # EX-SC-03 Tag # 00131 | Soil | Zinc · XRF |
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| Signature [signature] Date 7/29/96 Time 1400 | Signature [signature] Date 7/30/96 Time 10:15 | 6 |
| Signature Date Time | Signature Date Time | |

# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

**Samples sent to:**
John Ashe
Ashe Analytics, Inc.
1309 Kaw Ave
Butte, MT. 59701
(406) 723-2080

FOR LAB USE
LAB ID

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample# EX-SC-04 Tag # 00132 | Soil | Zinc - XRF |
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| Date Time | Date Time | |

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# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

**Samples sent to:**
John Ashe
Ashe Analytics, Inc.
1309 Kaw Ave.
Butte, MT. 59701
(406) 723-2080

FOR LAB USE
LAB ID

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # EX-SSE-01 Tag # 00133 | Soil | Zinc - XRF |
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| Date Time | Date Time | |

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# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

000030

**Samples sent to:**
Ashe Analytics, Inc.
1309 Kaw Ave.
Butte, MT. 59701
(406) 723-2080

FOR LAB USE
LAB ID_____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # EX-SSW-01 Tag # 00134 | Soil | Zinc - XRF |
| | | |
| Sample # EX-SSW-02 Tag # 00135 | Soil | Zinc - XRF |
| 8/22/96 | | |
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| Signature Date Time | Signature Date Time | |

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# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

**Samples sent to:**
John Ashe
ASHE Analytics, INC.
1309 Kaw Ave.
Butte, MT- 59701
(406) 723-2080

FOR LAB USE
LAB ID_____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Tag # 00137 Sample # EX-CO-01 | Soil | Zinc · XRF |
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| Signature Date Time | Signature Date Time | |

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# TECHNICAL MEMORANDUM
# on
# CONFIRMATION SOIL SAMPLING AND ANALYSIS RESULTS
# for
# RICO SITE REMEDIATION PROJECT

*Prepared for:*

**ATLANTIC RICHFIELD COMPANY**
444 South Flower Street
Los Angeles, California 90071

*Prepared by:*

**ESA CONSULTANTS INC.**
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525

November 7, 1996

ESA Consultants Inc.
2637 Midpoint Drive, Suite F, Fort Collins, Colorado 80525
Telephone: (970) 484-3611 ♦ FAX: (970) 484-4118

November 8, 1996
101.9601.051

Richard A. Elliott
Atlantic Richfield Company
444 South Flower Street
Los Angeles, CA 90071

RE: Technical Memorandum - Confirmation Soil Sampling and Analysis Results
Rico Site Remediation Project

Dear Richard:

This Technical Memorandum provides documentation of confirmation soil sampling performed as proposed for the Rico site remediation project implemented under the Colorado Voluntary Cleanup and Redevelopment Act. Confirmatory sampling verified the successful removal of either mine waste rock or mill tailings from the areas specified in the voluntary cleanup design plans for the following sites:

- Argentine tailings
- Columbia tailings
- Silver Swan mine
- Santa Cruz mine
- Pro Patria tailings
- Shamrock waste rock pile

A reproducible copy for preparation of the project construction completion report has been provided to Anderson Engineering.

Sincerely,
ESA Consultants Inc.

Edmund J. Schneider
Project Manager

Enclosures

cc: Anderson Engineering (2)

G:\PROJECTS\RICO\96CORRES\NOV1996\1108ARCO.LTR

## TABLE OF CONTENTS

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2.0 WASTE REMOVAL AND CONSOLIDATION OPERATIONS . . . . . 2

3.0 SAMPLING LOCATIONS AND METHODS . . . . . 2

4.0 SAMPLE ANALYSIS METHOD . . . . . 3

**APPENDICES**

Appendix A Soil Sampling Location Maps and Field Records
Appendix B Analytical Report Ashe Analytics, Inc.

**TECHNICAL MEMORANDUM**
**on**
**CONFIRMATION SOIL SAMPLING AND ANALYSIS RESULTS**
**for**
**RICO SITE REMEDIATION PROJECT**

Prepared by ESA Consultants Inc.
November 7, 1996

## 1.0 SUMMARY

This memorandum summarizes the methods and results for confirmation soil sampling performed subsequent to the removal of mine waste rock or mill tailings in accordance with Voluntary Cleanup Plans implemented in July 1996 at the following sites in Rico, Colorado:

- Argentine tailings (Pond 4)
- Silver Swan mine (river banks)
- Shamrock mine (east river bank)
- Columbia tailings (southwest corner)
- Santa Cruz mine (Winkfield & RGS "Y" tracts)
- Pro Patria tailings (entire site)

Confirmatory sampling was performed to verify the removal of mine waste rock or mill tailings from the areas designated for removal in the site-specific Voluntary Cleanup Plans and construction drawings. Soil investigations indicate the zinc content of natural bedrock and surficial materials (i.e., native soil, alluvium and colluvium) within the Town of Rico ranges from 200 ppm to 4,720 ppm. Verification of waste rock or tailings removal from specified areas was accomplished by sampling and analyzing the underlying soil. Removal work was considered successful if the post removal zinc content of the soil was less than 4,720 ppm. Additional material was removed and soil re-sampled where confirmatory sampling results indicated a zinc content greater than 4,720 ppm.

Final post-removal confirmatory analytical results for zinc are summarized by site as follows:

| Site Removal Area | Sample ID. | Zinc (ppm) | Remarks |
|---|---|---|---|
| Shamrock east bank | EX-SH-01 | 3,740 | Composite |
| Pro Patria | EX-PP-02 | 3,840 | Composite |
| Santa Cruz | EX-SC-02 | 1,440 | Single check |
| | EX-SC-03 | 2,640 | Single check |
| | EX-SC-04 | 422 | Composite |
| Silver Swan east bank | EX-SSE-01 | 2,030 | Composite |
| Silver Swan west bank | EX-SSW-01 | 788 | Composite |
| | EX-SSW-02 | 1,640 | Composite |
| Columbia tailings south | EX-CO-01 | 651 | Composite |
| Argentine tailings Pond 4 | EX-AR-01 | 1,130 | Composite |
| | EX-AR-02 | 1,120 | Composite |

These results confirm the removal actions were successful in the meeting the post-removal maximum concentration criterion of 4,720 ppm for zinc.

The following sections summarize waste removal and soil sampling and analysis methods. Appendix A includes copies of the sampling location maps by site, soil sampling field data and custody/shipping records. The analytical report for the soil samples prepared by Ashe Analytics, Inc. is included as Appendix B.

## 2.0 WASTE REMOVAL AND CONSOLIDATION OPERATIONS

Mine waste rock and mill tailings removal and consolidation operations were implemented in July and fully completed in August 1996 in accordance with site remediation technical specifications. A combination of conventional excavation methods were used for the removal of mine waste rock and tailings, including bulldozer, front end loader and tracked hoe/excavator operations. Haul trucks were used for transport and placement of waste materials consolidated at either the Columbia site or Argentine site.

The amount of material removed was determined primarily by visual identification by material type within the approximate boundaries of known waste materials delineated on construction drawings. The construction contractor was notified of final removal area boundaries during the course of removal operations. Removal activities were inspected to ensure removal of all visually identifiable waste material.

Approximately 10,200 c.y. of tailings and mixed tailings and soil material were removed from Argentine tailings Pond 4 and consolidated with Pond 3 tailings. A combined total of about 23,200 c.y. of waste materials removed from the Columbia (south side), Santa Cruz, Silver Swan, Pro Patria, and Shamrock sites were consolidated at the Columbia site. In addition, about 7,500 c.y. of material was removed from within 50 feet of the Dolores River and consolidated at the Silver Swan site.

## 3.0 SAMPLING LOCATIONS AND METHODS

A total of 11 final confirmation soil samples were collected from the six (6) sites where either mine waste or tailings removal operations were specified in the cleanup plans and prior to placement of growth media material. The location of the soil sampling locations are identified on Sheets AT-3, CT-2, SC-2, SS-2, and OS-1 (see Appendix A). Sample analysis results are listed in Section 1.0. In addition, two check samples were taken at the Santa Cruz (EX-SC-01) and Pro Patria (EX-PP-01) to confirm visual indications that excavation of additional material would be necessary in order to complete removal operations at these sites. The zinc content of both check samples exceeded the criterion for successful removal.

All except two of the final soil samples were collected as an aliquot of a composite of grab samples of equal proportions sampled from a depth interval of 0-6 inches. Two of the three Santa Cruz site samples were single point samples of soil from a depth interval of 0-6 inches. The composite samples consisted of five sub-samples: one sub-sample from the center of the sampling

location and four more sub-samples from discrete points 10 to 20 feet from the center point in a box pattern. Each sub-sample was sieved through a No. 4 (4.76 mm) stainless steel sieve to remove coarse materials and debris. Each of the composite sub-samples and single point samples were throughly mixed in a stainless steel bowl using a stainless steel spoon. After mixing, the sample composite was quartered and a sample aliquot from one of the quarters was placed in a certified contaminant-free 8 ounce high density polyethylene sample bottle. Each sample bottle was sealed, labeled and stored in a shipping box. All bottled samples remained in the custody of the sampler until shipped to the analytical laboratory. Custody was maintained by the sampler and the analytical laboratory according to standard chain-of-custody procedures and documentation. Chain-of-Custody and shipping records are provided in Appendix A.

## 4.0 SAMPLE ANALYSIS METHOD

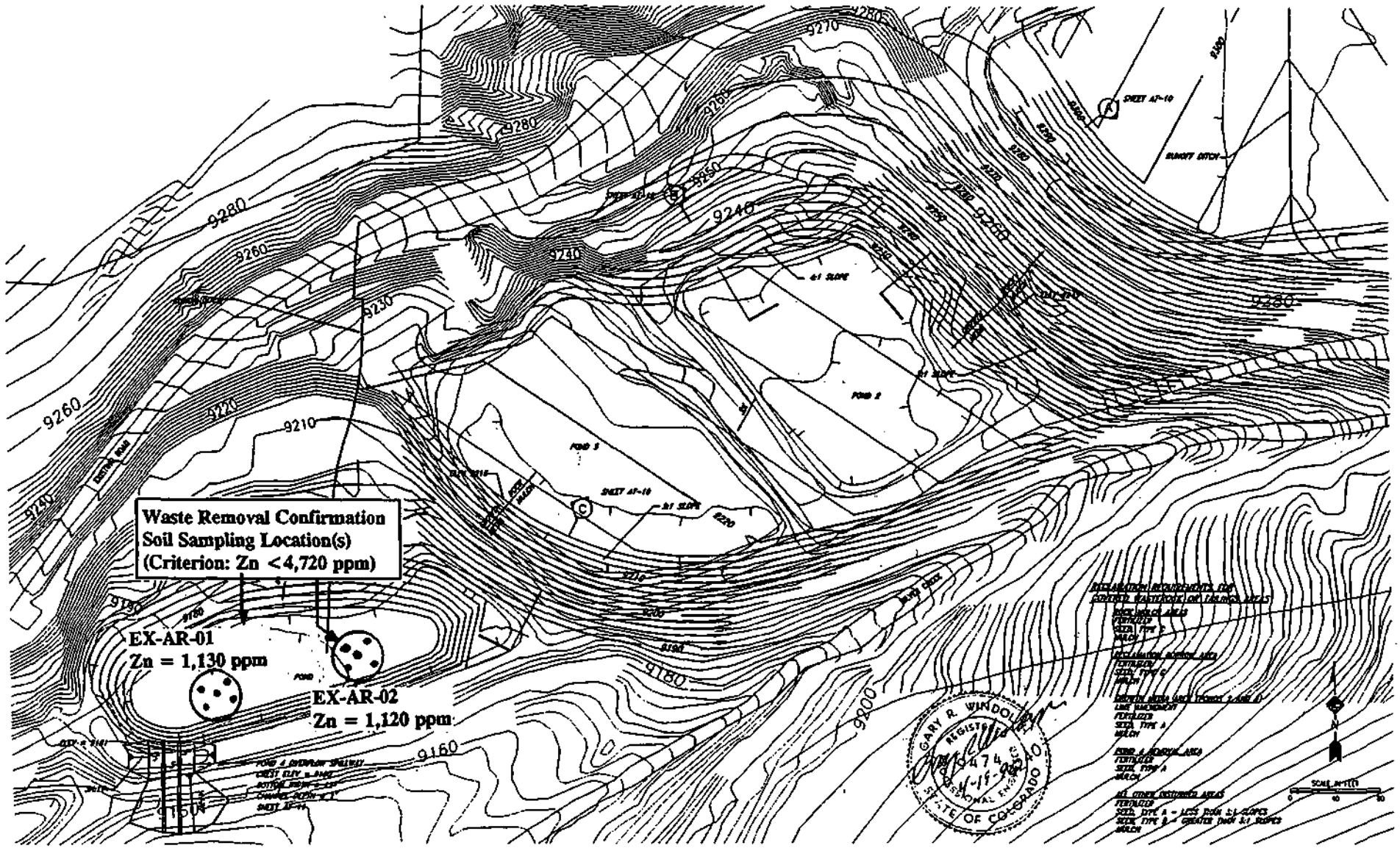
All confirmatory soil sample analyses for total zinc concentration were analyzed by x-ray fluorescence (XRF) spectroscopy using the laboratory-grade instrumentation and sample preparation methods developed by Ashe Analytics, Inc. and approved for Clark Fork River Superfund site investigations (Montana). Analyses were performed by Ashe Analytics, Inc. under the protocol defined in the following document:

> "Clark Fork River Superfund Site Investigations Laboratory Analytical Procedure for X-Ray Fluorescence Analysis of Solid Media: I. Laboratory-Grade Instrumentation method. Prepared for ARCO, Anaconda, Montana. Ashe Analytics, Inc., Butte, Montana. October 1995."

The Ashe analytical report for the Rico sample analyses is provided as Appendix B. The report includes analytical results, QA/QC information, method detection limits, raw data output, and sample log, sample preparation and chain-of-custody records.

# APPENDIX A

## SOIL SAMPLING LOCATION MAPS AND FIELD RECORDS

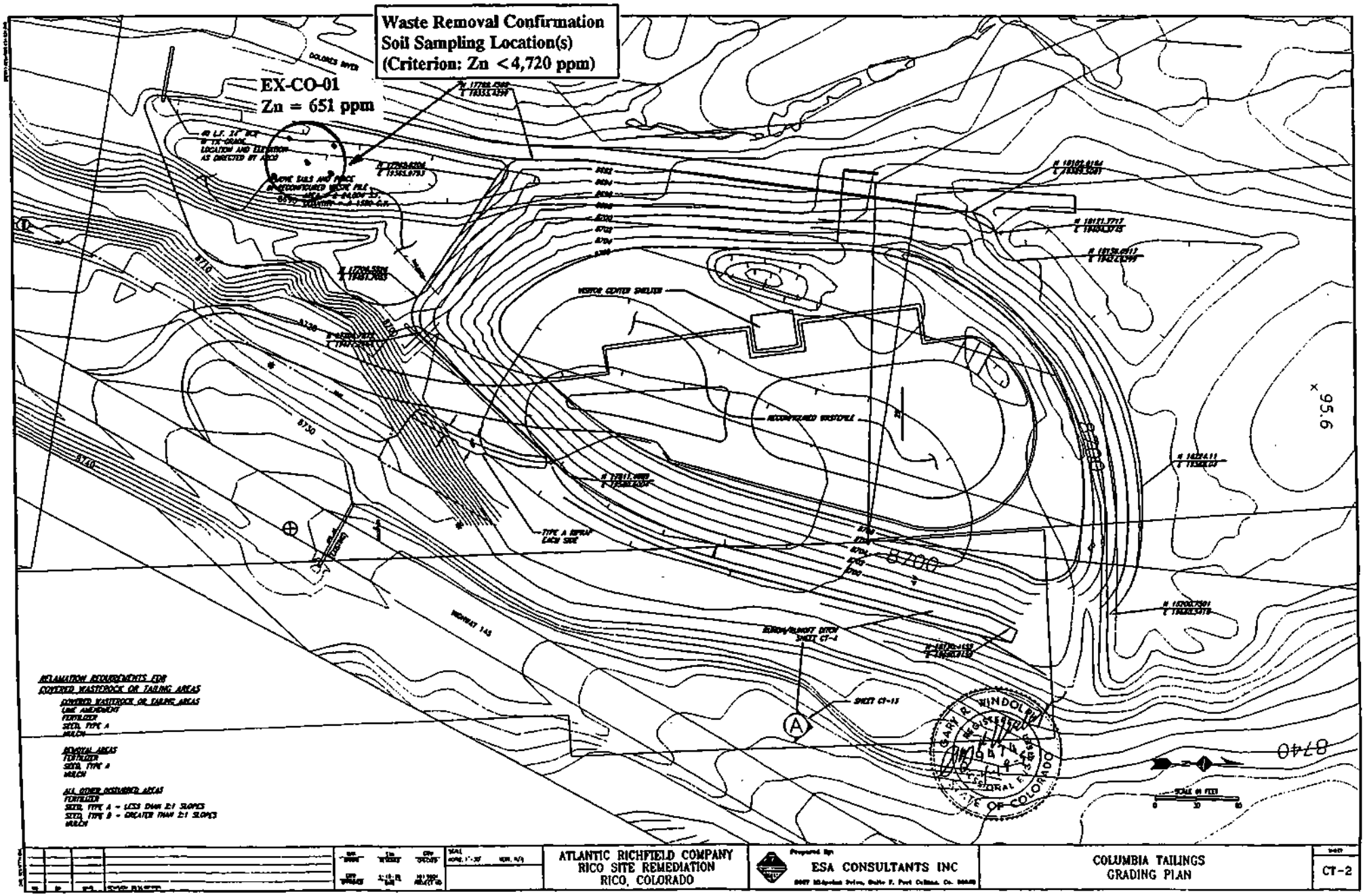



ATLANTIC RICHFIELD COMPANY
RICO SITE REMEDIATION
RICO, COLORADO

Prepared By
ESA CONSULTANTS INC

ARGENTINE TAILINGS
GRADING PLAN – PONDS 2, 3 AND 4

AT-3

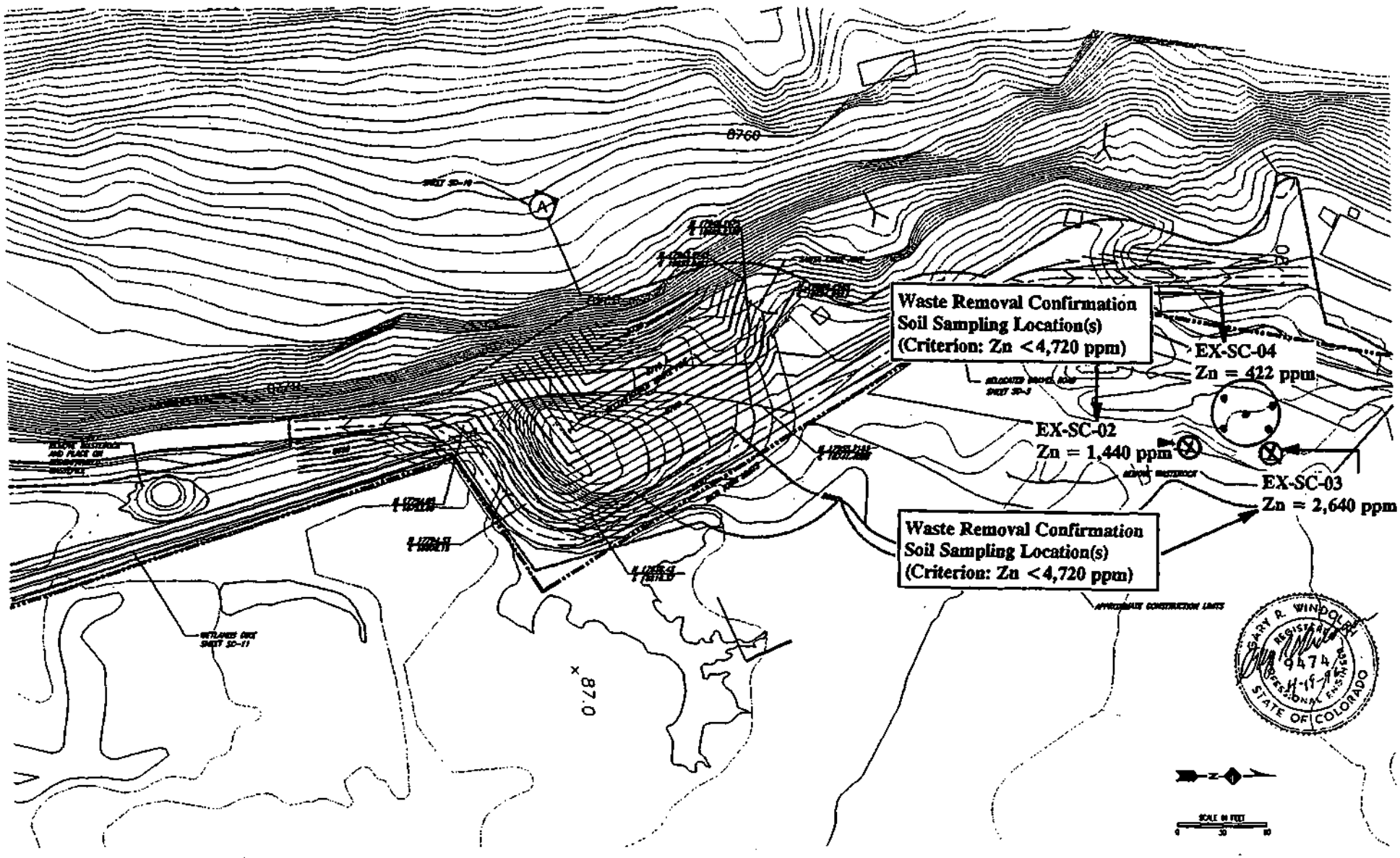



ATLANTIC RICHFIELD COMPANY
RICO SITE REMEDIATION
RICO, COLORADO

Prepared By:
ESA CONSULTANTS INC

COLUMBIA TAILINGS
GRADING PLAN

CT-2

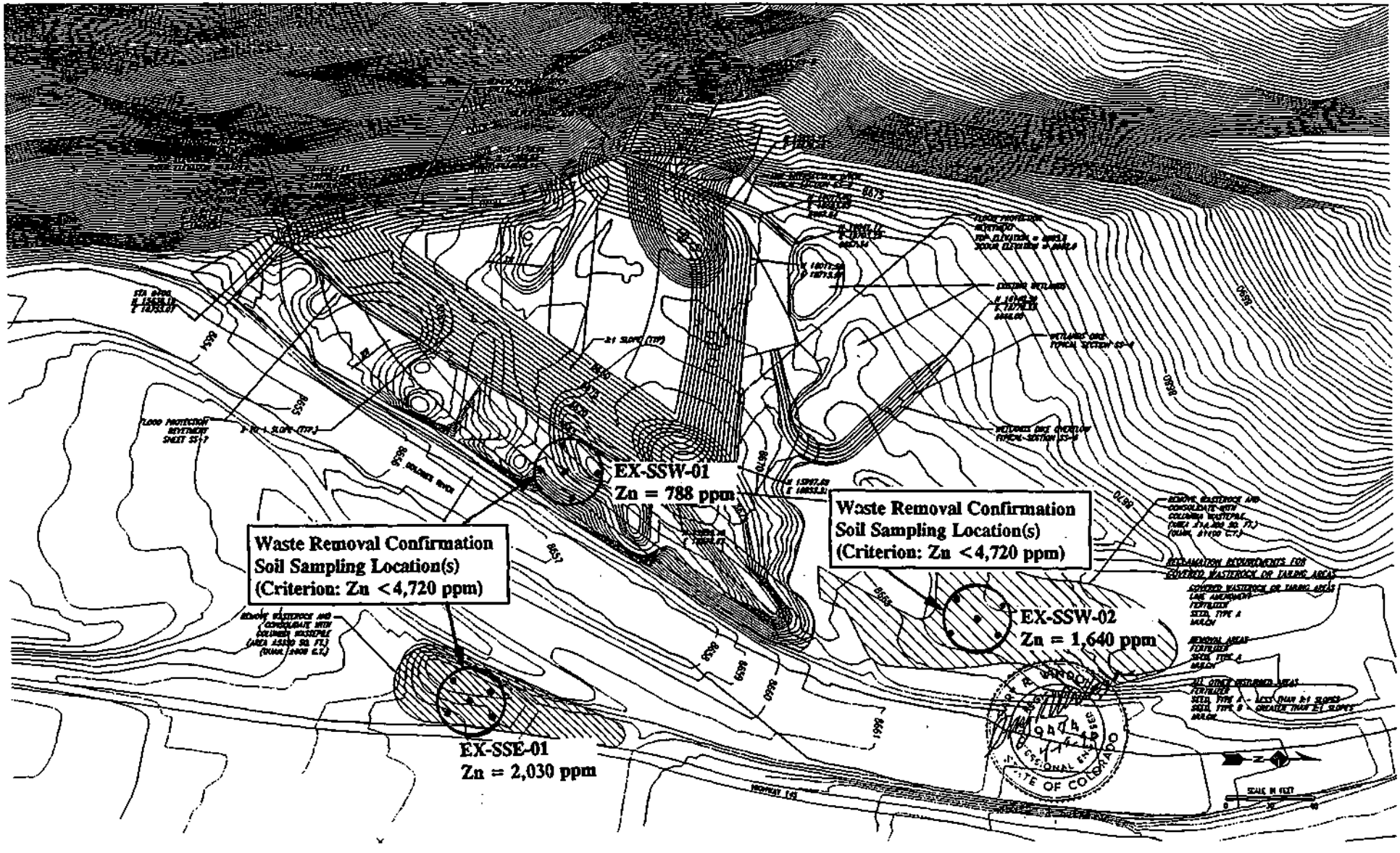



ATLANTIC RICHFIELD COMPANY
RICO SITE REMEDIATION
RICO, COLORADO

Prepared By:
ESA CONSULTANTS INC

SANTA CRUZ MINE AREA
GRADING PLAN

SC-2




ATLANTIC RICHFIELD COMPANY
RICO SITE REMEDIATION
RICO, COLORADO

Prepared By
ESA CONSULTANTS INC

SILVER SWAN
GRADING PLAN

SS-2

ATLANTIC RICHFIELD COMPANY
RICO SITE REMEDIATION

ESA CONSULTANTS INC

RICO SITE REMEDIATION
SURFICIAL WASTE REMOVAL

03-1

ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, CO 80525
(970) 484-3611 (970) 484-4118 FAX

# SOIL SAMPLING
## FIELD DATA FORM

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Date: 7/16/96 Tues.
Weather Conditions: Cloudcover, Warm. Temperature: 72°F

Sampling Personnel (Signatures): [signature]

Photo. Roll #: R2

*Tie picture numbers to samples below, if any

## SOIL SAMPLES

| | Tag Number | Sample Number | Sample Type | Depth Below Grade/Depth Interval | Time | Laboratory Analysis | Location | |
|---|---|---|---|---|---|---|---|---|
| 1. | 00123 | EX-SH-01 | Excavation Soil | 0-6" | 1330 | Zinc-XRF | Shamrock | Photo # 14 and # 15 |
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| 10. | | | | | | | | |

# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

**Samples sent to:**
ASHE Analytics, Inc.
1309 Kaw Ave.
Butte, MT. 59701
(406) 723-2080

FOR LAB USE
LAB ID_____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Tag · 00123 Sample · EX·SH·01 | Soil | Zinc · X-Ray fluorescence |
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| SAMPLES RELINQUISHED BY | SAMPLES RECEIVED BY | FORM NO. |
|---|---|---|
| Signature: [signature] Date: 7/16/96 Time: 1445 | Signature: Date: Time: | 1 |
| Signature: Date: Time: | Signature: Date: Time: | |

ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, CO 80525
(970) 484-3611 (970) 484-4118 FAX

# SOIL SAMPLING
## FIELD DATA FORM

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Date: 7/19/96 , 1130
Weather Conditions: Clear, Warm
Temperature: 75°F

Sampling Personnel (Signatures): [signature]
Photo. Roll #: R2

*Tie picture numbers to samples below, if any

## SOIL SAMPLES

| | Tag Number | Sample Number | Sample Type | Depth Below Grade/Depth Interval | Time | Laboratory Analysis | Location |
|---|---|---|---|---|---|---|---|
| 1. | 00125 | EX-AR-01 | Soil | 0-6" | 1130 | Zinc-XRF | Argentine - Pond 4 (SW Area) ☒ Photos R2, #1, #2 |
| 2. | | | | | | | Station Plotted on drawing AT-3 |
| 3. | | | | | | | |
| 4. | | | | | | | |
| 5. | | | | | | | |
| 6. | | | | | | | |
| 7. | | | | | | | |
| 8. | | | | | | | |
| 9. | | | | | | | |
| 10. | | | | | | | |

# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

Samples sent to:
Asha Analytics, Inc.
1309 Kaw Ave.
Butte, MT. 59701
(406) 723-2080

FOR LAB USE
LAB ID _____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # EX-AR-01 Tag # 00125 | Soil | Zinc - XRF |
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| SAMPLES RELINQUISHED BY | SAMPLES RECEIVED BY | FORM NO. |
|---|---|---|
| Signature [signature] Date 7/19/96 Time 1400 | Signature Date Time | 2 |
| Signature Date Time | Signature Date Time | |

G:\USERS\TYNAS\FORMS\FIELD\SMPLANAL.FRM

SAMPLE EX-AR-01

**UPS Next Day Air®**
**UPS Worldwide Express**
Shipping Document

See instructions on back. Call 1-800-PICK-UPS (800-742-5877) for additional information.

TRACKING NUMBER: 0090952100080 0

**1 SHIPMENT FROM**

SHIPPER'S UPS ACCOUNT NO.: 9907223326
UPS SHIPPER NO. / UPS BILLING NO.:
FOR UPS USE: 800X99

REFERENCE NUMBER: 101.9601.052

NAME: Steve Story
TELEPHONE: 970-484-3611

COMPANY: ESA CONSULTANTS

STREET ADDRESS: 2637 MIDPOINT DR STE F

CITY AND STATE: FORT COLLINS CO
ZIP CODE: 80525

**2 EXTREMELY URGENT DELIVERY TO**

NAME: John Ashe
TELEPHONE: (406) 723-2080

COMPANY: Ashe Analytics ~~Inc~~

STREET ADDRESS: 1309 Kaw Avenue
DEPT./FLOOR:

CITY AND STATE (INCLUDE COUNTRY IF INTERNATIONAL): Butte, MT
ZIP CODE: 59701

| | WEIGHT (ENTER "LTR" IF LETTER) | DIMENSIONAL WEIGHT (If Applicable) | ZONE | SHIPPER'S COPY |
|---|---|---|---|---|
| WEIGHT AND ZONE | 1.4 lbs. | | | |

| | | CHARGES |
|---|---|---|
| TYPE OF SERVICE | [X] NEXT DAY AIR [ ] WORLDWIDE EXPRESS (INTERNATIONAL) | $ |
| | FOR WORLDWIDE EXPRESS SHIPMENTS Mark an "X" in this box if shipment only contains documents of no commercial value. [ ] DOCUMENTS ONLY | |
| OPTIONAL SERVICES | [ ] SATURDAY PICKUP [ ] SATURDAY DELIVERY | $ |
| | [ ] DECLARED VALUE $ ____ AMOUNT | $ |
| | [ ] C.O.D. $ ____ AMOUNT | $ |
| ADDITIONAL HANDLING CHARGE | [ ] An Additional Handling Charge applies for certain items. See Instructions. | $ |
| TOTAL CHARGES | | $ |

METHOD OF PAYMENT: [X] BILL SHIPPER [ ] BILL RECEIVER [ ] BILL THIRD PARTY (Next Day Air Only) [ ] AMERICAN EXPRESS [ ] MASTER CARD [ ] VISA [ ] CHECK [ ] UPS USE CASH

Receiver Account No. in Section 8

**8 RECEIVER'S / THIRD PARTY'S UPS ACCT. NO. OR MAJOR CREDIT CARD NO.:**
EXPIRATION DATE:

THIRD PARTY'S COMPANY NAME:

STREET ADDRESS:

CITY AND STATE:
ZIP CODE:

**9 SHIPPER'S SIGNATURE:** X
DATE OF SHIPMENT: 7/19/96

010191120 9/95 W

SEE PRESS HARD
TO BE ABLE TO MAKE 3 COPIES

ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, CO 80525
(970) 484-3611 (970) 484-4118 FAX

# SOIL SAMPLING
## FIELD DATA FORM

Project Name: Rico Site Remediation
Project Number: 101.9601 ~~032~~ 052
Date: 7/22/96 0930
Weather Conditions: Clear, Warm Temperature: 65°F

Sampling Personnel (Signatures): [signature] Photo. Roll #: R3

*Tie picture numbers to samples below, if any

## SOIL SAMPLES

| | Tag Number | Sample Number | Sample Type | Depth Below Grade/Depth Interval | Time | Laboratory Analysis | Location |
|---|---|---|---|---|---|---|---|
| 1. | 00124 | EX-SC-01 | Soil | 0-6" | 0930 | Zinc-XRF | Santa Cruz (NW Area) · R3, #3, #4 |
| 2. | | | | | | | Sample Plotted on drawing SC-2 |
| 3. | | | | | | | |
| 4. | | | | | | | |
| 5. | | | | | | | |
| 6. | | | | | | | |
| 7. | | | | | | | |
| 8. | | | | | | | |
| 9. | | | | | | | |
| 10. | | | | | | | |

# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

**Samples sent to:**
John Ashe
Ashe Analytics, Inc.
1309 Kaw Ave.
Butte, MT. 59701

FOR LAB USE
LAB ID_____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~-052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # EX-SC-01 Tag # 00124 | Soil | Zinc - XRF |
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| SAMPLES RELINQUISHED BY | SAMPLES RECEIVED BY | FORM NO. |
|---|---|---|
| Signature Date 7/22/96 Time 1400 | Signature Date Time | 3 |
| Signature Date Time | Signature Date Time | |

**UPS Next Day Air®**
**UPS Worldwide Express**
**Shipping Document**

See instructions on back. Call 1-800-PICK-UPS (800-742-5877) for additional information.

**TRACKING NUMBER** 0909 521 009 9

**1 SHIPMENT FROM**

| SHIPPER'S UPS ACCOUNT NO. | UPS SHIPPER NO. / UPS BILLING NO. | FOR UPS USE |
|---|---|---|
| | 5907223326 | 800X99 |

REFERENCE NUMBER
101.9601.052

NAME: Steve Story
TELEPHONE: 970-484-3611

COMPANY: ESA CONSULTANTS

STREET ADDRESS: 2637 MIDPOINT DR STE F

CITY AND STATE: FORT COLLINS
ZIP CODE: CO 80525

**2 EXTREMELY URGENT DELIVERY TO**

NAME: John Ashe
TELEPHONE: (406) 723-2080

COMPANY: Ashe Analytics, Inc.

STREET ADDRESS: 1309 Kaw Avenue
DEPT./FLOOR:

CITY AND STATE (INCLUDE COUNTRY IF INTERNATIONAL): Butte, MT.
ZIP CODE: 59701

**3 WEIGHT AND ZONE**

| WEIGHT ENTER "LTR" IF LETTER | DIMENSIONAL WEIGHT (If Applicable) | ZONE |
|---|---|---|
| 1.08 lb. | | |

SHIPPER'S COPY

**4 TYPE OF SERVICE**

- [X] NEXT DAY AIR
- [ ] WORLDWIDE EXPRESS (INTERNATIONAL)

FOR WORLDWIDE EXPRESS SHIPMENTS Mark an "X" in this box if shipment only contains documents of no commercial value. [ ] DOCUMENTS ONLY

**5 OPTIONAL SERVICES**

- [ ] SATURDAY PICKUP See instructions.
- [ ] SATURDAY DELIVERY See instructions.
- [ ] DECLARED VALUE Contents are automatically protected up to $100. For declared value over $100, see instructions. $ AMOUNT
- [ ] C.O.D. If C.O.D., enter amount to be collected and attach completed UPS C.O.D. tag to package. $ AMOUNT

**6 ADDITIONAL HANDLING CHARGE**

- [ ] An Additional Handling Charge applies for certain items. See instructions.

**TOTAL CHARGES**

**7 METHOD OF PAYMENT**

| BILL SHIPPER | BILL RECEIVER (NEXT DAY AIR ONLY) | BILL THIRD PARTY (NEXT DAY AIR ONLY) | AMERICAN EXPRESS | MASTER CARD | VISA | CHECK | UPS USE (CASH) |
|---|---|---|---|---|---|---|---|
| X | | | | | | | |

Record Account No. in Section 8

**8 RECEIVER'S / THIRD PARTY'S UPS ACCT. NO. OR MAJOR CREDIT CARD NO.** EXPIRATION DATE

THIRD PARTY'S COMPANY NAME

STREET ADDRESS

CITY AND STATE
ZIP CODE

**9 SHIPPER'S SIGNATURE** X [signature]
DATE OF SHIPMENT 7/22/96

010191120 9/95 W

SAMPLE EX-SC-01

ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, CO 80525
(970) 484-3611 (970) 484-4118 FAX

# SOIL SAMPLING
## FIELD DATA FORM

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Date: 7/23/96 0830
Weather Conditions: Clear, Warm
Temperature: 60°F

Sampling Personnel (Signatures): [signature]
Photo. Roll #: R3

*Tie picture numbers to samples below, if any

## SOIL SAMPLES

| | Tag Number | Sample Number | Sample Type | Depth Below Grade/Depth Interval | Time | Laboratory Analysis | Location |
|---|---|---|---|---|---|---|---|
| 1. | 00126 | EX-PP-01 | Soil | 0-12" | 0830 | Zinc-XRF | Pro. Pastria. Center East Side. ☒ Photos R3 #13, 14. |
| 2. | | | | | | | Plotted on drawing OS-1 |
| 3. | | | | | | | |
| 4. | | | | | | | |
| 5. | | | | | | | |
| 6. | | | | | | | |
| 7. | | | | | | | |
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| 9. | | | | | | | |
| 10. | | | | | | | |

# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

**Samples sent to:**
John Ashe
Ashe Analytics, Inc.
1309 Kaw Ave.
Butte, MT. 59701

FOR LAB USE
LAB ID_____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601 ~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # EX-PP-01 Tag # 00126 | Soil | Zinc - XRF |
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| SAMPLES RELINQUISHED BY | SAMPLES RECEIVED BY | FORM NO. |
|---|---|---|
| Signature: [signature] Date 7/23/96 Time 1400 | Signature: Date: Time: | 4 |
| Signature: Date: Time: | Signature: Date: Time: | |

SAMPLE EX-PP-01

**UPS Next Day Air®**
**UPS Worldwide Express**
Shipping Document

See instructions on back. Call 1-800-PICK-UPS (800-742-5877) for additional information.

TRACKING NUMBER 0909 521 010 6

**1 SHIPMENT FROM**

SHIPPER'S UPS ACCOUNT NO. | UPS SHIPPER NO. / UPS BILLING NO. 5907223326 | FOR UPS USE 800X99

REFERENCE NUMBER 101.9601.052 RICO

NAME Steve Story | TELEPHONE 970-484-3611

COMPANY ESA CONSULTANTS

STREET ADDRESS 2637 MIDPOINT DR STE F

CITY AND STATE FORT COLLINS CO | ZIP CODE 80525

**2 EXTREMELY URGENT DELIVERY TO**

NAME John Ashe | TELEPHONE (406) 723-2080

COMPANY Ashe Analytics, Inc.

STREET ADDRESS 1309 Kaw Ave. | DEPT./FLOOR

CITY AND STATE (INCLUDE COUNTRY IF INTERNATIONAL) Butte, MT. ~~5~~ | ZIP CODE 59701

**3 WEIGHT AND ZONE**

| WEIGHT (ENTER "LTR" IF LETTER) | DIMENSIONAL WEIGHT (If Applicable) | ZONE |
|---|---|---|
| 1.02 lbs. | | |

SHIPPER'S COPY

**4 TYPE OF SERVICE** — CHARGES

- [X] NEXT DAY AIR
- [ ] WORLDWIDE EXPRESS (INTERNATIONAL)
- FOR WORLDWIDE EXPRESS SHIPMENTS Mark an "X" in this box if shipment only contains documents of no commercial value. [ ] DOCUMENTS ONLY — $

**5 OPTIONAL SERVICES**

- [ ] SATURDAY PICKUP (See instructions.) — $
- [ ] SATURDAY DELIVERY (See instructions.) — $
- [ ] DECLARED VALUE — Contents are automatically protected up to $100. For declared value over $100, see instructions. $ _____ AMOUNT — $
- [ ] C.O.D. — If C.O.D., enter amount to be collected and attach completed UPS C.O.D. tag to package. $ _____ AMOUNT — $

**6 ADDITIONAL HANDLING CHARGE**

- [ ] An Additional Handling Charge applies for certain items. See instructions. — $

**TOTAL CHARGES** — $

**7 METHOD OF PAYMENT**

- [X] BILL SHIPPER
- BILL RECEIVER [ ] (Next Day Air Only)
- BILL THIRD PARTY [ ] (Next Day Air Only)
- AMERICAN EXPRESS [ ]
- MASTER CARD [ ]
- VISA [ ]
- CHECK [ ]
- UPS USE CARD [ ]

Related Account No. or Secret #

**8 RECEIVER'S / THIRD PARTY'S UPS ACCT. NO. OR MAJOR CREDIT CARD NO.** | EXPIRATION DATE /

THIRD PARTY'S COMPANY NAME

STREET ADDRESS

CITY AND STATE | ZIP CODE

**9 SHIPPER'S SIGNATURE** X [signature] | DATE OF SHIPMENT 7/23/96

010191120 9/95 W

ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, CO 80525
(970) 484-3611 (970) 484-4118 FAX

# SOIL SAMPLING
## FIELD DATA FORM

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Date: 7/25/96
Weather Conditions: Overcast, Warm. Temperature: 68°F

Sampling Personnel (Signatures): Photo. Roll #: R4

*Tie picture numbers to samples below, if any

## SOIL SAMPLES

| | Tag Number | Sample Number | Sample Type | Depth Below Grade/Depth Interval | Time | Laboratory Analysis | Location |
|---|---|---|---|---|---|---|---|
| 1. | 00127 | EX-PP-02 | Soil | 0-6" | 1000 | Zinc-XRF | Pro Patria - Center West side · ☒ R4, #9, 10. Plotted OS-1 |
| 2. | 00128 | EX-AR-02 | Soil | 0-6" | 1040 | Zinc-XRF | Argentine · Pond 4 · East side · ☒ R4, # 11, 12. Plotted AT-3 |
| 3. | | | | | | | |
| 4. | | | | | | | |
| 5. | | | | | | | |
| 6. | | | | | | | |
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| 9. | | | | | | | |
| 10. | | | | | | | |

# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

**Samples sent to:**
John Ashe
Ashe Analytics, Inc.
1309 Kaw Ave.
Butte, MT. 59701
(406) 723-2080

FOR LAB USE
LAB ID_____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~002~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # EX-PP-02 Tag# 00127 | Soil | Zinc - XRF |
| Sample # EX-AR-02 Tag# 00128 | Soil | Zinc - XRF |
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| SAMPLES RELINQUISHED BY | SAMPLES RECEIVED BY | FORM NO. |
|---|---|---|
| Signature [signature] Date 7/25/96 Time 1400 | Signature Date Time | 5 |
| Signature Date Time | Signature Date Time | |

G:\USERS\TYNAS\FORMS\FIELD\SMPLANAL.FRM

SAMPLES EX-PP-02 & EX-AR-02

**UPS Next Day Air®**
**UPS Worldwide Express**
Shipping Document

See instructions on back. Call 1-800-PICK-UPS (800-742-5877) for additional information.

TRACKING NUMBER: 0909 521 011 5

**1 SHIPMENT FROM**

SHIPPER'S UPS ACCOUNT NO.: UPS SHIPPER NO. / UPS BILLING NO.: 5907223326

FOR UPS USE: 800X99

REFERENCE NUMBER: 101.9601.052 Rico

NAME: Steve Story

TELEPHONE: 970-484-3611

COMPANY: ESA CONSULTANTS

STREET ADDRESS: 2637 MIDPOINT DR STE F

CITY AND STATE: FORT COLLINS

ZIP CODE: CO 80525

**2 EXTREMELY URGENT DELIVERY TO**

NAME: John Ashe

TELEPHONE: (406) 723-2080

COMPANY: Ashe Analytics, Inc.

STREET ADDRESS: 1309 Kaw Ave.

DEPT./FLOOR:

CITY AND STATE (INCLUDE COUNTRY IF INTERNATIONAL): Butte, MT.

ZIP CODE: 59701

177

168

135

**3 WEIGHT AND ZONE**

| WEIGHT (ENTER "LTR" IF LETTER) | DIMENSIONAL WEIGHT (IF APPLICABLE) | ZONE |
|---|---|---|
| 2.2 lbs. | | |

SHIPPER'S COPY

**4 TYPE OF SERVICE** — CHARGES

- [X] NEXT DAY AIR
- [ ] WORLDWIDE EXPRESS (INTERNATIONAL)
- FOR WORLDWIDE EXPRESS SHIPMENTS Mark an "X" in this box if shipment only contains documents of no commercial value. [ ] DOCUMENTS ONLY — $

**5 OPTIONAL SERVICES**

- [ ] SATURDAY PICKUP (See instructions.) [ ] SATURDAY DELIVERY (See instructions.) — $
- [ ] DECLARED VALUE (Shipments are automatically protected up to $100. For declared value over $100, see instructions.) $ _____ AMOUNT — $
- [ ] C.O.D. (If C.O.D., enter amount to be collected and attach completed UPS C.O.D. tag to package.) $ _____ AMOUNT — $

**6 ADDITIONAL HANDLING CHARGE**

- [ ] An Additional Handling Charge applies for certain items. See instructions. — $

**TOTAL CHARGES** — $

**7 METHOD OF PAYMENT**

- [X] BILL SHIPPER
- [ ] BILL RECEIVER (Next Day Air Only)
- [ ] BILL THIRD PARTY (Next Day Air Only)
- [ ] AMERICAN EXPRESS
- [ ] MASTER CARD
- [ ] VISA
- [ ] CHECK
- [ ] UPS USE (CASH)

Record Account No. in Section 8

**8 RECEIVER'S / THIRD PARTY'S UPS ACCT. NO. OR MAJOR CREDIT CARD NO.** EXPIRATION DATE /

THIRD PARTY'S COMPANY NAME

STREET ADDRESS

CITY AND STATE

ZIP CODE

**9 SHIPPER'S SIGNATURE** X [signature] DATE OF SHIPMENT 7/25/96

010191120 9/95 W

ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, CO 80525
(970) 484-3611 (970) 484-4118 FAX

# SOIL SAMPLING
## FIELD DATA FORM

Project Name: Rico Site Remediation
Project Number: 101.9601-~~052~~ 052
Date: 7/26/96
Weather Conditions: Overcast
Temperature: 70°F

Sampling Personnel (Signatures): [signature]

Photo. Roll #: R4

*Tie picture numbers to samples below, if any

## SOIL SAMPLES

| | Tag Number | Sample Number | Sample Type | Depth Below Grade/Depth Interval | Time | Laboratory Analysis | Location |
|---|---|---|---|---|---|---|---|
| 1. | 00130 | EX-SC-02 | Soil-Organic | 0-6" | 1700 | Zinc-XRF | Santa Cruz · N.E. Area TOT 23, 24. Plotted on SC-2 |
| 2. | 00131 | EX-SC-03 | Soil-Organic | 0-6" | 1700 | Zinc-XRF | Santa Cruz · N.E. Area TOT 23, 24. Plotted on SC-2 |
| 3. | 00129 | LM-SC-01 | Soil-Organic | 0-6" | 1700 | Lime Application | Santa Cruz · N.E. Area TOT 23, 24. Plotted on SC-2 |
| 4. | | | | | | | |
| 5. | | | | | | | |
| 6. | | | | | | | |
| 7. | | | | | | | |
| 8. | | | | | | | |
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| 10. | | | | | | | |

# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

**Samples sent to:**
John Ashe
Ashe Analytics, Inc.
1309 Kaw Ave.
Butte, MT 59701
(406) 723-2080

FOR LAB USE
LAB ID_____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~-052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # FX-SC-02 Tag # 00130 | Soil | Zinc · XRF |
| | | |
| Sample # FX-SC-03 Tag # 00131 | Soil | Zinc · XRF |
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| SAMPLES RELINQUISHED BY | SAMPLES RECEIVED BY | FORM NO. |
|---|---|---|
| Signature [signature] Date 7/29/96 Time 1400 | Signature Date Time | 6 |
| Signature Date Time | Signature Date Time | |

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SAMPLES EX-SC-02 & EX-SC-03

**UPS Next Day Air®**
**UPS Worldwide Express**
Shipping Document

See instructions on back. Call 1-800-PICK-UPS (800-742-5877) for additional information.

TRACKING NUMBER 0909 521 012 4

**1 SHIPMENT FROM**

SHIPPER'S UPS ACCOUNT NO. 5907223326 — UPS SHIPPER NO. / UPS BILLING NO. — FOR UPS USE 800X99

REFERENCE NUMBER 101.9601.052

NAME Steve Story — TELEPHONE 970-484-3611

COMPANY ESA CONSULTANTS

STREET ADDRESS 2637 MIDPOINT DR STE F

CITY AND STATE FORT COLLINS CO — ZIP CODE 80525

**2 EXTREMELY URGENT DELIVERY TO**

NAME John Ashe — TELEPHONE (406)723-2080

COMPANY Ashe Analytics, Inc.

STREET ADDRESS 1309 Kaw Ave. — DEPT./FLOOR

CITY AND STATE (INCLUDE COUNTRY IF INTERNATIONAL) Butte, MT. — ZIP CODE 59701

**3 WEIGHT AND ZONE**

| WEIGHT (ENTER "LTR" IF LETTER) | DIMENSIONAL WEIGHT (IF APPLICABLE) | ZONE |
|---|---|---|
| 1.9 lbs. | | |

SHIPPER'S COPY

**4 TYPE OF SERVICE** — CHARGES

- [X] NEXT DAY AIR
- [ ] WORLDWIDE EXPRESS (INTERNATIONAL)
- FOR WORLDWIDE EXPRESS SHIPMENTS Mark an "X" in this box if shipment only contains documents of no commercial value. [ ] DOCUMENTS ONLY — $

**5 OPTIONAL SERVICES**

- [ ] SATURDAY PICKUP (See instructions.) [ ] SATURDAY DELIVERY (See instructions.) — $
- [ ] DECLARED VALUE (Contents are automatically protected up to $100. For declared value over $100, see instructions.) $ _____ AMOUNT — $
- [ ] C.O.D. (If C.O.D., enter amount to be collected and attach completed UPS C.O.D. tag to package.) $ _____ AMOUNT — $

**6 ADDITIONAL HANDLING CHARGE**

- [ ] An Additional Handling Charge applies for certain items. See instructions. — $

TOTAL CHARGES — $

**7 METHOD OF PAYMENT**

- [X] BILL SHIPPER
- [ ] BILL RECEIVER (Next Day Air Only)
- [ ] BILL THIRD PARTY (Next Day Air Only)
- [ ] AMERICAN EXPRESS
- [ ] MASTER CARD
- [ ] VISA
- [ ] CHECK
- [ ] UPS USE CARD

Record Account No. in Section 8

**8 RECEIVER'S / THIRD PARTY'S UPS ACCT. NO. OR MAJOR CREDIT CARD NO.** — EXPIRATION DATE

THIRD PARTY'S COMPANY NAME

STREET ADDRESS

CITY AND STATE — ZIP CODE

**9 SHIPPER'S SIGNATURE** X [signature] — DATE OF SHIPMENT 7/29/96

010191120 9/95 W

YOU PRESS HARD TO MAKE 3 COPIES

ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, CO 80525
(970) 484-3611 (970) 484-4118 FAX

# SOIL SAMPLING
## FIELD DATA FORM

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Date: 7/31/96
Weather Conditions: Cloud Cover, COOL.
Temperature: 60°F

Sampling Personnel (Signatures): [signature]

Photo. Roll #: R5

*Tie picture numbers to samples below, if any

## SOIL SAMPLES

| | Tag Number | Sample Number | Sample Type | Depth Below Grade/Depth Interval | Time | Laboratory Analysis | Location |
|---|---|---|---|---|---|---|---|
| 1. | 00132 | EX-SC-04 | Soil | 0-6" | 0910 | Zinc-XRF | Santa Cruz · N.E. Area · [illegible] #11, 12. |
| 2. | | | | | | | Plotted on sheet SC-2 |
| 3. | | | | | | | |
| 4. | | | | | | | |
| 5. | | | | | | | |
| 6. | | | | | | | |
| 7. | | | | | | | |
| 8. | | | | | | | |
| 9. | | | | | | | |
| 10. | | | | | | | |

# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

**Samples sent to:**
John Ashe
Ashe Analytics, Inc.
1309 Kaw Ave
Butte, MT. 59701
(406) 723-2080

FOR LAB USE
LAB ID_____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample# EX-SC-04 Tag # 00132 | Soil | Zinc · XRF |
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| SAMPLES RELINQUISHED BY | SAMPLES RECEIVED BY | FORM NO. |
|---|---|---|
| Signature [signature] Date 7/31/96 Time 1400 | Signature Date Time | 7. |
| Signature Date Time | Signature Date Time | |

SAMPLE EX-SC-04

**UPS Next Day Air®**
**UPS Worldwide Express**
Shipping Document

See instructions on back. Call 1-800-PICK-UPS (800-742-5877) for additional information.

TRACKING NUMBER: 0909 521 013 3

**1 SHIPMENT FROM**

SHIPPER'S UPS ACCOUNT NO.: UPS SHIPPER NO. / UPS BILLING NO.: 5907223326 — FOR UPS USE: 800X99

REFERENCE NUMBER: 101.9601.052

NAME: Steve Story — TELEPHONE: 970-484-3611

COMPANY: ESA CONSULTANTS

STREET ADDRESS: 2637 MIDPOINT DR STE F

CITY AND STATE: FORT COLLINS CO — ZIP CODE: 80525

PLEASE PRESS HARD YOU ARE MAKING 3 COPIES

**2 EXTREMELY URGENT DELIVERY TO**

NAME: John Ashe — TELEPHONE: (406)723-2080

177 COMPANY: Ashe Analytics, Inc.

168 STREET ADDRESS: 1309 Kaw Ave. — DEPT./FLOOR:

135 CITY AND STATE (INCLUDE COUNTRY IF INTERNATIONAL): Butte, MT. — ZIP CODE: 59701

**3 WEIGHT AND ZONE**

| WEIGHT ENTER "LTR" IF LETTER | DIMENSIONAL WEIGHT # Applicable | ZONE |
|---|---|---|
| 1.1 lb. | | |

SHIPPER'S COPY

**4 TYPE OF SERVICE** — CHARGES

- [X] NEXT DAY AIR
- [ ] WORLDWIDE EXPRESS (INTERNATIONAL)
- FOR WORLDWIDE EXPRESS SHIPMENTS Mark an "X" in this box if shipment only contains documents of no commercial value. [ ] DOCUMENTS ONLY — $
- [ ] SATURDAY PICKUP See instructions. [ ] SATURDAY DELIVERY See instructions. — $

**5 OPTIONAL SERVICES**

- [ ] DECLARED VALUE Contents are automatically protected up to $100. For declared value over $100, see instructions. $ ____ AMOUNT — $
- [ ] C.O.D. If C.O.D., enter amount to be collected and attach completed UPS C.O.D. tag to package. $ ____ AMOUNT — $

**6 ADDITIONAL HANDLING CHARGE**

- [ ] An Additional Handling Charge applies for certain items. See instructions. — $

TOTAL CHARGES — $

**7 METHOD OF PAYMENT**

| BILL SHIPPER | BILL RECEIVER (Next Day Air Only) | BILL THIRD PARTY (Next Day Air Only) | AMERICAN EXPRESS | MASTER CARD | VISA | CHECK | UPS USE CASH |
|---|---|---|---|---|---|---|---|
| [X] | [ ] | [ ] | [ ] | [ ] | [ ] | [ ] | [ ] |

Record Account No. in Section 8

**8** RECEIVER'S / THIRD PARTY'S UPS ACCT. NO. OR MAJOR CREDIT CARD NO. — EXPIRATION DATE

THIRD PARTY'S COMPANY NAME

STREET ADDRESS

CITY AND STATE — ZIP CODE

**9** SHIPPER'S SIGNATURE X [signature] — DATE OF SHIPMENT 7/31/96

010191120 9/95 W

ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, CO 80525
(970) 484-3611 (970) 484-4118 FAX

# SOIL SAMPLING
## FIELD DATA FORM

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Date: 8/2/96
Weather Conditions: Clear, Calm, Warm
Temperature: 70°F

Sampling Personnel (Signatures): [signature]

Photo. Roll #: R5

*Tie picture numbers to samples below, if any

## SOIL SAMPLES

| | Tag Number | Sample Number | Sample Type | Depth Below Grade/Depth Interval | Time | Laboratory Analysis | Location |
|---|---|---|---|---|---|---|---|
| 1. | 00133 | EX-SSE-01 | Soil | 0-6" | 1245 | Zinc-XRF | ~~Sand~~ Silver Swan East. ~~[illegible]~~ R5, # 18, 19. |
| 2. | | | | | | | Plotted on Sheet SS-2 |
| 3. | | | | | | | |
| 4. | | | | | | | |
| 5. | | | | | | | |
| 6. | | | | | | | |
| 7. | | | | | | | |
| 8. | | | | | | | |
| 9. | | | | | | | |
| 10. | | | | | | | |

# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

Samples sent to:
John Ashe
Ashe Analytics, Inc.
1309 Kaw Ave.
Butte, MT. 59701
(406) 723-2080

FOR LAB USE
LAB ID _____

Address Report to:
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values; Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # EX-GSE-01 Tag # 00133 | Soil | Zinc. XRF |
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| SAMPLES RELINQUISHED BY | SAMPLES RECEIVED BY | FORM NO. |
|---|---|---|
| Signature [signature] Date 8/2/96 Time 1400 | Signature Date Time | 8 |
| Signature Date Time | Signature Date Time | |

G:\USERS\TYNAS\FORMS\FIELD\SMPLANAL.FRM

SAMPLE EX-SSE-01

**UPS Next Day Air®**
**UPS Worldwide Express**
Shipping Document

See instructions on back. Call 1-800-PICK-UPS (800-742-5877) for additional information.

TRACKING NUMBER: 0909 521 014 2

**1 SHIPMENT FROM**

SHIPPER'S UPS ACCOUNT NO: 5907223326
UPS SHIPPER NO. / UPS BILLING NO.
FOR UPS USE: 800X99

REFERENCE NUMBER: 101.9601.052

NAME: Steve Story
TELEPHONE: 970-484-3611

COMPANY: ESA CONSULTANTS

STREET ADDRESS: 2637 MIDPOINT DR STE F

CITY AND STATE: FORT COLLINS CO
ZIP CODE: 80525

PLEASE PRESS HARD YOU'RE MAKING 3 COPIES

**2 EXTREMELY URGENT DELIVERY TO**

NAME: John Ashe
TELEPHONE: (406) 723-2080

COMPANY: Ashe Analytics, Inc.

177 STREET ADDRESS: 1309 Kaw Ave.
DEPT./FLOOR:

168 CITY AND STATE (INCLUDE COUNTRY IF INTERNATIONAL): Butte, MT.
135 ZIP CODE: 59701

**3 WEIGHT AND ZONE**

| WEIGHT (ENTER "LTR" IF LETTER) | DIMENSIONAL WEIGHT (If Applicable) | ZONE |
|---|---|---|
| 1.1 lb. | | |

SHIPPER'S COPY

**4 TYPE OF SERVICE** — CHARGES

- [X] NEXT DAY AIR
- [ ] WORLDWIDE EXPRESS (INTERNATIONAL)
- FOR WORLDWIDE EXPRESS SHIPMENTS Mark an "X" in this box if shipment only contains documents of no commercial value. [ ] DOCUMENTS ONLY — $

**5 OPTIONAL SERVICES**

- [ ] SATURDAY PICKUP (See instructions.) [ ] SATURDAY DELIVERY (See instructions.) — $
- [ ] DECLARED VALUE (Contents are automatically protected up to $100. For declared value over $100, see instructions.) $ _____ AMOUNT — $
- [ ] C.O.D. (If C.O.D., enter amount to be collected and attach completed UPS C.O.D. tag to package.) $ _____ AMOUNT — $

**6 ADDITIONAL HANDLING CHARGE**

- [ ] An Additional Handling Charge applies for certain items. See instructions. — $

TOTAL CHARGES — $

**7 METHOD OF PAYMENT**

- [X] BILL SHIPPER
- [ ] BILL RECEIVER (Next Day Air Only)
- [ ] BILL THIRD PARTY (Next Day Air Only)
- [ ] AMERICAN EXPRESS
- [ ] MASTER CARD
- [ ] VISA
- [ ] CHECK
- [ ] UPS USE (CASH)

(Provide Account No. in Section 8)

**8** RECEIVER'S / THIRD PARTY'S UPS ACCT. NO. OR MAJOR CREDIT CARD NO. — EXPIRATION DATE

THIRD PARTY'S COMPANY NAME

STREET ADDRESS

CITY AND STATE — ZIP CODE

**9** SHIPPER'S SIGNATURE: X [signature] — DATE OF SHIPMENT: 8/2/96

010191120 9/95 W

ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, CO 80525
(970) 484-3611 (970) 484-4118 FAX

# SOIL SAMPLING
## FIELD DATA FORM

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Date: 8/20/96
Weather Conditions: Partly cloudy, Sprinkling Rain
Temperature: 68°F

Sampling Personnel (Signatures):

Photo. Roll #: 7

*Tie picture numbers to samples below, if any

## SOIL SAMPLES

| | Tag Number | Sample Number | Sample Type | Depth Below Grade/Depth Interval | Time | Laboratory Analysis | Location |
|---|---|---|---|---|---|---|---|
| 1. | 00134 | EX-SSW-01 | Soil | 0-6" | 1340 | Zinc XRF | Silver Swan West. Between Main Pile (on East side) |
| 2. | " | " | " | " | " | " | and Dolores River. Photo # 24, 25. Plotted on Sheet SS-2 |
| 3. | 00135 | EX-SSW-02 | Soil | 0-6" | 1410 | Zinc XRF | Silver Swan West. Stripped Area North of Main Pile. |
| 4. | | | | | | | Photo # 29, 30. Plotted on Sheet SS-2 |
| 5. | | | | | | | |
| 6. | | | | | | | |
| 7. | | | | | | | |
| 8. | | | | | | | |
| 9. | | | | | | | |
| 10. | | | | | | | |

# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

**Samples sent to:**
Ashe Analytics, Inc.
1309 Haw Ave.
Butte, MT. 59701
(406) 723-2080

FOR LAB USE
LAB ID_____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # EX-55W-01 Tag # 00134 | Soil | Zinc · XRF |
| | | |
| Sample # EX-55W-02 Tag # 00135 | Soil | Zinc · XRF |
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| SAMPLES RELINQUISHED BY | SAMPLES RECEIVED BY | FORM NO. |
|---|---|---|
| Signature [signature] Date 8/21/96 Time 1400 | Signature Date Time | 9. |
| Signature Date Time | Signature Date Time | |

G:\USERS\TYNAS\FORMS\FIELD\SMPLANAL.FRM

SAMPLES EX-SSW-01 & EX-SSW-02

**UPS Next Day Air®**
**UPS Worldwide Express**
Shipping Document

See instructions on back. Call 1-800-PICK-UPS (800-742-5877) for additional information.

TRACKING NUMBER: 0909 521 021 3

**1 SHIPMENT FROM**

SHIPPER'S UPS ACCOUNT NO.: UPS SHIPPER NO. / UPS BILLING NO.: 5907223326 — FOR UPS USE: 800X99

REFERENCE NUMBER: Rico 101.9601.052

NAME: Steve Story — TELEPHONE: 970-484-3611

COMPANY: ESA CONSULTANTS

STREET ADDRESS: 2637 MIDPOINT DR STE F

CITY AND STATE: FORT COLLINS CO — ZIP CODE: 80525

**2 EXTREMELY URGENT DELIVERY TO**

NAME: John Ashe — TELEPHONE: (406)723-2080

COMPANY: Ashe Analytics, Inc.

STREET ADDRESS: 1309 Kaw Ave. — DEPT./FLOOR:

CITY AND STATE (INCLUDE COUNTRY IF INTERNATIONAL): Butte, MT. — ZIP CODE: 59701

177
168
135

PLEASE PRESS HARD
YOU ARE MAKING 3 COPIES

**3 WEIGHT AND ZONE**

| WEIGHT ENTER "LTR" IF LETTER | DIMENSIONAL WEIGHT If Applicable | ZONE |
|---|---|---|
| 1.9 lb. | | |

SHIPPER'S COPY

**4 TYPE OF SERVICE**

- [X] NEXT DAY AIR
- [ ] WORLDWIDE EXPRESS (INTERNATIONAL)
- FOR WORLDWIDE EXPRESS SHIPMENTS Mark an "X" in this box if shipment only contains documents of no commercial value. [ ] DOCUMENTS ONLY

**5 OPTIONAL SERVICES**

- [ ] SATURDAY PICKUP See instructions.
- [ ] SATURDAY DELIVERY See instructions.
- [ ] DECLARED VALUE Contents are automatically protected up to $100. For declared value over $100, see instructions. $ AMOUNT
- [ ] C.O.D. If C.O.D., enter amount to be collected and check completed UPS C.O.D. tag to package. $ AMOUNT

**6 ADDITIONAL HANDLING CHARGE**

- [ ] An Additional Handling Charge applies for certain items. See instructions.

TOTAL CHARGES

CHARGES: $ / $ / $ / $ / $

**7 METHOD OF PAYMENT**

- [X] BILL SHIPPER
- BILL RECEIVER [ ] — NEXT DAY AIR ONLY
- BILL THIRD PARTY [ ] — NEXT DAY AIR ONLY
- AMERICAN EXPRESS [ ] — RECORD ACCOUNT NO. IN SECTION 8
- MASTER CARD [ ] — RECORD ACCOUNT NO. IN SECTION 8
- VISA [ ] — RECORD ACCOUNT NO. IN SECTION 8
- CHECK [ ]
- UPS USE CASH [ ]

**8 RECEIVER'S / THIRD PARTY'S UPS ACCT. NO. OR MAJOR CREDIT CARD NO.** — EXPIRATION DATE

THIRD PARTY'S COMPANY NAME

STREET ADDRESS

CITY AND STATE — ZIP CODE

**9 SHIPPER'S SIGNATURE** X [signature] — DATE OF SHIPMENT 8/21/96

010191120 9/95 W

ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, CO 80525
(970) 484-3611 (970) 484-4118 FAX

# SOIL SAMPLING
## FIELD DATA FORM

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Date: 8/26/96
Weather Conditions: Overcast, Calm. Temperature: 60°F

Sampling Personnel (Signatures): [signature]

Photo. Roll #: ~~R8~~ R9

*Tie picture numbers to samples below, if any

## SOIL SAMPLES

| | Tag Number | Sample Number | Sample Type | Depth Below Grade/Depth Interval | Time | Laboratory Analysis | Location |
|---|---|---|---|---|---|---|---|
| 1. | 00137 | EX-CO-01 | Soil | 0-6" | 1115 | Zinc XRF | Stripped Area South of Columbia Pile |
| 2. | | | | | | ☒ | Photos # 2, #3. Plotted on Sheet CT-2. |
| 3. | | | | | | | |
| 4. | | | | | | | |
| 5. | | | | | | | |
| 6. | | | | | | | |
| 7. | | | | | | | |
| 8. | | | | | | | |
| 9. | | | | | | | |
| 10. | | | | | | | |

# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

**Samples sent to:**
John Ashe
ASHE Analytics, INC.
1309 Kaw Ave.
Butte, MT. 59701
(406) 723-2080

FOR LAB USE
LAB ID_____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Tag # 00137 Sample # EX-CO-01 | Soil | Zinc XRF |
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| SAMPLES RELINQUISHED BY | SAMPLES RECEIVED BY | FORM NO. |
|---|---|---|
| Signature [signature] Date 8/26/96 Time 1400 | Signature Date Time | 10. |
| Signature Date Time | Signature Date Time | |

SAMPLE EX-CO-Ø1

**UPS Next Day Air**
**UPS Worldwide Express**
**Shipping Document**

See instructions on back. Call 1-800-PICK-UPS (800-742-5877) for additional information.

TRACKING NUMBER: 0909 521 022 2

**1 SHIPMENT FROM**

SHIPPER'S UPS ACCOUNT NO.: UPS SHIPPER NO. / UPS BILLING NO.: 5907223326 — FOR UPS USE: 800X99

REFERENCE NUMBER: Rico 101.9601.052

NAME: Steve Story — TELEPHONE: 970-484-3611

COMPANY: ESA CONSULTANTS

STREET ADDRESS: 2637 MIDPOINT DR STE E

CITY AND STATE: FORT COLLINS — ZIP CODE: CO 80525

PLEASE PRESS HARD YOU ARE MAKING 3 COPIES

**2 EXTREMELY URGENT DELIVERY TO**

NAME: John Ashe — TELEPHONE: (406)723-2080

COMPANY: Ashe Analytics, Inc.

177

STREET ADDRESS: 1309 Kaw Ave. — DEPT./FLOOR:

168

CITY AND STATE (INCLUDE COUNTRY IF INTERNATIONAL): Butte, MT. — ZIP CODE: 59701

135

**3 WEIGHT AND ZONE**

| WEIGHT ENTER "LTR" IF LETTER | DIMENSIONAL WEIGHT | ZONE |
|---|---|---|
| 1.25 lb. | | |

SHIPPER'S COPY

**4 TYPE OF SERVICE**

- [X] NEXT DAY AIR
- [ ] WORLDWIDE EXPRESS (INTERNATIONAL)

FOR WORLDWIDE EXPRESS SHIPMENTS Mark an "X" in this box if shipment only contains documents of no commercial value. [ ] DOCUMENTS ONLY

**5 OPTIONAL SERVICES**

- [ ] SATURDAY PICKUP See instructions.
- [ ] SATURDAY DELIVERY See instructions.
- [ ] DECLARED VALUE Contents are automatically protected up to $100. For declared value over $100, see instructions. $ AMOUNT
- [ ] C.O.D. If C.O.D., enter amount to be collected and attach completed UPS C.O.D. tag to package. $ AMOUNT

**6 ADDITIONAL HANDLING CHARGE**

- [ ] An Additional Handling Charge applies for certain items. See instructions.

**7 METHOD OF PAYMENT**

- [X] BILL SHIPPER
- [ ] BILL RECEIVER (Next Day Air Only)
- [ ] BILL THIRD PARTY
- [ ] AMERICAN EXPRESS
- [ ] MASTER CARD
- [ ] VISA
- [ ] CHECK
- [ ] UPS USE CASH

Record Account No. in Section 8

CHARGES: $ / $ / $ / $

**8 RECEIVER'S / THIRD PARTY'S UPS ACCT. NO. OR MAJOR CREDIT CARD NO.** — EXPIRATION DATE

THIRD PARTY'S COMPANY NAME

STREET ADDRESS

CITY AND STATE — ZIP CODE

**9 SHIPPER'S SIGNATURE** X [signature] — DATE OF SHIPMENT 8/26/96

010191120 9/95 W

# APPENDIX B

## ANALYTICAL REPORT
## ASHE ANALYTICS, INC.

**Ashe Analytics, Inc.**
P.O. Box 4172 • Butte, Montana 59701
(406) 723-2080

RECEIVED
SEP 16 1996

September 12, 1996

Mr. Ed Schneider
ESA CONSULTANTS, INC.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525

RE: RICO SITE REMEDIATION Analytical Report
Project 101.9601.052

Dear Mr. Schneider:

Attached is the analytical report for samples relating to the Rico site remediation (Project 101.9601.052).

Samples were received in good condition. They are being held, in ambient laboratory conditions, for final disposition instructions. The laboratory is locked and secured when not occupied.

Analyses were performed under the protocol defined in the "Laboratory Analytical Procedures for x-ray fluorescence analysis of solid media. I: Laboratory-grade instrumentation method" dated October, 1995. A copy is attached for information. No violations of the QA/QC standards occurred to cause any re-analyses.

No unusual events which could affect the analytical results occurred during the analysis period.

Sincerely,

John B. Ashe, PhD
President

TABLE OF CONTENTS


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| II. | QA/QC measurements and calculations | 3 |
| III. | Detection Limits | 6 |
| IV. | Spectrometer output (Raw Data) | 7 |
| V. | Log of incoming samples | 8 |
| VI. | Sample preparation records | 13 |
| VII. | Chain of Custody/Analysis Request | 22 |
| VIII. | Last page (Blank) | 32 |


John B. Ashe, PhD
President

ANALYTICAL RESULTS
RICO SITE REMEDIATION
PROJECT NO. 101.9601.052

| LABORATORY SAMPLE NUMBER | SAMPLE I.D. | Zinc (mg/kg) | SAMPLE PREP GROUP |
|---|---|---|---|
| 6-0882.1 | EX-SH-01 | 3740 | 999242 |
| 6-0897 | EX-AR-01 | 1130 | 999242 |
| 6-0910 | EX-SC-01 | 6330 | 999243 |
| 6-0911 | EX-PP-01 | 16600 | 999243 |
| 6-0914 | EX-PP-02 | 3840 | 999243 |
| 6-0915 | EX-AR-02 | 1120 | 999243 |
| 6-0918 | EX-SC-02 | 1440 | 999243 |
| 6-0919 | EX-SC-03 | 2640 | 999243 |
| 6-0939 | EX-SC-04 | 422 | 999243 |
| 6-0944 | EX-SSE-01 | 2030 | 999243 |
| 6-0968 | EX-SSW-01 | 788 | 999244 |
| 6-0969 | EX-SSW-02 | 1640 | 999244 |
| 6-0978.1 | EX-C~~B~~O-01 | 651 | 999244 |

QA/QC SAMPLES
RICO SITE REMEDIATION
PROJECT NO. 101.9601.052

| SAMPLE LABEL | REMARKS | ZN PPM |
|---|---|---|
| N-2710/A | ICV, 7/17/96 | 6975.96 |
| CERTIFIED | | 6952 |
| RECOVERY | | 100.3 |
| N-2711/A | ICV, 7/17/96 | 374.641 |
| CERTIFIED | | 350.4 |
| RECOVERY | | 106.9 |
| 6-0882.1 | | 3739.73 |
| 6-0882.2 | LAB DUP | 3708.9 |
| 6-0882R | LAB REP | 3919.32 |
| RPD, LAB DUP | | 0.83 |
| RPD, LAB REP | | 4.69 |
| 999242 | XCS | 2.538 |
| 990242 | BLANK | 1.159 |

THE ABOVE BLANKS ARE ASSOCIATED WITH SPG 999242.

| | | |
|---|---|---|
| N-2710/A | LCS, 7/17/96 | 7006.04 |
| CERTIFIED | | 6952 |
| RECOVERY | | 100.8 |

THE ABOVE LCS ASSOCIATED WITH SAMPLE 6-0882.

| | | |
|---|---|---|
| N-2710/A | ICV, 7/22/96 | 6936.09 |
| CERTIFIED | | 6952 |
| RECOVERY | | 99.8 |
| N-2711/A | ICV, 7/22/96 | 357.606 |
| CERTIFIED | | 350.4 |
| RECOVERY | | 102.1 |
| N-2710/A | LCS, 7/22/96 | 6994.95 |
| CERTIFIED | | 6952 |
| RECOVERY | | 100.6 |

THE ABOVE LCS ASSOCIATED WITH SAMPLE 6-0897.

| | | |
|---|---|---|
| N-2710/A | ICV, 7/24/96 | 6897.21 |
| CERTIFIED | | 6952 |
| RECOVERY | | 99.2 |

| SAMPLE LABEL | REMARKS | ZN PPM |
|---|---|---|
| N-2711/A | ICV, 7/24/96 | 351.872 |
| CERTIFIED | | 350.4 |
| RECOVERY | | 100.4 |
| 999243 | XCS | 2.722 |
| 990243 | BLANK | |

THE ABOVE BLANKS ARE ASSOCIATED WITH SPG 999243.

| | | |
|---|---|---|
| N-2710/A | LCS, 7/24/96 | 7052.99 |
| CERTIFIED | | 6952 |
| RECOVERY | | 101.5 |

THE ABOVE LCS ASSOCIATED WITH SAMPLES 6-0910 & 6-0911.

| | | |
|---|---|---|
| N-2710/A | ICV, 7/26/96 | 7002.29 |
| CERTIFIED | | 6952 |
| RECOVERY | | 100.7 |
| N-2711/A | ICV, 7/26/96 | 361.461 |
| CERTIFIED | | 350.4 |
| RECOVERY | | 103.2 |
| N-2710/A | LCS, 7/26/96 | 7071.51 |
| CERTIFIED | | 6952 |
| RECOVERY | | 101.7 |

THE ABOVE LCS ASSOCIATED WITH SAMPLES 6-0914 & 6-0915.

| | | |
|---|---|---|
| N-2710/A | ICV, 7/30/96 | 6882.92 |
| CERTIFIED | | 6952 |
| RECOVERY | | 99.0 |
| N-2711/A | ICV, 7/30/96 | 345.565 |
| CERTIFIED | | 350.4 |
| RECOVERY | | 98.6 |
| N-2710/A | LCS, 7/30/96 | 6858.85 |
| CERTIFIED | | 6952 |
| RECOVERY | | 98.7 |

THE ABOVE LCS ASSOCIATED WITH SAMPLES 6-0918 & 6-0919.

| | | |
|---|---|---|
| N-2710/A | ICV, 8/01/96 | 6983.7 |
| CERTIFIED | | 6952 |
| RECOVERY | | 100.5 |
| N-2710/A | LCS, 8/01/96 | 6898.98 |
| CERTIFIED | | 6952 |
| RECOVERY | | 99.2 |

THE ABOVE LCS ASSOCIATED WITH SAMPLE 6-0939.

| SAMPLE LABEL | REMARKS | ZN PPM |
|---|---|---|
| N-2710/A | ICV, 8/05/96 | 6975.17 |
| CERTIFIED | | 6952 |
| RECOVERY | | 100.3 |
| N-2711/A | ICV, 8/05/96 | 347.641 |
| CERTIFIED | | 350.4 |
| RECOVERY | | 99.2 |
| N-2710/A | LCS, 8/05/96 | 7077.06 |
| CERTIFIED | | 6952 |
| RECOVERY | | 101.8 |

THE ABOVE LCS ASSOCIATED WITH SAMPLE 6-0944.

| | | |
|---|---|---|
| 999244 | XCS | 5.276 |
| 990244 | BLANK | 3.362 |

THE ABOVE BLANKS ARE ASSOCIATED WITH SPG 999244.

| | | |
|---|---|---|
| N-2710/A | ICV, 8/22/96 | 6775.14 |
| CERTIFIED | | 6952 |
| RECOVERY | | 97.5 |
| N-2710/A | LCS, 8/22/96 | 6916.29 |
| CERTIFIED | | 6952 |
| RECOVERY | | 99.5 |

THE ABOVE LCS ASSOCIATED WITH SAMPLES 6-0968 & 6-0969.

| | | |
|---|---|---|
| N-2710/A | ICV, 8/27/96 | 6839.84 |
| CERTIFIED | | 6952 |
| RECOVERY | | 98.4 |
| N-2711/A | ICV, 8/27/96 | 356.75 |
| CERTIFIED | | 350.4 |
| RECOVERY | | 101.8 |
| 6-0978.1 | | 651.497 |
| 6-0978.2 | LAB DUP | 689.11 |
| 6-0978R | LAB REP | 669.177 |
| RPD, LAB DUP | | 5.61 |
| RPD, LAB REP | | 2.68 |
| N-2710/A | LCS, 8/27/96 | 6875.42 |
| CERTIFIED | | 6952 |
| RECOVERY | | 98.9 |

THE ABOVE LCS ASSOCIATED WITH SAMPLE 6-0978.

3rd QUARTER, 1996

(Measured on July 24 through July 27, 1996)

| | MDL (mg/kg) | LOQ (mg/kg) |
|---|---|---|
| Copper | 11.6 | 38.7 |
| Zinc | 13.8 | 46.0 |
| Arsenic | 7.8 | 26.0 |
| Cadmium | 2.9 | 9.5 |
| Lead | 6.2 | 20.7 |

RAW DATA PRINTOUT (QA SAMPLES ANNOTATED)
RICO SITE REMEDIATION
PROJECT NO. 101.9601.052

| SAMPLE LABEL | ZN PPM | REMARKS |
|---|---|---|
| N-2710/A | 6975.957 | ICV, 7/17/96 |
| N-2711/A | 374.641 | ICV, 7/17/96 |
| 6-0882.1 | 3739.734 | |
| 6-0882.2 | 3708.899 | LAB DUP |
| 6-0882R | 3919.324 | LAB REP |
| 999242 | 2.538 | XCS |
| 990242 | 1.159 | BLANK |
| N-2710/A | 7006.042 | LCS, 7/17/96 |
| N-2710/A | 6936.087 | ICV, 7/22/96 |
| N-2711/A | 357.606 | ICV, 7/22/96 |
| 6-0897 | 1133.828 | |
| N-2710/A | 6994.953 | LCS, 7/22/96 |
| N-2710/A | 6897.206 | ICV, 7/24/96 |
| N-2711/A | 351.872 | ICV, 7/24/96 |
| 999243 | 2.722 | XCS |
| 990243 | | BLANK |
| 6-0910 | 6334.604 | |
| 6-0911 | 16624.346 | |
| N-2710/A | 7052.988 | LCS, 7/24/96 |
| N-2710/A | 7002.286 | ICV, 7/26/96 |
| N-2711/A | 361.461 | ICV, 7/26/96 |
| 6-0914 | 3836.429 | |
| 6-0915 | 1116.985 | |
| N-2710/A | 7071.514 | LCS, 7/26/96 |
| N-2710/A | 6882.916 | ICV, 7/30/96 |
| N-2711/A | 345.565 | ICV, 7/30/96 |
| 6-0918 | 1439.337 | |
| 6-0919 | 2637.194 | |
| N-2710/A | 6858.851 | LCS, 7/30/96 |
| N-2710/A | 6983.695 | ICV, 8/01/96 |
| 6-0939 | 422.489 | |
| N-2710/A | 6898.981 | LCS, 8/01/96 |
| N-2710/A | 6975.166 | ICV, 8/05/96 |
| N-2711/A | 347.641 | ICV, 8/05/96 |
| 6-0944.1 | 2026.085 | |
| N-2710/A | 7077.059 | LCS, 8/05/96 |
| 999244 | 5.276 | XCS |
| 990244 | 3.362 | BLANK |
| N-2710/A | 6775.142 | ICV, 8/22/96 |
| 6-0968 | 788.068 | |
| 6-0969 | 1643.174 | |
| N-2710/A | 6916.293 | LCS, 8/22/96 |
| N-2710/A | 6839.839 | ICV, 8/27/96 |
| N-2711/A | 356.75 | ICV, 8/27/96 |
| 6-0978.1 | 651.497 | |
| 6-0978.2 | 689.11 | LAB DUP |
| 6-0978R | 669.177 | LAB REP |
| N-2710/A | 6875.422 | LCS, 8/27/96 |

| Lab Number | Sample Id | | | Date Rcvd | |
|---|---|---|---|---|---|
| 6-0862 | LL | 0100 | 7/11/96 | 7/15/96 | |
| 6-0863 | TL | 1400 | 7/11/96 | | |
| 6-0864 | TL | 1400 | 7/11/96 | | |
| 6-0865 | LL | 1400 | 7/11/96 | | |
| 6-0866 | LL | 1400 | 7/11/96 | | |
| 6-0867 | Cement In | 22:00 | 7/11/96 | | |
| 6-0868 | Cement In | 22:00 | 7/11/96 | | |
| 6-0869 | 2nd Thickener | 22:00 | 7/11/96 | | |
| 6-0870 | DOOG | 07:00 | 7/12/96 | 7/15/96 | |
| 6-0871 | ~~7/13/96~~ #1 | 7 136 | #1 | 7/15/96 | |
| 6-0872 | 7/ | 7146 | #5 | 7/15/96 | |
| 6-0873 | RBSH COMP | | | 7/15/96 | |
| 6-0874 | RB SH-COMP | | | 7/15/96 | |
| 6-0875 | #1 | | | 7/15/96 | |
| 6-0876 | #2 | | | | |
| 6-0877 | #3 | | | | |
| 6-0878 | #4 | | | | |
| 6-0879 | #5 | | | | |
| ~~6-0880~~ | ~~Sluice~~ | Delete | | ~~7/16/96~~ | 6-0880A Run |
| ~~6-0881~~ | ~~Auger Tank~~ | Delete | | ~~7/16/96~~ | |
| 6-0882 | EX-SH-01 | | | 7/17/96 | |

| Lab Number | Sample I.D. | | Date Recvd |
|---|---|---|---|
| 6-0883 | #1 CD | (red) | 8/17/96 |
| 6-0884 | #2 CD | (grey) | 8/17/96 |
| 6-0885 | Cement. In | 02:30 7/15/96 | 7/19/96 |
| 6-0886 | Cement. Out | 02:30 7/15/96 | |
| 6-0887 | 2nd Thickener | 02:30 7/15/96 | |
| 6-0888 | Cement. Inlet | 15:45 7/16/96 | |
| 6-0889 | Cement. Outlet | 15:45 7/16/96 | |
| 6-0890 | 2nd Thickener | 15:40 7/16/96 | |
| 6-0891 | Cement. Inlet | 22:30 7/16/96 | |
| 6-0892 | Cement. Outlet | 22:30 7/16/96 | |
| 6-0893 | 2nd Thickener | 22:30 7/16/96 | |
| 6-0894 | Cement. Inlet | 19:30 7/17/96 | |
| 6-0895 | Cement Outlet | 19:30 7/17/96 | |
| ~~6-0896~~ | ~~2nd Thickener~~ | ~~19:30 7/17/96~~ | ~~7/19/96~~ |
| 6-0897 | Ex-Al-01 | | 7/22/96 |
| ~~6-0898~~ | ~~UN Numbered~~ | | ~~7/22/96~~ |
| 6-0899 | Drainage ditch Bell St | | 7/23/96 |
| 6-0900 | SW Quadrant Bell St | | |
| 6-0901 | NW Quadrant Bell St | | |
| 6-0902 | NE Quadrant Bell St | | |
| 6-0903 | SE Quad Bell St | | 7/23/96 |

| Lab Number | Sample I.D. | Date Rcvd |
|---|---|---|
| 6-0904 | CM-0723-5S | 7/23/96 |
| 6-0905 | CM-0723-9S | |
| 6-0906 | CM-0723-10S | |
| 6-0907 | CM-0723-11S | |
| 6-0908 | CM-RINSATE | 7/23/96 |
| ~~6-0909~~ | ~~Kelly 5 Edford~~ | ~~7/24/96~~ |
| 6-0910 | EX-SC-01 | 7/24/96 |
| 6-0911 | EX-PP-01 | 7/24/96 |
| ~~6-0912~~ | ~~OWTP-1~~ | ~~7/25/96~~ |
| ~~6-0913~~ | ~~OWTP-2~~ | ~~7/25/96~~ |
| 6-0914 | EX-PP-02 | 7/26/96 |
| 6-0915 | EX-AR-02 | 7/26/96 |
| ~~6-0916~~ | ~~Buffalo/Summit St~~ | ~~7/26/96~~ |
| ~~6-0917~~ | ~~Corner of Buffalo St & Summit~~ | ~~7/26/96~~ |
| 6-0918 | EX-SC-02 | 7/30/96 |
| 6-0919 | EX-SC-03 | 7/30/96 |
| ~~6-0920~~ | ~~SHRIVER COMP 7/18/96~~ | ~~7/30/96~~ |
| 6-0921 | Cement Inlet 20:00 7/18/96 | |
| 6-0922 | Cement Outlet 20:00 7/18/96 | |
| 6-0923 | 2nd U/F 20:00 7/18/96 | |
| 6-0924 | SHRIVER 7/22/96 | 7/30/96 |

| Lab Number | Sample I.D. | | Date Rcvd |
|---|---|---|---|
| 6-925 | Cement Inlet | 02:45 7/22/96 | 7/30/96 |
| 6-926 | Cement Outlet | 02:45 7/22/96 | |
| 6-927 | 2nd U/F | 02:45 7/22/96 | |
| 6-928 | Cement Inlet | 7/24/96 | |
| 6-929 | Cement Outlet | 7/24/96 | |
| 6-930 | 2nd Thickener | 7/24/96 | |
| 6-931 | SHRIVER | 03:00 7/25/96 | |
| 6-932 | SHRIVER | 7/25/96 | |
| 6-933 | Cement Inlet | 7/25/96 | |
| 6-934 | Cement Outlet | 7/25/96 | |
| 6-935 | 2nd Thickener | 7/25/96 | 7/30/96 |
| 6-936 | BB-1 | | 7/30/96 |
| 6-937 | BB-2 | | |
| ~~6-938~~ | ~~BB-3~~ | | ~~7/31/96~~ |
| 6-939 | EX-SC-04 | | 8/01/96 |
| ~~6-940~~ | ~~Cement Inlet~~ | ~~7/29/96~~ | ~~8/01/96~~ |
| 6-941 | Cement Outlet | 7/29/96 | |
| 6-942 | 2nd Thickener | 7/29/96 | |
| ~~6-943~~ | ~~Cement Inlet~~ | ~~7/30/96~~ | ~~8/01/96~~ |
| 6-944 | EX-SSE-01 | | 8/05/96 |
| ~~6-945~~ | ~~Shriver~~ | ~~02:30 7/31/96~~ | ~~8/07/96~~ |

| Lab Number | Sample I.D. | Date Recvd. |
|---|---|---|
| ~~6-0967~~ | ~~TP-4~~ | ~~8/14/96~~ |
| 6-0968 | Ex-SSW-01 | 8/22/96 |
| 6-0969 | Ex-SSW-02 | 8/22/96 |
| ~~6-0970~~ | ~~DK-1 0-18"~~ | ~~8/22/96~~ |
| 6-0971 | DK-2 0-24" | |
| 6-0972 | DK-3 0-18" | |
| 6-0973 | ~~TPC-1 Pits 3 & 4~~ | |
| 6-0974 | TPC-2 Pits 1 & 2 | |
| 6-0975 | WDPC-1 Pit 1, 4, 5, 8 | |
| 6-0976 | WDPC-2 Pits 3 & 6 | |
| ~~6-0977~~ | ~~WDPC-3 Pits 2 & 7~~ | ~~8/22/96~~ |
| 6-0978 | Ex-CD-01 | 8/27/96 |
| ~~6-0979~~ | | |
| ~~6-0980~~ | | |
| 6-0981 | | |
| 6-0982 | | |
| 6-0983 | | |
| 6-0984 | | |
| 6-0985 | | |
| 6-0986 | | |
| 6-0987 | | |

July 17, 1996

Scale Calibration

| Weight | Reading |
|---|---|
| 5g | |
| 10g | |
| 20g | |
| 50g | |

Lot # 4 Cleaning Sand

| Sample I.D. | Grinding Head | Sample Wt (gms) |
|---|---|---|
| 6-0882 | 1 | 15.7 |
| 6-0882R | 2 | 16.7 |
| 7/17/96 ~~999242~~ | | ~~13.9~~ |
| 999242, 990242 | 3 | 13.9, 14.1 |

7/17/96

July 22, 1996

| Scale Weight | Calibration Reading |
|---|---|
| 5g | 5.0g |
| 10g | 10.0g |
| 20g | 20.0g |
| 50g | 50.0g |

Lot # 4 Cleaning Sand

| Sample I.D. | Grinding Vessel | Sample Wt (gm) |
|---|---|---|
| 6-0897 | 1 | 15.7g |

7/22/96

July 24, 1996

Scale Calibration

| Weight | Reading |
|---|---|
| 5g | 5.0g |
| 10g | 10.0g |
| 20g | 20.0g |
| 50g | 50.0g |

Lot # 4 Cleaning Sand

| Sample I.D. | Grinding Vessel | Sample Wt (grams) |
|---|---|---|
| ~~6-0909~~ | ~~1~~ | ~~16.1~~ |
| 6-0910 | 2 | 17.3 |
| ~~6-0911~~ | ~~3~~ | ~~17.3~~ |
| ~~6-0901~~ 990243, 990243 | 1 | 13.3, 13.2 |
| ~~6-0902~~ | ~~2~~ | ~~16.3~~ |
| 6-0903 | 3 | 16.5 |
| 6-0901 | 1 | 16.1 |
| ~~6-0909~~ | ~~1~~ | ~~16.7~~ |
| 6-0910 | 2 | 16.8 |
| 6-0911 | 3 | 16.6 |

John Black
7/24/96

July 26, 1996

| Scale Weight | Calibration Reading |
|---|---|
| 5g | 5.0g |
| 10g | 10.0g |
| 20g | 20.0g |
| 50g | 50.0g |

(guess)

Lot #4 Cleaning Sand

| Sample I.D. | Grinding Vessel | Sample wt (guess) |
|---|---|---|
| ~~6-0912~~ | ~~1~~ | ~~16.3~~ |
| ~~6-0913~~ | ~~2~~ | ~~16.4~~ |
| 6-0914 | 3 | 16.1 |
| 6-0915 | 1 | 16.5 |
| ~~6-0916~~ | ~~2~~ | ~~16.7~~ |
| ~~6-0917~~ | ~~3~~ | ~~15.8~~ |

[signature]
7/26/96

7/30/96

| Scale Weight | Calibration Reading |
|---|---|
| 5g | 5.0g |
| 10g | 10.0g |
| 20g | 20.0g |
| 50g | 50.0g |

Lot #4 Cleaning Sand

| Sample I.D. | Grading Sieve | Sample Wt. (g) |
|---|---|---|
| 6-0918 | 1 | 16.7 |
| 6-0919 | 2 | 16.3 |
| ~~6-0926~~ | ~~3~~ | ~~17.1~~ |
| ~~6-0927~~ | ~~1~~ | ~~16.4~~ |
| ~~6-0938~~ | ~~2~~ | ~~16.4~~ |

7/30/96

8/01/96

| Scale Weight | Calibration Reading |
|---|---|
| 5g | 5.0g |
| 10g | 10.0g |
| 20g | 20.0g |
| 50g | 50.1g |

Lot # 4 Cleaning Sand

| Sample I.D. | Grading Sand | Sample wt. (grams) |
|---|---|---|
| 6-0939 | 1 | 16.6g |

8/01/96

August 05, 1996

| Scale Weight | Calibration Reading |
|---|---|
| 5g | 5.0g |
| 10g | 10.0g |
| 20g | 20.0g |
| 50g | 50.0g |

For # 4 Cleaning Sand

| Sample I.D. | Grinding Vessel | Sample Wt (gm) |
|---|---|---|
| 6-0944 | 1 | 16.6 |

August 05, 1996

8/22/96

Scale Calibration

| Weight | Reading |
|---|---|
| 5g | 5.0g |
| 10g | 10.0g |
| 20g | 20.0g |
| 50g | 50.0g |

Lot #4 Cleaning Sand

| Sample I.D. | Grinding Vessel | Sample Wt (gms) |
|---|---|---|
| 6-0968 | 1 | 16.6 |
| 6-0969 | 2 | 16.4 |
| | | |
| | | |
| | | |
| | | |
| | | |

Wt (gms)

8/22/96

Aug. 23, 1996

Scale Calibration

| ~~Sample~~ Weight | Reading |
|---|---|
| 5g | 5.0g |
| 10g | 10.0g |
| 20g | 20.0g |
| 50g | 50.0g |

Lot #4 Cleaning Sand

| Sample I.D. | Grinding Time | Sample Wt (gms) |
|---|---|---|
| 6-0978 | 1 | 17.4 |
| 6-0978R | 2 | 12.4 |

(gms)
1.6
1.9
6.5
8
6.7
1.4
1.5
7.3
23

000022

# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

**Samples sent to:**
ASHE Analytics, Inc.
1309 Kaw Ave.
Butte, MT. 59701
(406) 723-2080

FOR LAB USE
LAB ID_____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Tag: 00123 Sample: EX-SH-01 | Soil | Zinc · X-Ray fluorescence |
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| SAMPLES RELINQUISHED BY | SAMPLES RECEIVED BY | FORM NO. |
|---|---|---|
| Signature [signature] Date 7/16/96 Time 1445 | Signature [signature] Date 7/16/96 Time 10:15 | 1 |
| Signature Date Time | Signature Date Time | |

G:\USERS\TYNAS\FORMS\FIELD\SMPLANAL.FRM

# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

000023

**Samples sent to:**
Asha Analytics, Inc.
1309 Kew Ave.
Butte, MT. 59701
(406) 723-2080

FOR LAB USE
LAB ID_____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601 ~~.032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # EX-AR-01 Tag # 00125 | Soil | Zinc - XRF |
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| SAMPLES RELINQUISHED BY | SAMPLES RECEIVED BY | FORM NO. |
|---|---|---|
| [signature] 7/19/96 1400 | [signature] 7/22/96 10:15 | 2 |
| Date Time | Date Time | |

G:\USERS\TYNAS\FORMS\FIELD\SMPLANAL.FRM

# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM 000024

**Samples sent to:**
John Ashe
Ashe Analytics, Inc.
1309 Kaw Ave
Butte, MT. 59701

FOR LAB USE
LAB ID_____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # EX-SC-01 Tag # 00124 | Soil - Santa Cruz Site | Zinc - XRF |
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# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

000025

**Samples sent to:**
John Ashe
Ashe Analytics, Inc.
1309 Kaw Ave.
Butte, MT. 59701

FOR LAB USE
LAB ID

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601 ~~.032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # BX-PP-01 Tag # 00126 | Soil | Zinc - XRF |
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# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM 000020

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Butte, MT. 59701
(406) 723-2080

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2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| pic # EX-PP-02 Tag # 00127 | Soil | Zinc - XRF |
| sample # EX-AR-02 Tag # 00128 | Soil | Zinc - XRF |
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| Signature Date Time | Signature Date Time | |

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# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

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Ashe Analytics, Inc.
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Butte, MT 59701
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Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # EX-SC-02 Tag # 00130 | Soil | Zinc · XRF |
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| Sample # EX-SC-03 Tag # 00131 | Soil | Zinc · XRF |
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| Signature Date Time | Signature Date Time | |

# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

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Ashe Analytics, Inc.
1309 Kaw Ave
Butte, MT. 59701
(406) 723-2080

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LAB ID _____

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ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # EX-SC-04 Tag # 00132 | Soil | Zinc · XRF |
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Ashe Analytics, Inc.
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(406) 723-2080

FOR LAB USE
LAB ID_____

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ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # EX-SSE-01 Tag # 00133 | Soil | Zinc - XRF |
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# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

000030

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1309 Kaw Ave.
Butte, MT. 59701
(406) 723-2080

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LAB ID_____

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Sample # EX-SSW-01 Tag # 00134 | Soil | Zinc - XRF |
| | | |
| Sample # EX-SSW-02 Tag # 00135 8/21/96 | Soil | Zinc - XRF |
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# SAMPLE ANALYSIS REQUEST/CHAIN OF CUSTODY FORM

**Samples sent to:**
John Ashe
ASHE Analytics, INC.
1309 Kaw Ave.
Butte, MT. 59701
(406) 723-2080

FOR LAB USE
LAB ID

**Address Report to:**
ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525
Attn: Ed Schneider

Project Name: Rico Site Remediation
Project Number: 101.9601.~~032~~ 052
Contact Person: Ed Schneider
Telephone No.: (970) 484-3611

| List Sample Numbers or Identification | DESCRIBE MATRIX (Note any unusual properties) | LIST ANALYTES TO BE DETERMINED (Give anticipated range of values: Low, Medium, High) Describe any special preparation procedures required. |
|---|---|---|
| Tag # 00137 Sample # EX-CO-01 | Soil | Zinc · XRF |
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# APPENDIX B

## ARGENTINE TAILINGS ENGINEERING DATA/CALCULATIONS

- B1 HYDROLOGY
  - B1A RUNON/RUNOFF CALCULATIONS
  - B1B SILVER CREEK HYDROLOGY
- B2 HYDRAULIC FACILITIES
- B3 GEOTECHNICAL DATA
- B4 SLOPE STABILITY ANALYSES
- B5 WETLANDS DESIGN
- B6 TAILINGS VOLUME AND ASSAY DATA

# B1 HYDROLOGY

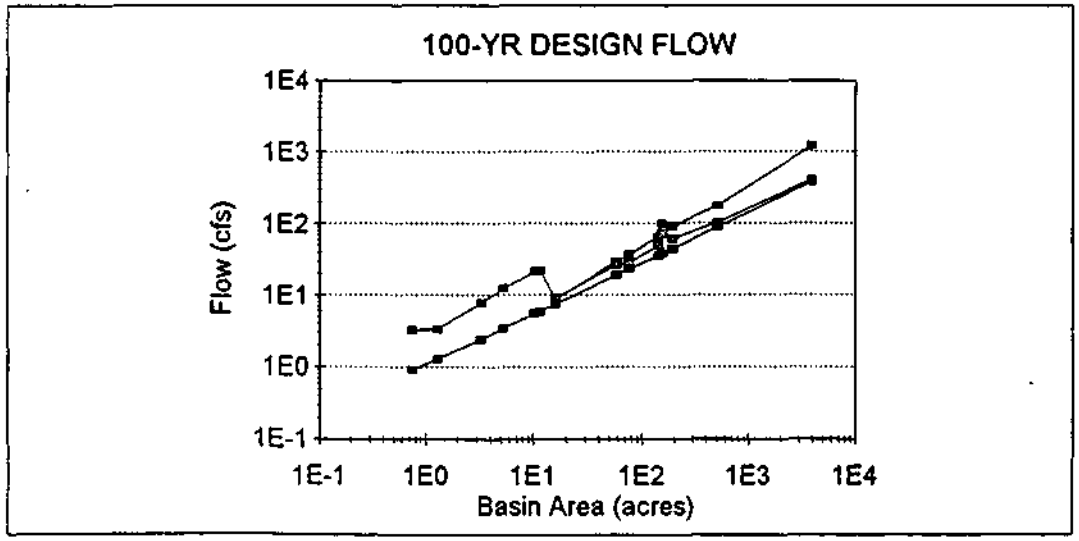
## B1A RUNON/RUNOFF CALCULATIONS
## B1B SILVER CREEK HYDROLOGY

# B1A RUNON/RUNOFF CALCULATIONS

## *Summary of Results*

Job: 101.9502
Project: Rico
By: ACJ
Re: 100-yr basin runoff

| Basin Number | Nickname | Area (acres) | Time of Concentration (min) | * Maximum Flow Path: Horizontal Length (ft) | Vertical Drop (ft) | Average Slope (ft/ft) | Average Water Velocity* (fps) | Q(cfs): Rational Method | TR-55 | Regional Regression | Q/A (cfs/ac) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Santa Cruz | Pile Runoff | 0.75 | 4.4 | 160 | 33 | 21% | 0.6 | 3.2 | - | 0.9 | 4.27 |
| Silver Swan | Pile Runoff | 1.3 | 18.6 | 315 | 9 | 3% | 0.3 | 3.3 | - | 1.3 | 2.54 |
| Columbia Tailings | Pile Runoff | 3.3 | 22.6 | 800 | 12 | 2% | 0.6 | 7.7 | - | 2.4 | 2.33 |
| Argentine Tailings | Pile Runoff - Area A | 5.3 | 23 | 1050 | 20 | 2% | 0.8 | 12.3 | - | 3.4 | 2.32 |
| | Pile Runoff - Area A,B | 10.3 | 27.5 | 1650 | 85 | 5% | 1.0 | 21.3 | - | 5.5 | 2.07 |
| | Pile Runoff - Area A,B,C | 11.5 | 31.4 | 2150 | 115 | 5% | 1.1 | 21.8 | - | 5.9 | 1.90 |
| A7 | | 16 | 16.3 | 1250 | 350 | 28% | 1.3 | 8.7 | 9.0 | 7.5 | 0.54 |
| A5 | | 58 | 19.8 | 3950 | 1500 | 38% | 3.6 | 29 | 26 | 19 | 0.45 |
| A8 | | 76 | 22.4 | 5750 | 2000 | 35% | 4.5 | 37 | 28 | 23 | 0.37 |
| A9 | | 142 | 24.1 | 6350 | 1790 | 28% | 4.6 | 66 | 50 | 35 | 0.35 |
| A3 | | 154 | 11.3 | 2500 | 1639 | 66% | 4.4 | 98 | 72 | 38 | 0.47 |
| A10 | Spear Slide | 192 | 24.0 | 8250 | 3400 | 41% | 6.2 | 90 | 61 | 44 | 0.32 |
| A6 | Sulphur Creek | 521 | 43.8 | 11800 | 3371 | 29% | 4.7 | 174 | 101 | 89 | 0.19 |
| Silver Creek Basin | (at Argentine Tailings) | 4000 | 58.8 | 21800 | 3481 | 16% | 6.3 | 1205 | 408 | 378 | 0.09 |




* Calculated using slope distance. Overland and shallow concentrated flow times included.

**Attachment B1A-1**
**Rainfall Data**

| Region of applicability[a] | Equation | Corr. coeff. | No. of stations | Mean of computed stn. values (inches) | Standard error of estimate (inches) |
|---|---|---|---|---|---|
| South Platte, Republican, Arkansas, and Cimarron River Basins (1) | $Y_2 = 0.218 + 0.709[(X_6)(X_4/X_6)]$ | 0.94 | 75 | 1.01 | 0.074 |
| | $Y_{100} = 1.897 + 0.439[(X_6)(X_4/X_6)] - 0.0082$ | .84 | 75 | 2.68 | .317 |
| San Juan, Upper Rio Grande, Upper Colorado, and Gunnison River Basins and Green River Basin below confluence with the Yampa River (2) | $Y_2 = -0.011 + 0.942[(X_6)(X_4/X_6)]$ | .95 | 86 | 0.72 | .085 |
| | $Y_{100} = 0.494 + 0.755[(X_6)(X_4/X_6)]$ | .90 | 85 | 1.96 | .290 |
| Yampa and Green River Basins above confluence of Green and Yampa Rivers (3) | $Y_2 = 0.019 + 0.711[(X_6)(X_4/X_6)] + 0.001Z$ | .82 | 99 | 0.40 | .031 |
| | $Y_{100} = 0.338 + 0.670[(X_6)(X_4/X_6)] + 0.001Z$ | .80 | 79 | 1.04 | .141 |
| North Platte (4) | $Y_2 = 0.028 + 0.890[(X_6)(X_4/X_6)]$ | .93 | 90 | 0.60 | .062 |
| | $Y_{100} = 0.671 + 0.757[(X_6)(X_4/X_6)] - 0.0032$ | .91 | 88 | 1.71 | .236 |

[a] Numbers in parentheses refer to geographic regions shown in figure 19. See text for more complete description.

List of variables

$Y_2$ = 2-yr 1-hr estimated value
$Y_{100}$ = 100-yr 1-hr estimated value
$X_4$ = 2-yr 6-hr value from precipitation-frequency maps
$X_6$ = 2-yr 24-hr value from precipitation-frequency maps
$X_4$ = 100-yr 6-hr value from precipitation-frequency maps
$X_6$ = 100-yr 24-hr value from precipitation-frequency maps
Z = point elevation in hundreds of feet

Figure 15. *Ratio of 2-yr 24-hr value for all data to 2-yr 24-hr value for rainfall only vs. latitude.*

15 percent, with some individual differences as large as 40 to 50 percent. About half the stations have differences greater than 10 percent. These differences indicate that frequency values computed from an annual series of rainfall amounts only would be different from those computed of all-precipitation values, and two separate sets of precipitation-frequency maps were needed.

Snowfall observations are made at only about 15 percent of the precipitation stations used in this study. For this reason, a rainfall-frequency study could not be made by direct methods. Since most snowfall occurs during the colder half of the year, a series containing only values for the May to October season was compared with the series that was based on rainfall only. The two series were in good agreement, except for a slight bias toward higher values for the May to October season. This bias results from some large amounts in late October and early May occurring as snow and thus excluded from the rainfall-only series. The average difference is only about 4 percent, with no consistent preference toward higher elevations or particular geographic regions.

Two sets of maps were prepared for Colorado. The first set consists of annual maps based on precipitation data from all months of the year without regard to the type of precipitation: rain, rain and snow mixed, all snow, hail, etc. The second series takes precipitation values from the months May to October. No attempt was made in this second series to differentiate between types of precipitation occurring within these months, but the investigations mentioned in the preceding paragraph indicate that these maps will approximate the values that would be obtained by using a data series made up of precipitation events that are exclusively rain. Since data for only part of the year were used, these maps have been labeled with the appropriate probabilities rather than with a return period in years (figs. 32–43).

| Duration (min) | 5 | 10 | 15 | 30 |
|---|---|---|---|---|
| Ratio to 1-hr | 0.29 | 0.45 | 0.57 | 0.79 |

(Adopted from *U.S. Weather Bureau Technical Paper No. 40*, 1961.)

## Procedures for Estimating Values for Durations Other Than 6 and 24 Hrs

The isopluvial maps in this Atlas are for 6- and 24-hr durations. For many hydrologic purposes, values for other durations are necessary. Such values can be estimated using the 6- and 24-hr maps and the empirical methods outlined in the following sections. The procedures detailed below for obtaining 1-, 2-, and 3-hr estimates were developed specifically for this Atlas. The procedures for obtaining estimates for less than 1-hr duration and for 12-hr duration were adopted from *Weather Bureau Technical Paper* No. 40 (U.S. Weather Bureau 1961) only after investigation demonstrated their applicability to data from the area covered by this Atlas.

*Procedures for estimating 1-hr (60-min) precipitation-frequency values.* Multiple-regression screening techniques were used to develop equations for estimating 1-hr duration values. Factors considered in the screening process were restricted to those that could be determined easily from the maps of this Atlas or from generally available topographic maps.

The 11 western states were separated into several geographic regions. The regions were chosen on the basis of meteorological and climatological homogeneity and are generally combinations of river basins separated by prominent divides. Four of these geographic regions are partially within Colorado. For convenience and use as an overlay on the precipitation-frequency maps, these regions are outlined on figure 19. The first Colorado region is part of the region that lies to the east of the Continental Divide and the crest of the Sangre de Cristo and Sacramento Mountains and is south of the divide separating the drainage basins of the North and South Platte Rivers. It consists of that portion of Colorado drained by the South Platte, Republican, Arkansas, and Cimarron Rivers (Region 1, fig. 19). The second region consists of the area drained by the San Juan, Upper Rio Grande, Upper Colorado, and Gunnison Rivers and by the Green River below its confluence with the Yampa River (Region 2, fig. 19). This is part of a larger region that extends from southwestern Colorado, westward to the Wasatch Mountains of Utah, and southward through Arizona and the western half of New Mexico. The third region is the mountainous portion of the area between the Continental Divide and the crest of the Cascade Range. The portion that lies within Colorado is the northwestern portion of the State that is drained by the Yampa River and the Green River above its confluence with the Yampa (Region 3, fig. 19). A small portion of Colorado drained by the North Platte is Region 4, figure 19. The larger region of which this is a part includes that portion of Wyoming and Montana east of the Continental Divide. Equations to provide estimates for the 1-hr duration for 2- and 100-yr return periods are shown in table 11. Also listed are the statistical parameters associated with each equation. In these equations, the variable $[(X_4)(X_4/X_6)]$ or

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$[(X_3)(X_3/X_1)]$ can be regarded as the 6-hr value times the slope of the line connecting the 6- and 24-hr values for the appropriate return period.

As with any separation into regions, the boundary can only be regarded as the sharpest portion of a zone of transition between regions. These equations have been tested for boundary discontinuities by computing values using equations from both sides of the boundary. Differences were found to be mostly under 15 percent. However, it is suggested that when computing estimates along or within a few miles of a regional boundary computations be made using equations applicable to each region and that the average of such computations be adopted.

**Estimates of 1-hr precipitation-frequency values for return periods between 2 and 100 yrs.** The 1-hr values for the 2- and 100-yr return periods can be plotted on the nomogram of figure 6 to obtain values for return periods greater than 2 yrs or less than 100 yrs. Draw a straight line connecting the 2- and 100-yr values and read the desired return-period value from the nomogram.

**Estimates for 2- and 3-hr (120- and 180-min) precipitation-frequency values.** To obtain estimates of precipitation-frequency values for 2 or 3 hrs, plot the 1- and 6-hr values from the Atlas on the appropriate nomogram of figure 16. Draw a straight line connecting the 1- and 6-hr values, and read the 2- and 3-hr values from the nomogram. This nomogram is independent of return period. It was developed using data from the same regions used to develop the 1-hr equations.

The mathematical solution from the data used to develop figure 16 gives the following equations for estimating the 2- and 3-hr values:

| | | |
|---|---|---|
| For Region 1, | 2-hr = 0.342 (6-hr) + 0.658 (1-hr) | (3) |
| figure 19 | 3-hr = 0.597 (6-hr) + 0.403 (1-hr) | (4) |
| For Region 2, | 2-hr = 0.341 (6-hr) + 0.659 (1-hr) | (5) |
| figure 19 | 3-hr = 0.569 (6-hr) + 0.431 (1-hr) | (6) |
| For Regions 3 | 2-hr = 0.250 (6-hr) + 0.750 (1-hr) | (7) |
| and 4, figure 19 | 3-hr = 0.467 (6-hr) + 0.533 (1-hr) | (8) |

**Estimates for 12-hr (720-min) precipitation-frequency values.** To obtain estimates for the 12-hr duration, plot values from the 6- and 24-hr maps on figure 17. Read the 12-hr estimates at the intersection of the line connecting these points with the 12-hr duration line of the nomogram.

**Estimates for less than 1 hr.** To obtain estimates for durations of less than 1 hr, apply the values in table 12 to the 1-hr value for the return period of interest.

| | 1-hr | 2-hr | 3-hr | 6-hr | 24-hr |
|---|---|---|---|---|---|
| 2-yr | *0.71* | *0.83* | *0.91* | 1.05 | 1.58 |
| 5-yr | | | | 1.38 | 1.88 |
| 10-yr | | | | 1.59 | 2.27 |
| 25-yr | | | | 1.80 | 2.65 |
| 50-yr | | | | 2.19 | 2.85 |
| 100-yr | *1.86* | | | 2.28 | 3.35 |

**Table 13.** *Precipitation data for depth-frequency atlas computation point 106°00′ W., 39°00′ N.*

## Illustration of Use of Precipitation-Frequency Maps, Diagrams, and Equations

To illustrate the use of these maps, values were read from figures 20 to 31 for the point at 39°00′ N. and 106°00′ W. These values are shown in boldface type in table 13. The values read from the maps should be plotted on the return-period diagram of figure 6 because (1) not all points are as easy to locate on a series of maps as are latitude-longitude intersections, (2) there may be some slight registration differences in printing, and (3) precise interpolation between isolines is difficult. This has been done for the 24-hr values in table 13 (fig. 18a) and a line of best fit has been drawn subjectively. On this nomogram, the line fits the data rather well. Had any points deviated noticeably from the line, the value would have been reread from the line and the new value substituted in table 13 and adopted in preference to the original readings.

The 2- and 100-yr 1-hr values for the point were computed from the equations applicable to Region 1, figure 19 (table 11), since the point is east of the Continental Divide. The 2-yr 1-hr value is estimated at 0.71 in. (2-yr 6- and 24-hr values from table 13); the estimated 100-yr 1-hr value is 1.86 in. (100-yr 6- and 24-hr values from table 13 and elevation of 9,500 ft). By plotting these 1-hr values on figure 6 and connecting them with a straight line, one can obtain estimates for return periods of 5, 10, 25, and 50 yrs.

The 2- and 3-hr values can be estimated by using the nomogram of figure 16 or equations (3) and (4). The 1- and 6-hr values for the desired return period are obtained as above. Plot these points on the nomogram of figure 16 and connect them with a straight line. Read the estimates for 2 or 3 hrs at the intersections of the connecting line and the 2- and 3-hr vertical lines. An example is shown in figure 18b for the 2-yr return period. The 2-yr 2-hr (0.83 in.) and 2-yr 3-hr (0.91 in.) values are in italics on table 13.

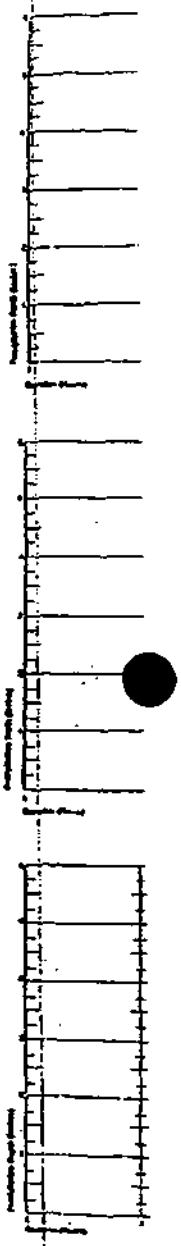


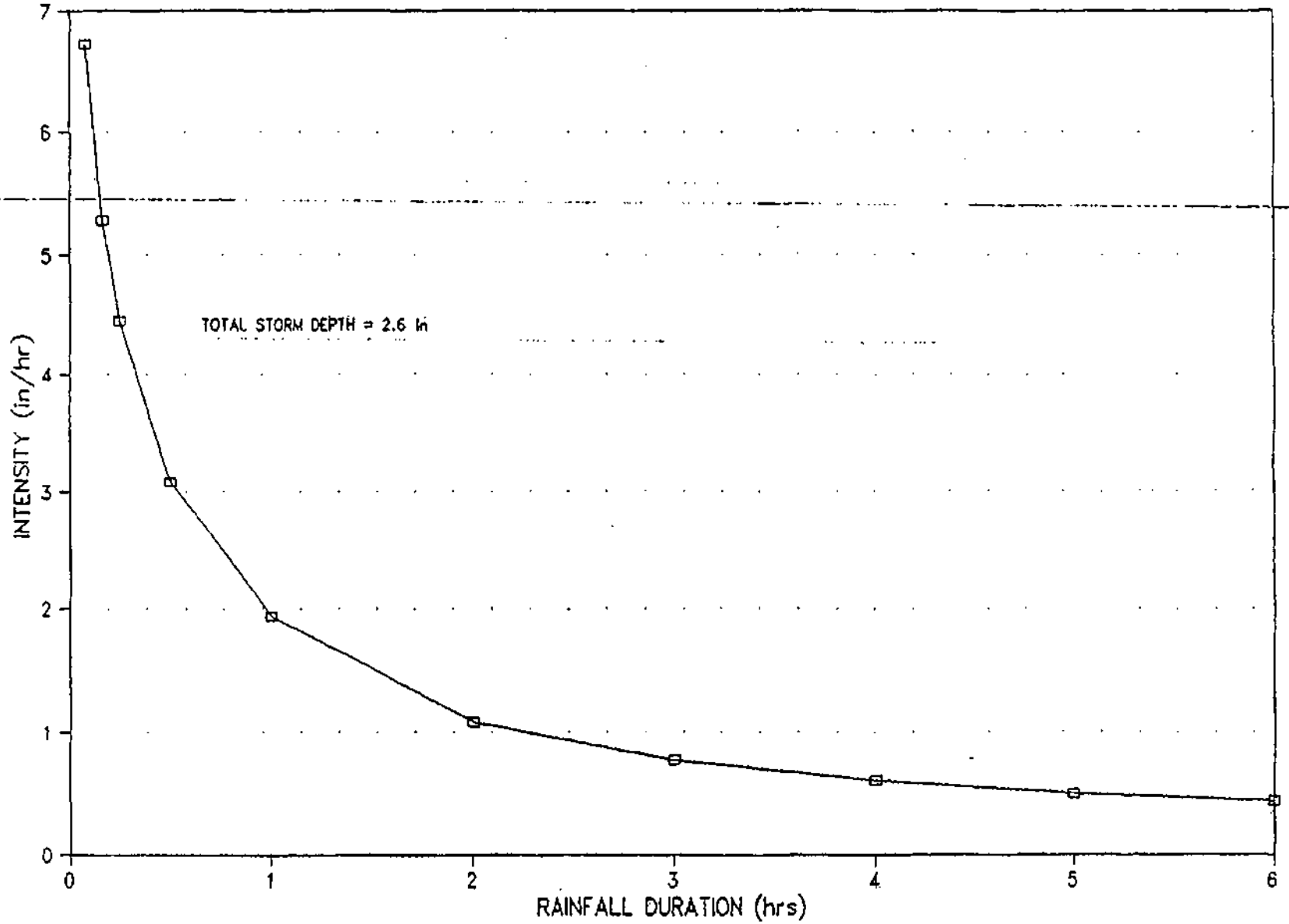
**Figure 10.** *Precipi*
*a. Sou*

SO RCE FILE: RICO PD. 2
100 YR 6 HR DESIGN STORM AND DISCHARGE FOR RICO C
07/27/95

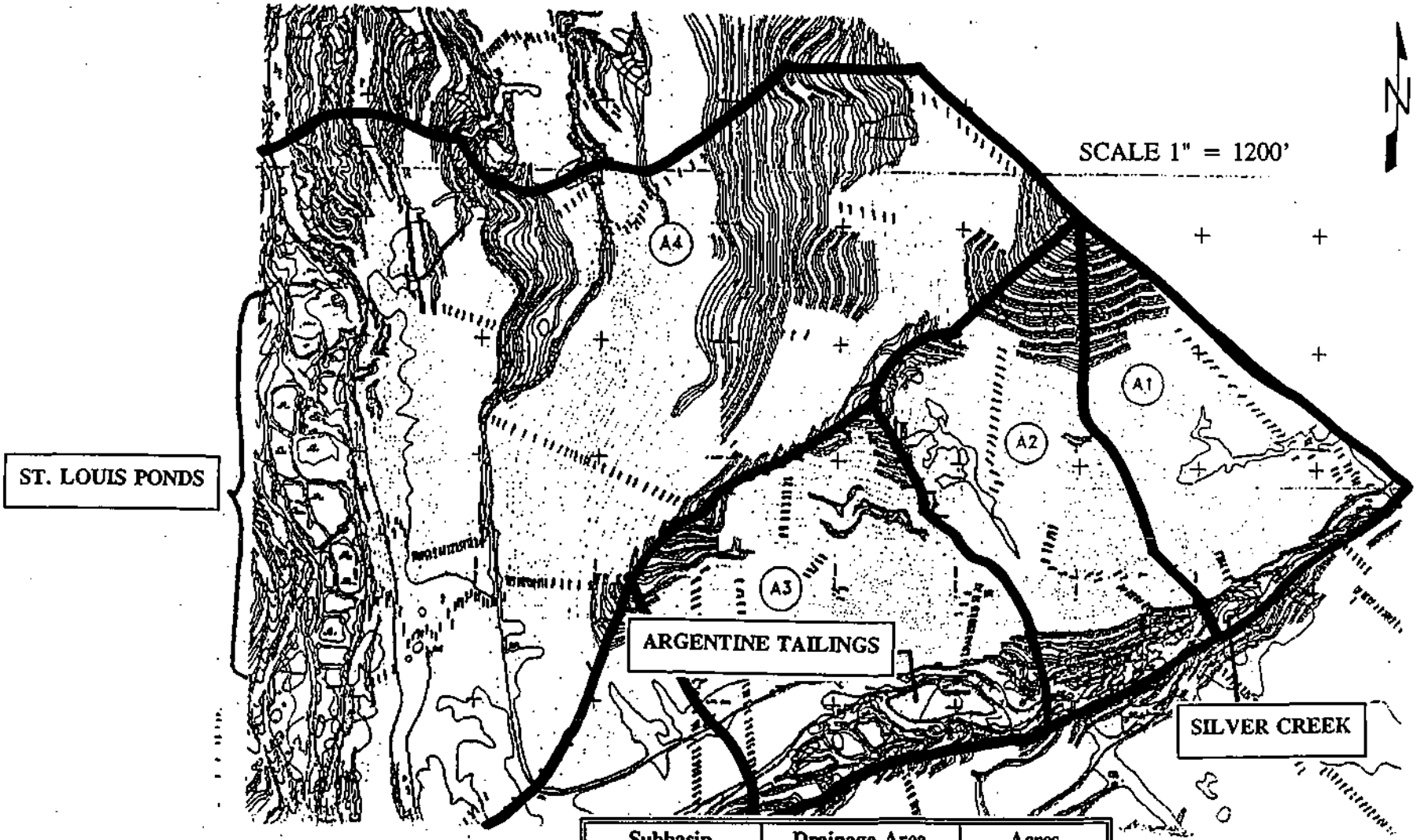
REF: NOAA ATLAS 2, VOL III
DESIGN STORM
100 YR - 6HR

| PERIOD (hrs) | TOTAL DEPTH (IN) | INC DEPTH (IN) | INTENSIT (in/hr) | BORTED INC DEPTH (IN) | ARRANG INC DEPTH (IN) |
|---|---|---|---|---|---|
| 0.083333 | 0.56 | 0.56 | 6.72 | 0.56 | 0.08 |
| 0.166667 | 0.88 | 0.32 | 5.28 | 0.43 | 0.1 |
| 0.25 | 1.11 | 0.23 | 4.44 | 0.41 | 0.15 |
| 0.5 | 1.54 | 0.43 | 3.08 | 0.32 | 0.22 |
| 1 | 1.95 | 0.41 | 1.95 | 0.23 | 0.32 |
| 2 | 2.17 | 0.22 | 1.085 | 0.22 | 0.43 |
| 3 | 2.32 | 0.15 | 0.773333 | 0.15 | 0.56 |
| 4 | 2.4 | 0.08 | 0.6 | 0.1 | 0.41 |
| 5 | 2.5 | 0.1 | 0.5 | 0.1 | 0.23 |
| 6 | 2.6 | 0.1 | 0.433333 | 0.08 | 0.1 |
| | | | | TOTAL = | 2.6 |

100 YR - 6HR DESIGN STORM
RICO COLORADO



**Attachment B1A-2**
**Basin Delineations**




| Subbasin | Drainage Area | Acres |
|---|---|---|
| Silver Creek | A1 | 102 |
| Silver Creek | A2 | 116 |
| Silver Creek | A3 | 164 |
| St. Louis Ponds | A4 | 517 |

**Attachment B1A-3**
**Rational Method Methodology**

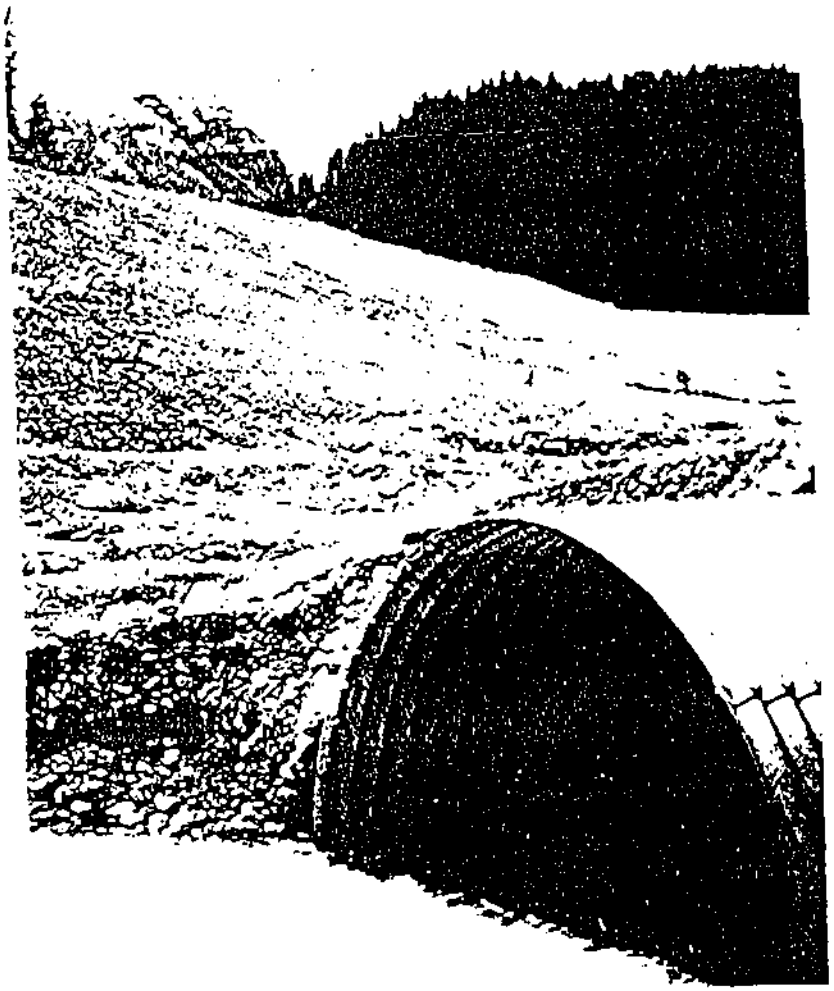


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Figure 3.1 Effective handling of drainage requires comprehensive hydraulic design.

# CHAPTER 3 Hydraulics

## INTRODUCTION

Many millions of dollars are spent annually on culverts, storm drains and subdrains, all vital to the protection of streets, highways and railroads. If inadequate, they can jeopardize the roadway and bring excessive property damage and loss of life. Overdesign means extravagance. Good engineering can find an economic solution.

Because topography, soil and climate combine in infinite variety, drainage sites should be designed individually from reasonably adequate data for each particular site. In addition, the designer is advised to consult with those of long experience in maintaining drainage structures in the area. One state highway engineer comments:

> "With the exception of the riding qualities of the traveled way, no other single item requires as much attention on the part of the maintenance man as highway culverts. Many of the problems of culvert maintenance stem from the fact that designers in all too many instances consider that culverts will be required to transport only clear water. This is a condition hardly ever realized in practice, and in many instances storm waters may be carrying as much as 50 percent detrital material which, due to a rapid change in grade line at the culvert entrance, causes complete blockage of the culvert, with resulting overflow across the highway and in some cases, especially where high fills are involved, the intense static pressure results in loss of the embankment."

## HYDROLOGY

The hydrological cycle as presented in many hydrology textbooks is defined as a group of numerous inter-related phenomena representing the different paths through which water in nature circulates and is transformed. A simplistic representation of this cycle is schematicized below. (Fig. 3.2)

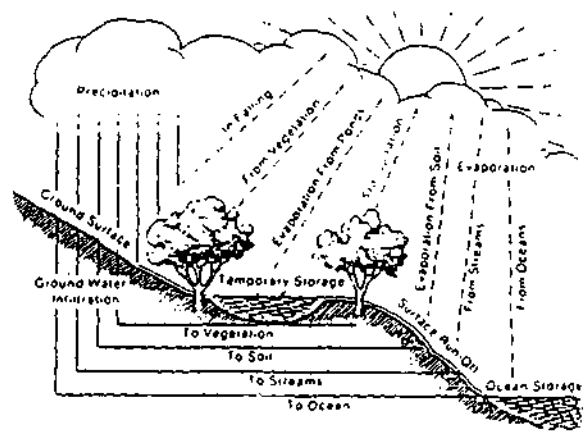



Figure 3.2 Hydrologic cycle—where water comes from and where it goes. From M G Spangler's *Soil Engineering*[1]

[1] Superior numbers indicate references at the end of this chapter

Due to our complex urban environment such ... ger valid. Modification of natural drainage paths, damming of waterways, impoundment of water, re-use of storm water and implementation of new storm water management processes results in highly intricate hydrologic processes.

The objective of this section will be to introduce the designer to different methods of estimating the hydrologic process from the precipitation state to runoff.

## ESTIMATION OF RAINFALL

The amount of rainfall and distribution of rainfall over time is usually the required input for most runoff calculations. This input may be in the form of actual rainfall events, representative design storms, the widely used intensity duration frequency curves, or statistical analysis of rainfall records.

### Rainfall Intensity-Duration Frequency Curves (Fig. 3.3)

Rainfall intensity-duration frequency (IDF) curves are derived from the statistical analysis of rainfall records compiled over a number of years. Each curve represents the intensity-time relationship for a certain return frequency, from a series of storms. These curves are then said to represent storms of a specific return frequency.

The intensity, or the rate of rainfall is usually expressed in depth per unit time with the highest intensities occurring over short time intervals and progressively decreasing as the time intervals increase. The greater intensity of the storm the lesser their recurrence frequency, thus the highest intensity for a specific duration for n years of records, is called the n year storm, with a frequency of once in n years.

Using Tabulated data

| (hrs) | Th | i (in/hr) | Time (min) |
|---|---|---|---|
| .083 | .56 | 6.75 | 5 |
| .167 | .88 | 5.27 | 10 |
| .25 | 1.11 | 4.44 | 15 |
| .65 | 1.54 | 3.08 | 25 |
| 1.0 | 1.95 | 1.95 | 60 |

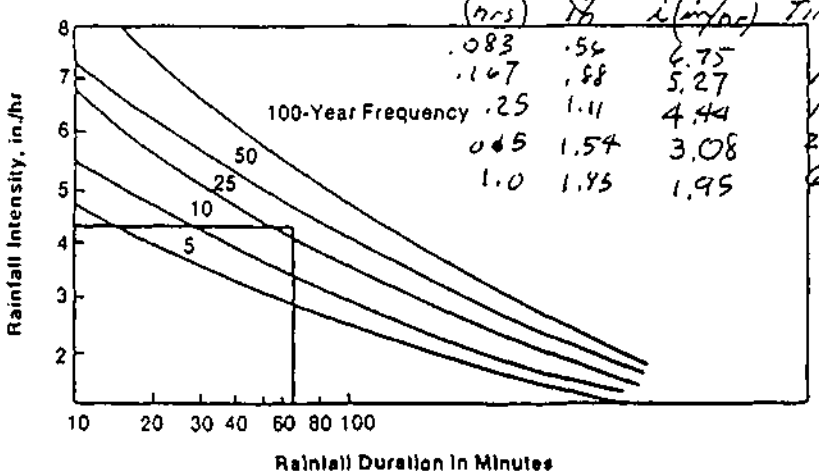



Figure 3.3 Example curve showing rainfall intensities for various storm frequencies vs. rainfall duration.



The curves may be in the graphical form as the example shown in Figure 3.3, or may be represented by individual equations that express the time intensity relationship for specific frequencies, in the form:

$$i = \frac{a}{(t + c)^b}$$

where:

i = intensity (in./hr.)
t = time in minutes
a,b,c = constants developed for each IDF curve

The fitting of rainfall data to the equation may be obtained by either graphical or least square methods.[2]

It should be noted that the I.D.F. curves *do not* represent a rainfall pattern, but are the distribution of the highest intensities over time durations for a storm of n frequency.

The rainfall-intensity-duration curves are readily available from governmental agencies, local municipalities and towns, and as such are widely used in the designing of drainage facilities and flood flow analysis.

### Rainfall Hyetographs

Rainfall hyetographs are a graphical representation of the intensity distribution of a rainfall event over time. (Fig. 3.4)

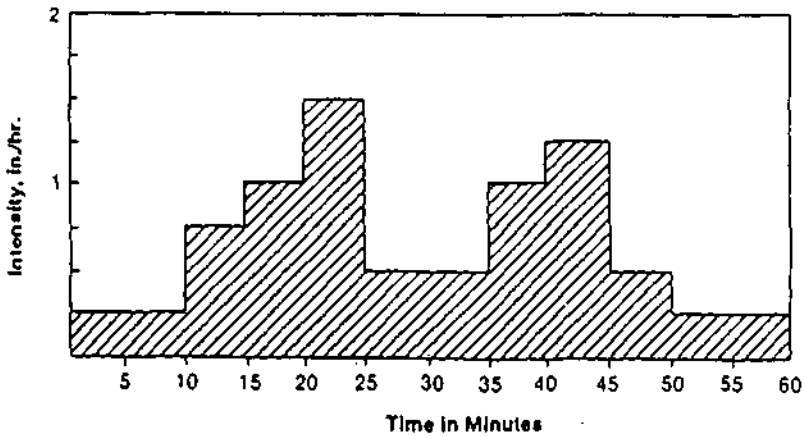



Figure 3.4 Example synthetic rainfall hyetograph.

Rainfall hyetographs are available from weather stations which have recording gauges.

### Synthetic Rainfall Hyetographs (Fig. 3.5)

Hyetographs are often not available for all locations or a standard hyetograph may be required for designing of the drainage system. In such cases a synthetic hyetograph may be developed to be representative of a certain design storm. The synthetic hyetograph may be derived from the I.D.F. curve of a specified return period using the ...

The I.D.F. curve is required in the form

$$i = \frac{a}{(t + c)^b}$$

The rising and receding legs of the hyetographs are described by the following equations:

b) After the peak

$$i_a = \frac{a\left[(1 - b)\dfrac{t_a}{(1 - r)} + c\right]}{\left(\dfrac{t_a}{(1 - r)} + c\right)^{1 + b}}$$

a) Before the peak

$$i_b = \frac{a\left[(1 - b)\dfrac{t_b}{(r)} + c\right]}{\left(\dfrac{t_b}{(r)} + c\right)^{1 + b}}$$

where: $t_a$ = time after peak
$t_b$ = time before peak
$r$ = ratio of time before the peak occurs to the total duration time (the value of $r$ is derived from analysis of actual rainfall events)

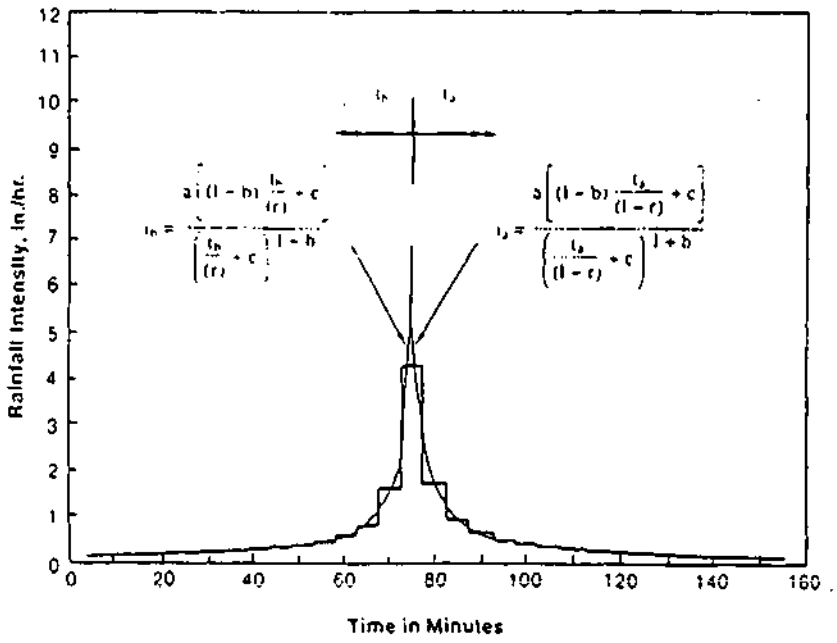



Figure 3.5 Example synthetic rainfall hyetograph.



## RAINFALL-RUNOFF RELATIONSHIPS

The volume and peak flows of the rainfall runoff is one of the key factors in the design of stormwater drainage facilities.

From Figure 3.6 it can be deduced that the net storm rain (that portion of the total precipitation which will appear as direct surface runoff) can be obtained from consideration of the phenomena of retention, infiltration and overland flow. Essentially, in terms of watershed yield (surface runoff), one may write a simple continuity equation:

Inflow = Outflow + Change in Storage.

Precipitation = Depressional Storage + Evaporation + Infiltration + Interception + Surface Runoff.

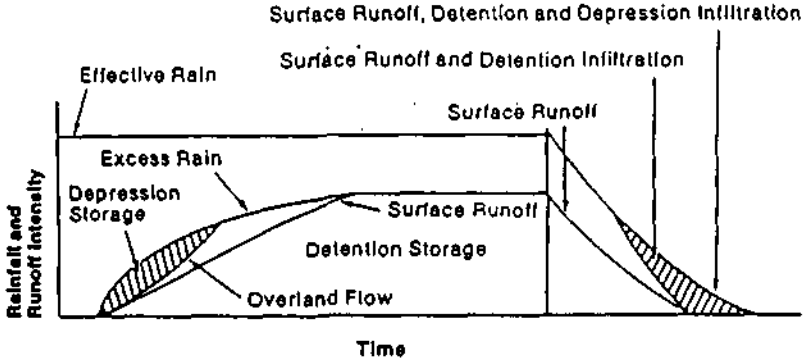



Figure 3.6 Hydrographs showing the rates of disposition of a hypothetical, uniform, effective rainfall.[4]

### Evaporation

Evaporation is the process by which water changes in state from liquid to gas. In the hydrological practice evaporation is defined as the net rate of vapor transfer. It is estimated that approximately 75 per cent of the total annual precipitation is returned to the earth's atmosphere. During a single rainfall event evaporation is negligible, but should be considered when long term continuous rainfall-runoff is being simulated.

### Interception

Interception is defined as that portion of the precipitation falling to the earth's surface which may be stored on above ground objects until it is returned to the atmosphere by evaporation.

Interception as a percentage of total rainfall may vary from 10 to 25 per cent in areas with some vegetal cover.

### Depression Storage

Precipitation which reaches the ground may become trapped in small depressions on the surface, from which the only escape is infiltration or evaporation. The amount of depression storage available is a function of the land use. The following empirical equation has been developed to represent this process.

$V = Sd(1 - e^{-kPe})$
$V$ = volume of storage at any particular time
$Sd$ = maximum storage capacity of depression
$Pe$ = rainfall excess = gross rainfall minus evaporation, interception and infiltration
$k$ = 1/sd constant

Table 3.1 Typical Depression and Detention for Various Land Covers[5]

| Land Cover | Depression & Detention, in. | Recommended, in. |
|---|---|---|
| Impervious. | | |
| Large Paved Areas | 0.05 – 0.15 | 0.1 |
| Pervious | | |
| Lawn Grass | 0.2 – 0.5 | 0.3 |
| Wooded Area and Open Fields | 0.2 – 0.6 | 0.4 |

## Infiltration

Infiltration is the most important abstraction in the surface runoff phenomena. It is defined as the flow of water into the ground through the earth's surface. The degree of infiltration is affected by the type and extent of the vegetal cover, surface conditions, temperature, rainfall intensity, soil properties and water quality. Field tests have shown that bare-soil infiltration can be increased by 3 to 7.5 times with good permanent forest or grass cover, but little or no increase with poor row crops. Empirical relationships describing infiltration have been developed with one of the simplest being the Φ Index Method. This method assumes that infiltration occurs at some constant rate over the duration of the rainfall event. This method tends to underestimate infiltration early in the storm and overestimates it late in the storm. Thus the method should be applied to wet soils, or high intensity storms where the rate of infiltration is assumed to have reached a constant rate early in the storm. (Fig. 3.7)

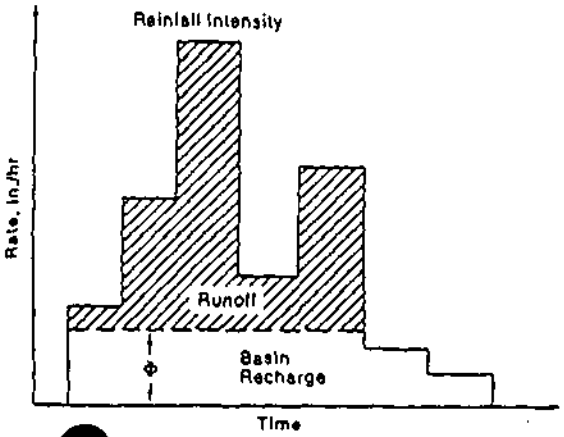



Figure 3.7 Schematic diagram illustrating the derivation and meaning of the Φ index.



Horton developed a mathematical equation for defining the rate curve of infiltration capacity:

$$f = f_c + (f_o - f_c)\, e^{-kt}$$

where:
$f$ = rate of infiltration at period of time
$f_c$ = minimum rate of infiltration
$f_o$ = initial rate of infiltration
$k$ = rate of decrease in f per unit of time
$t$ = time

A typical residential infiltration curve has the equation

$$f = .52 + (3 - .52)e^{-.0015t}$$

note $k$ = .0015 per second in this case, fc and fo in in./hr
Typical infiltration curves are shown in Figure 3.8.

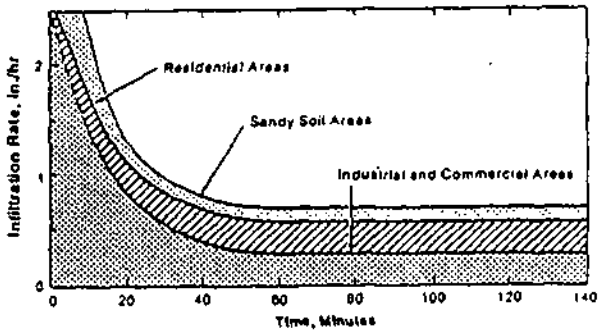



Figure 3.8 Pervious surface infiltration-capacity curves.[5]

## Estimation of Runoff

A number of methods to estimate the amount of runoff are available today. They range from the widely used rational formula developed in the late 1800's to the more recently developed computer models that are being upgraded continuously. The method selected should be based on the size of drainage area, the data available, and the degree of sophistication warranted for the design. The criteria for selecting the most suitable method is described in the following section.

## RATIONAL METHOD

The rational method for estimating peak flows is the method most widely used by design engineers. It is based on a simple intensity-runoff relationship:

$$Q = CIA \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where:

| English | Metric |
|---|---|
| $Q$ = runoff, $ft^3$/sec | $Q$ = CIA x 2.78 liter/sec (l/s) |
| $C$ = runoff coefficient | $C$ = runoff coefficient |
| $I$ = intensity, in./hr | $I$ = intensity, mm/hr |

When using the rational method, the following assumptions are considered:

1) the rainfall intensity is uniform over the entire watershed during the entire storm duration.
2) the maximum runoff rate occurs when the rainfall lasts as long or longer than the time of concentration.
3) the time of concentration is the time required for the runoff from the most remote part of the watershed to reach the point under design.

Runoff Coefficient (C)

Since the only manipulative factor in the rational formula is the runoff coefficient (C) judgement should be used in selecting this value, as it must incorporate most of the hydrological abstractions, soil types, antecedent conditions, etc. Values of typical C coefficients are listed in Table 3.2.

**Table 3.2 Values of Relative Imperviousness**

| Type of Surface | Factor C |
|---|---|
| For all watertight roof surfaces | 0.75 to 0.95 |
| For asphalt runway pavements | 0.80 to 0.95 |
| For concrete runway pavements | 0.70 to 0.90 |
| For gravel or macadam pavements | 0.35 to 0.70 |
| *For impervious soils (heavy) | 0.40 to 0.65 |
| *For impervious soils, with turf | 0.30 to 0.55 |
| *For slightly pervious soils | 0.15 to 0.40 |
| *For slightly pervious soils, with turf | 0.10 to 0.30 |
| *For moderately pervious soils | 0.05 to 0.20 |
| *For moderately pervious soils, with turf | 0.00 to 0.10 |

*For slopes from 1% to 2%

Modifications to the rational method have been proposed in order that the C coefficient may account for antecedent precipitation conditions. Recommended Antecedent Precipitation Factors are listed below. The rational formula now includes a new variable: $Q = C\,C_a\,I\,A$

Recommended Antecedent Precipitation Factors for the Rational Formula

| Recurrence Interval (Years) | $C_a$ |
|---|---|
| 2 to 10 | 1.0 |
| 25 | 1.1 |
| 50 | 1.2 |
| 100 | 1.25 |

NOTE: The product of C x $C_a$ should not exceed 1



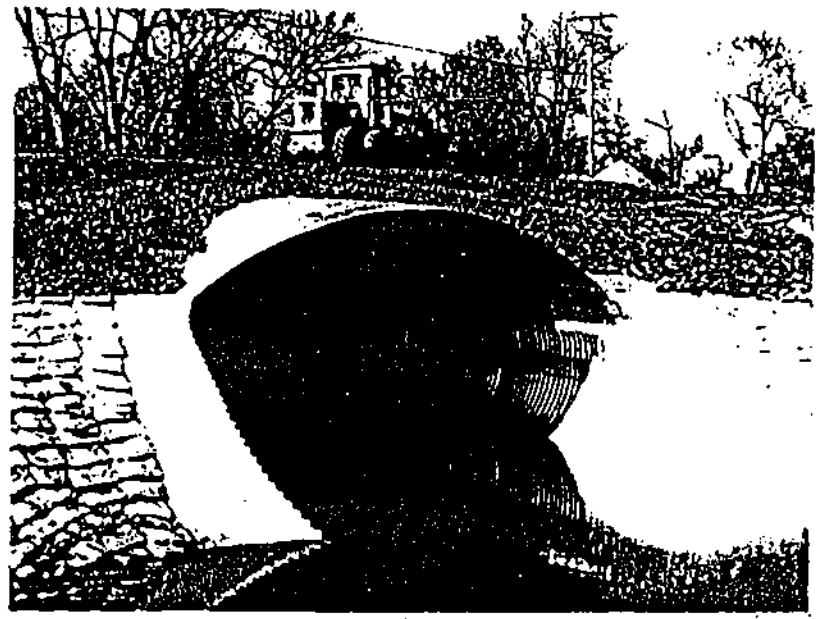


Figure 3.9

Time of Concentration for Small Watersheds

According to the theory underlying the Rational Method, maximum discharge at any point in a drainage system occurs when:

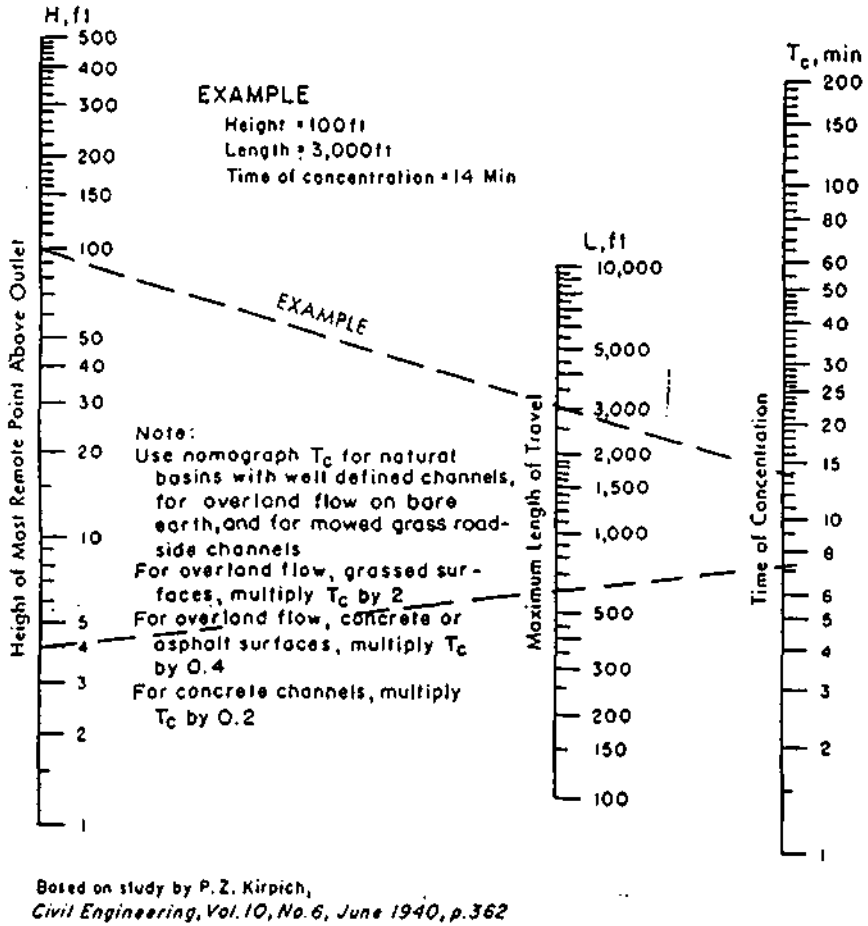
1) The entire area tributary to that point is contributing to the flow.
2) The rainfall intensity producing such flow is based upon the rate of rainfall which can be expected to fall in the time required for water to flow from the most remote point of the area to the point being investigated. The "most remote point" is the point from which the time of flow is greatest. It may not be at the greatest linear distance from the point under investigation.

A minimum time of 5 minutes is recommended by the Federal Highway Administration. A Time of Concentration Nomograph (Fig. 3.10) may be used to assist with the hydrologic analysis.

The drainage area can be measured on a topographic map or determined in the field by estimation, pacing, aerial photos, or a survey comparable in accuracy to a stadia-compass traverse.

*Example*

Find the discharge for a 10-year frequency rainfall at the outlet of a grassed roadside channel 400 ft from the crest of a hill with the contributing area 238 ft wide, consisting of 12 ft of concrete pavement, 26 ft of gravel shoulder, channel, and 200 ft backslope of grassed pasture—giving a weighted $C = 0.35$. The channel grade is 0.5 per cent; and the outer edge of the contributing area is 4 ft above the channel. Location is near Washington, D.C.




Based on study by P. Z. Kirpich,
*Civil Engineering, Vol. 10, No. 6, June 1940, p. 362*

Figure 3.10 Time of concentration of rainfall on small drainage basins.

The distance from the channel to the ridge of the area is 210 ft and that of the channel is 400 ft making $L = 610$ ft. The height of the most remote point above the outlet = 4 ft + (0.005 × 400) = 6 ft. From (Fig. 3.10), the time of concentration, $Tc = 6.5$ min.

The rainfall intensity for a 6.5 minute duration and 10-year return period is 6.9 in./hr.

The drainage area = 238 × 400 = 95,200 ft² or

$$\frac{95{,}200}{43{,}560} = 2.2 \text{ acres}$$

Then $Q$ [illegible]5 × 6.9 × 2.2 = 5.3 ft³/sec.



## TIME OF CONCENTRATION FOR LARGE WATERSHEDS

In large watersheds Tc should be obtained from stream flow records or field inspection of the stream channel and watershed characteristics. When such data is unavailable, the following empirical equation for concentration may be used for estimating the time of concentration:

Kirpich (1940)

$$Tc = 0.00013 \frac{L^{0.77}}{S^{0.385}} \text{ (Fig. 3.11)}$$

in which Tc = time of concentration, hrs
L = maximum length of travel of water, ft
S = slope, equal to H/L where H is the difference in elevation between the most remote point on the basin and the outlet, ft/ft

Note: Use Kirpich equation for natural basins with well defined channels for overland flow on bare earth, and mowed grass roadside channels. For overland flow, grassed surfaces, multiply Tc by 2. For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4. For concrete channels, multiply Tc by 0.2.

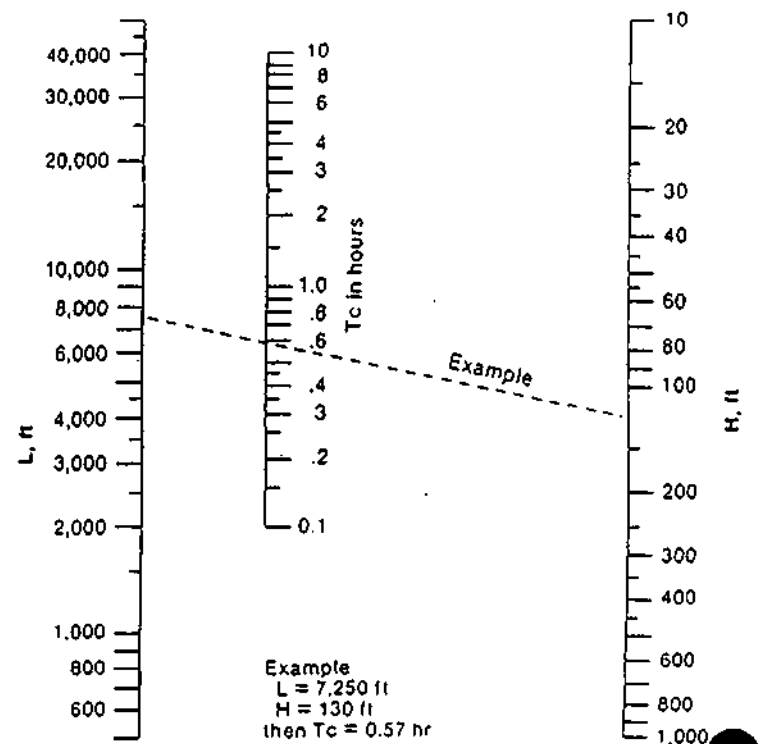



Figure 3.11 Tc nomograph for large watersheds.

When calculating travel times for overland flow in watersheds with a variety of land covers, the Uplands Method may be used. The individual times are calculated, with their summation giving the total travel time. (Fig. 3.12). In large watersheds greater than 2000 acres, the stream flow velocities under the flood flow conditions should be used to estimate the Tc.

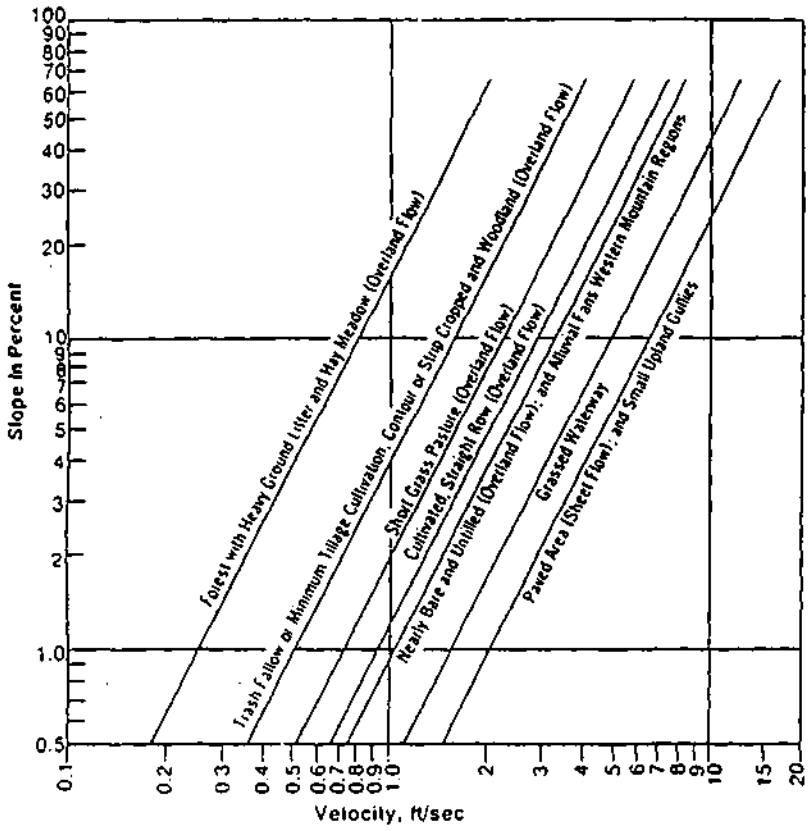



Figure 3.12 Velocities for upland method for estimating travel time for overland flow.

## Hydrograph Methods

Generally hydrograph methods are used when dealing with larger drainage areas where the rational method cannot be applied. A detailed explanation of most of these methods is given in *Modern Sewer Design*,[6] published by the American Iron and Steel Institute, Washington, D.C.



Table 3.3 Summary of Runoff Estimation Methods

| METHOD | SIZE OF DRAINAGE AREA | REQUIRED INFORMATION | VARIABLES | OUTPUT | APPLICATIONS |
|---|---|---|---|---|---|
| RATIONAL METHOD | ≤ 20 acres (APWA Spec. Rep. No. 43) | Land Cover<br>Tc<br>IDF Curves | Runoff Coefficient (C) | Peak Flows | Minor System Design |
| UNIT HYDRO-GRAPH | ≤1000 sq mi (only daily rainfall and average daily discharge)<br>Up to 5000 sq mi (extensive records required) | Rainfall and Streamflow Records | | Hydrograph | Flood Flows<br>Major System<br>Storage Volumes |
| SCS UNIT HYDRO-GRAPH | Up to 20 sq mi; if large watershed break down to 20 sq mi sections | Soil Type<br>Rainfall Data<br>Tc | Runoff Curve No. (CN)<br>Accounts for Hydrological Abstractions | Hydrograph | Flood Flows<br>Minor & Major System<br>Storage Volumes |
| SCS TABULAR METHOD | Up to 20 sq mi; if large watershed break down to 20 sq mi sections | Soil Type<br>Cumulative Rainfall<br>Tc | Runoff Curve No. (CN)<br>Accounts for Hydrological Abstractions | Hydrograph | Flood Flows<br>Major System<br>Storage Volumes |
| SCS GRAPHICAL METHOD | ≤ 20 sq mi | Soil Type<br>Cumulative Rainfall | Runoff Curve No. (CN)<br>Accounts for Hydrological Abstractions | Peak Flow | Flood Peaks<br>Minor & Major System |
| COMPUTER PROGRAMS | Dependent on capacity of program | Technical Information of Minor System<br>Rainfall | See Users Manual | Hydrographs | Trouble Shooting<br>Design of Minor and Major Systems<br>Storage Volumes |
| RATIONAL MASS INFLOW | ≤ 20 Acres | Landcover<br>IDF Curves<br>Mass Outflow Curve | Runoff Coefficient (C) | Storage Volume | Detention Facility Design |
| HYDRO-GRAPH METHOD (Volume Determination) | Dependent on source of hydrograph | Inflow Hydrograph<br>Approximate Outflow Hydrograph | | Storage Volume<br>Outflow Hydrograph | Detention Facility Design<br>Reservoir Routing |
| SCS GRAPHICAL VOLUME METHOD | Dependent on source of peak flow | Peak Inflow Rate<br>Desired Outflow Rate<br>Type of control | | Storage Volume | Detention Facility Design |

**Attachment B1A-4**
**TR-55 Methodology**

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154--Frisco-Horsethief Complex, 30 to 70 percent slopes, very stony.

Map Unit Description

This map unit is a complex of very deep, well drained soils on mountain sideslopes. This map unit typically has .1 to 3 percent stones on the surface. Elevation is 8,400 to 11,500 feet. The average annual precipitation is 25 to 45 inches, the average annual air temperature is 34 to 38 degrees F, and the average frost-free period is 50 to 70 days. The moisture and temperature regimes are udic and cryic, respectively.

This unit is 60 percent Frisco loam and 25 percent Horsethief loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Brief Soil Description

Frisco loam

The Frisco soil formed in glacial outwash derived dominantly from gneiss, schist and sedimentary rocks. Typically, the surface is covered with a mat of decomposing twigs, needles and bark about 2 inches thick. The surface layer is grayish brown loam about 3 inches thick. The subsurface layer is brown loam about 6 inches thick. The upper part of the subsoil is yellowish brown gravelly loam about 8 inches thick. The next part is brown extremely stony sandy clay loam about 29 inches thick. The lower part is brown extremely stony loam extending to 60 inches or more.

Permeability of the Frisco soil is moderate. Available water capacity is moderate. The hydrologic group is B. Effective rooting depth is 60 inches or more. Runoff is medium to rapid, and the hazard of water erosion is moderate. Content of rock fragments range from 35 to 75 percent in the Bt horizons.

Horsethief loam

The Horsethief soil formed in colluvium and alluvium derived dominantly from sandstone, and volcanic and igneous rocks. Typically, the surface is covered with a mat of needles, twigs and bark about 2 inches thick. The surface layer is pale brown loam about 3 inches thick. The subsurface layer is light yellowish brown fine sandy loam about 19 inches thick. The upper 8 inches of the subsoil is pale brown sandy clay loam. The lower 17 inches is brown very stony clay loam. The substratum to a depth of 60 inches or more is brown very stony clay loam.

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7/94

158--Sponsor-Leadville complex 30 to 60 percent slopes.

Map Unit Description

This map unit is a complex of very deep, well drained soils on mountainsides. Elevation is 8,800 to 10,000 feet. The average annual precipitation is 25 to 35 inches, the average annual air temperature is 36 to 42 degrees F, and the average frost-free period is 80 to 90 days. The moisture and temperature regimes are udic and cryic, respectively.

This unit is 60 percent Sponsor loam and 30 percent Leadville loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Brief Soil Description

Sponsor loam

The Sponsor soil formed in glacial outwash, and landslide material derived dominantly from gneiss, schist and sedimentary rocks. Typically, the surface is covered with a mat of organic material about 1 inches thick. The surface layer is dark reddish gray loam about 6 inches thick. The subsurface layer is dark reddish gray loam about 5 inches thick. The upper part of the subsoil is reddish brown clay loam about 13 inches thick. The next part is reddish brown cobbly clay loam about 18 inches thick. The lower part is reddish brown very stony clay loam extending to 48 inches or more.

Permeability of the Sponsor soil is moderately slow. Available water capacity is high. The hydrologic group is B. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is moderate. Content of rock fragments range from 5 to 35 percent in the upper part of the subsoil and 20 to 60 percent in the lower part.

Leadville loam

The Leadville soil formed in glacial outwash or slopewash material derived dominantly from gneiss, schist or sedimentary rocks. Typically, the surface is covered with a mat of leaves, needles and partly decomposed organic material about 3 inches thick. The surface layer is brown loam about 1 inch inch thick. The subsurface layer is pinkish gray loam about 3 inches thick. The upper part of the subsoil is pinkish gray very stony clay loam about 14 inches thick. The next part is light reddish brown very cobbly clay loam about 16 inches thick. The lower part is light reddish brown stony clay loam about 34 inches thick. The substratum to a depth of 75 inches or more is light reddish brown very stony sandy clay loam.

# Exhibit A-1, continued: Hydrologic soil groups for United States soils

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| FREEST | C | FULSHEAR | C | GAPCOT | D | GEO | D | GILISPIE | D |
| FREESTONE | C | FULSTONE | C | GAPO | D | GEE | C | GILLAND | C |
| FREETOWN | D | FULTON | D | GAPO, DRAINED | C | GEEBURG | C | GILLENDER | D |
| FREEWATER | B | FULTS | D | GAPPMAYER | B | GEEMORE | C | GILLIAM | C |
| FREEZENER | F | FULVIDER | D | GARA | C | GEER | B | GILLIGAN | B |
| FREEZEOUT | B | FUNTER | D | GARBER | B | GEERTSEN | B | GILLS | C |
| FRELSBURG | D | FUQUAY | B | GARBO | B | GEFO | A | GILLSBURG | C |
| FREMONT | C | FURNISS | D | GARBUTT | B | GEISEL | B | GILMAN | B |
| FREN | B | FURSHUR | D | GARCENO | C | GEKE | C | GILMORE | C |
| FRENCH | C | FURY | D | GARCES | D | GELKIE | B | GILPAR | B |
| FRENCHCREEK | B | FURY, DRAINED | C | GARCIA | C | GEM | C | GILPIN | C |
| FRENCHJOHN | C | FUSULINA | D | GARCITAS | C | GEM, STONY | D | GILROY | C |
| FRENCHMAN | B | FUSUYAR | D | GARCON | C | GEMID | C | GILSTON | B |
| FRENCHTOWN | D | GAASTRA | C | GARDELLA | D | GEMSON | B | GILT EDGE | D |
| FRESHWATER | D | GABALDON | B | GARDENA | B | GENAW | D | GINLETT | B |
| FRESNO, | D | GABBS | C | GARDINER | A | GENEGRAF | B | GINAT | D |
| SALINE-ALKALI | | GABBVALLY | D | GARDNER'S FORK | B | GENESEE | B | GINEX | D |
| FRESNO, THICK | C | GABEL | C | GARDNERVILLE | C | GENEVA | B | GINGER | D |
| SOLUM | | GABICA | D | GARDONE | A | GENDA | D | GINI | B |
| FREWA | B | GABINO | D | GAREY | B | GENOLA | B | GINLAND | D |
| FREZNIK | D | GACEY | D | GARFAN | B | GENTILLY | D | GINNIS | C |
| FRIANA | D | GACHADO | D | GARFIELD | C | GENTRY | D | GINSER | C |
| FRIANT | D | GACIBA | D | GARHILL | D | GEOCONDA | C | GIRARD | D |
| FRIDLO | C | GADDES | C | GARIPER | C | GEOHROCK | B | GIRARDOT | D |
| FRIEDLANDER | C | GADDY | A | GARITA | E | GEORGECREEK | B | GIRD | B |
| FRIEDMAN | C | GADSDEN | D | GARLAND | B | GEORGETOWN | D | GIST | D |
| FRIENDS | C | GADSDEN, WET | C | GARLET | E | GEORGEVILLE | B | GITAKUP | C |
| FRIENDSHIP | A | SUBSTRATUM | | GARLOCK | B | GEORGIA | C | GITAN | D |
| FRIES | D | GADWELL | C | GARMON | C | GERFORD | D | GIVIN | C |
| FRIESLAND | B | GAGEBY | B | GARMORE | D | GERP | B | GLACIERCREEK | A |
| FRIJOLES | B | GAGETOWN | B | GARNEL | D | GERPERT | C | GLADDEN | B |
| FRINDLE | C/ | GAGIL | B | GARNER | D | GERALD | D | GLADEL | D |
| FRINES | C | GAHEE | B | GARNES | B | GERRER | D | GLADEVILLE | D |
| FRIO | B | GAIR | D | GARO | D | GERDRUM | D | GLADEWATER | D |
| FRIONA | C | GAILA | B | GARR | D | GERING | B | GLADSTONE | B |
| FRIJTON | C | GAINES | C | GARRETSON | B | GERLACH | D | GLADWIN | A |
| FRIPP | A | GAINESBORO | C | GARRETT | B | GERLANE | B | GLASGOW | C |
| FRISCO | B | GAINESVILLE | A | GARRISON | B | GERLE | B | GLASSNER | D |
| FRISITE | B | GALATA | D | GARROCHALES | D | GERMANTOWN | B | GLEAN | B |
| FRITZ | B | GALBRETH | D | GARSID | C | GERMANY | B | GLEASON | B |
| FRITZELL | C | GALCHUTT | C | GARTON | C | GERMER | C | GLEBE | C |
| FRODERG | D | GALE | B | GARVESON | C | GERONI | B | GLEN | B |
| FRODO | D | GALEN | B | GARVIN | D | GERRARD | C | GLENBAR | B |
| FROHMAN | C | GALEPPI | B | GARWIN | B/D | GERRARD, DRAINED | B | GLENBAR, WET | C |
| FROLIC | B | GALESTINA | C | GARZA | B | GERST | D | GLENBERG | B |
| FROLIC, | C | GALESTOWN | A | GARZONA | D | GESSIE | B | GLENBLAIR | C |
| ELEVATION<3000 | | GALEY | B | GAS CREEK | D | GESSNER | B/D | GLENBROOK | D |
| FROLIC, FLOODED | C | GALILEE | C | GASCONADE | D | GESTRIN | B | GLENCARB | B |
| FRONDORF | B | GALISTEO | C | GASIL | B | GETAWAY | B | GLENCARB, WET, | C |
| FRONTENAC | B | GALISTEO, | B | GASOUTT | B | GETCHELL | C | SALINE | |
| FRONTIER | C | SALINE-ALKALI | | GASSAWAY | D | GETRAIL | D | GLENCOE | B/D |
| FRONTON | D | GALLAND | B | GASSVILLE | C | GETTYS | C | GLENCOE, PONDED | D |
| FROST | D | GALLATIN | C | GASTON | C | GETZVILLE | D | GLENDALE | B |
| FROZARD | C | GALLEGOS | B | GAT | B | GEWTER | C | GLENDALE, WET | C |
| FRUITA | B | GALLEN | B | GATES | B | GEYSEN | C | GLENDALE, RARELY | C |
| FRUITFIELD | A | GALLIA | B | GATESON | C | GIBBLER | C | FLOODED | |
| FRUITHURST | C | GALLIME | B | GATEVIEW | B | GIBBON | B | GLENDERSON | B |
| FRUITLAND | B | GALLION | B | GATEWAY | C | GIBBONSCREEK | C | GLENDIVE | B |
| FRUITLAND, | C | GALLMAN | B | GATEWOOD | C | GIBBS | D | GLENDORA | A/D |
| MODERATELY WET | | GALLUP | B | GATLIN | B | GIBNEY | C | GLENEDEN | D |
| FRUITLAND, WET | C | GALOO | C/D | GATOR | D | GIBSONVILLE | D | GLENELG | B |
| FRYE | C | GALT | D | GATTON | B | GIBWELL | C | GLENFORD | C |
| FRYEBURG | B | GALVA | B | GAULDY | B | GIDEON | C | GLENHALL | B |
| FT. DRUM | C | GALVESTON | A | GAULEY | C | GIELOW | C | GLENHAM | B |
| FT. GREEN | D | GALVEZ | C | GAVEL | C | GIFFORD | D | GLENHEN | B |
| FUBAR | C | GALVIN | D | GAVILAN | C | GIGGER | C | GLENHORA | C |
| FUBBLE | D | GALWAY | B | GAVINS | D | GILA | B | GLENHALLEN | C |
| FUEGO | C | GAMBLER | B | GAVIOTA | D | GILBERT | D | GLENOKA | B |
| FUEGOSTA | D | GAMBOA | B | GAY | B/D | GILBOA | B | GLENPOOL | A |
| FUERA | C | GANGEE | C | GAYLESVILLE | D | GILBY | B | GLENRIO | D |
| FUGAWEE | B | GANADO | D | GAYLORD | C | GILCHRIST | A | GLENROSE | B |
| FUGHES | C | GANCE | C | GAYNOR | C | GILCO | B | GLENROSS | D |
| FULCHER | C | GANDO | D | GAYVILLE | D | GILCREST | B | GLENSTED | D |
| FULDA | C/D | GANIS | D | GAZELLE | D | GILEAD | C | GLENTON | B |
| FULLAM | C | GANNETT | D | GAZOS | C | GILES | B | GLENTON, WET | C |
| FULLER | D | GANSNER | C | GAZWELL | C | GILFORD | B/D | GLENTOSH | A |
| FULLERTON | B | GANSNER, PONDED | D | GEARHART | A | GILFORD, | D | GLENVIEW | B |
| FULMER | D | GANY | B | GEARY | B | STRATIFIED | | GLENVILLE | C |
| FULMER, DRAINED | C | GAPBUTTE | B | GEBSON | B | SUBSTRATUM | | GLENYON | B |

NOTES: TWO HYDROLOGIC SOIL GROUPS SUCH AS B/C INDICATES THE DRAINED/UNDRAINED SITUATION.
MODIFIERS SHOWN, E.G., BEDROCK SUBSTRATUM, REFER TO A SPECIFIC SOIL SERIES PHASE FOUND IN SOIL MAP LEGEND.

# Exhibit A-1, continued: Hydrologic soil groups for United States soils

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| LANKIN | B | LARIAT | B | LAVINA | D | LEETONIA | C | LEW | B |
| LANO | C | LARIN | B | LAVON | C | LEEVAN | C | LEWBEACH | C |
| LANOILLE | B | LARIMER | B | LAWAI | B | LEFOR | B | LEWDLAC | D |
| LANONDI | B | LARIOSCAMP | D | LAWEN | B | LEGALL | B | LEWIS | D |
| LANONI | C | LARKIN | B | LAWET | B/D | LEGAULT | D | LEWISBERRY | B |
| LANONT | B | LARKSON | C | LAWET, SALINE-ALKALI | B | LEGGETT | C | LEWISBURG | C |
| LANONTA | D | LARMINE | C | | | LEGLER | B | LEWISTON | C |
| LANOOSE | D | LAROQUE | B | LAWLER | B | LEGORE | B | LEWISVILLE | B |
| LANOTTE | B | LAROSE | D | LAWNDALE | B | LEHEW | C | LEWKALB | C |
| LANOURE | C | LARRUPIN | B | LAWNWOOD | B/D | LEHIGH | C | LEX | B |
| LANPASAS | D | LARRY | D | LAWNWOOD, DEPRESSIONAL | D | LEHMANS | D | LEXINGTON | B |
| LANPHIER | B | LARRY, DRAINED | C | | | LEHR | B | LEXTON | B |
| LANPSHIRE | D | LARSON | D | LAWRENCE | C | LEICESTER | C | LEYBA | B |
| LANSON | B/D | LARTON | A | LAWRENCEVILLE | C | LEIDL | C | LEYDEN | C |
| LANARK | B | LARUE | A | LAWSHE | D | LEIGHCAN | B | LIBBINGS | D |
| LANCASTER | B | LARUSH | B | LAWSON | C | LEILEHUA | B | LIBEG | B |
| LANCE | B | LARVIE | D | LAWTHER | D | LEISY | B | LIBERAL | D |
| LAND | C | LAS | C | LAWTON | C | LELA | D | LIBORY | A |
| LAND, DRAINED | B | LAS ANIMAS | C | LAWYER | B | LELAND | D | LIBRARY | D |
| LANDAVASO | B | LAS FLORES | D | LAX | C | LEMAH | A | LIBUSE | C |
| LANDCO | C | LAS LUCAS | B | LAXAL | B | LEMBOS | C | LICHA | B |
| LANDER | C | LAS POSAS | C | LAXTON | C | LEMCO | C | LICK | B |
| LANDES | B | LAS VEGAS | D | LAYCOCK | B | LEMERT | D | LICKDALE | D |
| LANDLOW | C | LASA | A | LAYOINT | C | LEMETA | D | LICKING | C |
| LANDMAN | B | LASALLE | D | LAYTON | A | LEMING | C | LICKSKILLET | D |
| LANDSEND | C | LASAUSES | D | LAYVIEW | D | LEMITAR | D | LIDAN | C |
| LANE | C | LASCO | B | LAZAN | D | LEMM | B | LIDDELL | B/D |
| LANESBORO | C | LASIL | D | LAZEAR | D | LEMOLD | D | LIDDIEVILLE | B |
| LANEXA | D | LASKA | B | LE BAR | B | LEMONO | B/D | LIDY | B |
| LANEY | B | LASSEL | C | LE SUEUR | B | LEMONEX | C | LIEBERMAN | B |
| LANG | C | LASSEN | D | LEA | C | LEMOORE | C | LIEN | D |
| LANGFORD | C | LASSITER | B | LEADER | B | LEMPIRA | B | LIESNOI | D |
| LANGHEI | B | LASTANCE | B | LEADORE | B | LEN | C | LIGGET | B |
| LANGLADE | B | LATAH | D | LEADPOINT | C | LENA | A/D | LIGHTNING | D |
| LANGLOIS | D | LATAH, HIGH RAINFALL, DRAINED | C | LEADVALE | C | LENA, FLOODED | D | LIGNUM | C |
| LANGOLA | B | | | LEADVILLE | B | LENAPAH | D | LIGON | D |
| LANGRELL | B | LATAH, DRAINED | C | LEAF | D | LENAWEE | B/D | LIGURTA | B |
| LANGSPRING | B | LATANCO | C | LEAFRIVER | A/D | LENAWEE, PONDED | D | LIHEN | A |
| LANGSTON | B | LATANCO, WET | D | LEAKU | C | LENBERG | C | LIHUE | B |
| LANGTRY | D | LATANIER | D | LEAGUEVILLE | B/D | LENNEP | C | LIKES | A |
| LANIER | A | LATCH | A | LEAKSVILLE | D | LENOIR | D | LILAH | A |
| LANIGER | B | LATENE | B | LEAL | D | LENZ | B | LILBERT | B |
| LANIGER, GRAVELLY | C | LATES | C | LEALANDIC | D | LENZ, STONY | C | LILBOURN | B |
| LANKBUSH | B | LATEX | C | LEANNA | D | LENZ, VERY STONY | C | LILLINGS | B |
| LANKIN | C | LATHAM | D | LEANTO | D | LENZBURG | B | LILLINGTON | B |
| LANKTREE | C | LATHER | D | LEAPS | C | LEO | A | LILLYLANDS | C |
| LANOAK | B | LATHROP | B | LEATHAM | C | LEOLA | B | LILTEN | C |
| LANOMA | B | LATIGO | B | LEATHERMAN | D | LEON | B/D | LILY | B |
| LANSDALE | B | LATINA | D | LEAVENWORTH | C | LEONARD | D | LIM | C |
| LANSDOWNE | C | LATIUM | D | LEAVERS | B | LEONARDO | B | LIMA | B |
| LANSING | B | LATON | D | LEAVITT | B | LEONARDTOWN | D | LIMBER | B |
| LANTERN | B | LATONIA | B | LEAVITTVILLE | B | LEONI | B | LIMEKILN | D |
| LANTIS | B | LATOUCHE | D | LEBAM | B | LEQUIEU | D | LIMERICK | C |
| LANTON | D | LATOUR | B | LEBANON | C | LERDAL | C | LIMERIDGE | D |
| LANTON, LOW PRECIPITATION | C | LATOURELL | B | LEBEAU | D | LERDO | C | LIMKING | B |
| | | LATTAS | D | LEBEC | B | LEROY | B | LIMON | C |
| LANTONIA | B | LATTY | D | LEBO | B | LERROW | C | LIMON, WET | D |
| LANTRY | B | LAUDERDALE | D | LEBSACK | C | LESHARA | B | LIMONES | B |
| LANTZ | D | LAUDERHILL | B/D | LECK KILL | B | LESHO | C | LIMPIA | C |
| LANVER | C | LAUFER | D | LECRAG | D | LESLIE | D | LINCO | B |
| LANYON | C/D | LAUGENOUR, LOAMY SUBSTRATUM | C | LEDFORD | B | LESON | D | LINCOLN | A |
| LAP | D | | | LEDGEFORK | A | LESPATE | C | LINDAAS | C/E |
| LAPARITA | C | LAUGENOUR, SILTY SUBSTRATUM | B | LEDMOUNT | D | LESTER | B | LINDALE | C |
| LAPDUN | B | | | LEDOW | B | LESWILL | B | LINDELL | C |
| LAPED | D | LAUGENOUR, DRAINED | B | LEDRU | D | LETA | C | LINDEN | B |
| LAPEER | B | LAUGHLIN | C | LEDUB | B | LETCHER | D | LINDER | B |
| LAPHAM | A | LAUMATA | B | LEDWITH | B/D | LETHA | C | LINDLEY | C |
| LAPINE | A | LAUREL | D | LEE | D | LETHENT | D | LINDRITH | B |
| LAPLATTA | C | LAURELWOOD | B | LEEBENCH | D | LETNEY | A | LINDSIDE | C |
| LAPON | D | LAUREN | B | LEEDS | C | LETON | D | LINDSTROM | B |
| LAPORTE | D | LAURENTIEN | B | LEEFIELD | C | LETORT | B | LINDY | C |
| LAPOSA | C | LAVACREEK | B | LEEKO | C | LETRI | B/D | LINE | B |
| LAPWAI | B | LAVALLEE | B | LEEKO, WARM | B | LETTIA | B | LINEVILLE | C |
| LARAND | B | LAVATE | B | LEELANAU | A | LEVASY | C | LINGANORE | B |
| LARCHMOUNT | B | LAVEAGA | C | LEEMONT | D | LEVELTON | D | LINHART | A |
| LARDELL | C | LAVEEN | B | LEEPER | D | LEVELTON, DRAINED | C | LININGER | C |
| LAREDO | B | LAVENTANA | B | LEERAY | D | LEVERETT | C | LINKER | B |
| LARES | C | LAVERKIN | C | LEESBURG | B | LEVIATHAN | B | LINKUP | D |
| LARGO | B | LAVIC | B | LEESVILLE | B | LEVY | D | LINKVILLE | B |

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# Exhibit A-1, continued: Hydrologic soil groups for United States soils

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| HESCH | B | HILLSBORO | B | HOLDERMAN | C | HOODVIEW | B | HOWELL | C |
| HESPER | B | HILLSDALE | B | HOLDERNESS | C | HOOGDAL | C | HOWLAND | C |
| HESPERIA | B | HILLTO | B | HOLDINGFORD | C | HOOKS | B | HOWSON | C |
| HESPERUS | B | HILLWOOD | B | HOLDREGE | B | HOOKSAN | A | HOYE | B |
| HESSEL | B/D | HILMAR | D | HOLILLIPAH | A | HOOKTON | C | HOYLETON | C |
| HESSELBERG | D | HILMAR, DRAINED | B | HOLLAND | B | HOOLEHUA | B | HOYPUS | A |
| HESSELTINE | B | HILMOE | C | HOLLANDLAKE | B | HOOLY | C | HOYTVILLE | C/D |
| HESSING | B | HILO | A | HOLLINGER | B | HOOPAL | D | HUACHUCA | D |
| HESSLAN | C | HILOLO | D | HOLLIS | C/D | HOOPER | D | HUALAPAI | C |
| HESSON | C | HILT | B | HOLLISTER | D | HOOPESTON | B | HUB | B |
| HETERWA | C | HILTON | B | HOLLOMAN | D | HOOPLITE | D | HUBBARD | A |
| HETTINGER | C/D | HINCKLEY | A | HOLLOMEX | B | HOOSAN | B | HUBBARDTON | D |
| HEUSSER | C | HINDES | C | HOLLOW | C | HOOSEGOW | B | HUBBELL | B |
| HEUVELTON | C | HINESBURG | C | HOLLOWAY | B | HOOSIC | A | HUBERLY | D |
| HEWITT | D | HINKER | C | HOLLOWTREE | C | HOOSIERVILLE | C | HUBERT | B |
| HEXT | B | HINKLE | D | HOLLY | B/D | HOOSIMBIM | B | HUBLERSBURG | B |
| HEYDER | B | HINMAN | C | HOLLY, PONDED | D | HOOT | D | HUCKLEBERRY | C |
| HEYDLAUFF | B | HINSDALE | D | HOLLY SPRINGS | D | HOOTEN | D | HUCKLEBERRY, HIGH RAINFALL | B |
| HEYTOU | B | HIRAMSBURG | C | HOLLYBELL | B | HOPCO | C | | |
| HEZEL | B | HIRIDGE | D | HOLLYWOOD | D | HOPDRAY | A | HUDNUT | B |
| HI VISTA | C | HIRSCHDALE | C | HOLMAN | A | HOPEKA | D | HUDSON | C |
| HIARC | C | HISEGA | C | HOLMDEL | C | HOPKINS | B | HUECO | C |
| HIBAR | C | HISKEY | B | HOLMES | B | HOPLAND | B | HUEL | A |
| HIBBARD | C | HISLE | D | HOLOMAN | B | HOPLEY | B | HUENEME | C |
| HIBBING | C | HITCHCOCK | B | HOLOMUA | B | HOPSONVILLE | C | HUENEME, MODERATELY WET | B |
| HIBERNIA | C | HITILO | A | HOLOPAW | B/D | HOQUIAM | B | | |
| HIBRITEN | B | HITT | B | HOLOPAW, DEPRESSIONAL | D | HORD | B | HUENEME, DRAINED | B |
| HICKMAN | B | HIVAL | D | | | HOREB | C | HUERFANO | D |
| HICKORY | C | HIWAN | D | HOLOPAW, FREQUENTLY FLOODED | D | HOREB, GRAVELLY SUBSTRATUM | B | HUEY | D |
| HICKS | B | HIWASSEE | B | | | | | HUFFINE | B |
| HICKSVILLE | B | HIWOOD | A | | | HORNELL | D | HUFFMAN | B |
| HICKSVILLE, BEDROCK SUBSTRATUM | C | HIXTON | B | HOLSINE | B | HORNING | B | HUFFTON | B |
| | | HOADLY | C | HOLSTEIN | B | HORNITOS | D | HUGGINS | C |
| | | HOBACKER | B | HOLSTON | B | HORNSBY | C | HUGHES | B |
| HICOTA | B | HOBAN | B | HOLT | B | HORNSVILLE | C | HUGHESVILLE | C |
| HIDALGO | B | HOBBS | B | HOLTER | B | HORRODEN | B | HUGO | B |
| HIDATSA | B | HOBCAW | D | HOLTLE | B | HORSECAMP | D | HUGUS | B |
| HIDEAWAY | D | HOBE | A | HOLTON | C | HORSERIDGE | B | HUGUSTON | D |
| HIDEWOOD | B/D | HOBERG | C | HOLTVILLE | C | HORSESHOE | B | HUICHICA | C |
| HIERRO | B | HOBIT | C | HOLYOKE | C/D | HORSETHIEF | B | HUICHICA, PONDED | D |
| HIGGINS | D | HOBO | D | HOMA | C | HORSLEY | D | HUIKAU | A |
| HIGGINSVILLE | C | HOBOG | D | HOME CAMP | C | HORST | B | HUKILL | B |
| HIGH GAP | C | HOBONNY | D | HOMELAKE | B | HORTONVILLE | B | HULETT | B |
| HIGHAMS | D | HOBSON | C | HOMELAND | C | HOSKIN | C | HULLS | C |
| HIGHBANK | C | HOBUCKEN | D | HOMER | B | HOSKINNINI | D | HULLT | B |
| HIGHCAMP | B | HOCAR | D | HOMESTAKE | C | HOSLEY | D | HULUA | D |
| HIGHFIELD | B | HOCHHEIM | B | HOMESTEAD | B | HOSMER | C | HUM | B |
| HIGHHORN | B | HOCKINSON | D | HOMEWOOD | C | HOSSICK | B | HUMACAO | B |
| HIGHMORE | B | HOCKINSON, MODERATELY WET | C | HOMME | C | HOSTAGE | B | HUMATAS | C |
| HIGHPOINT | D | | | HOMME, MODERATELY WET | B | HOT LAKE | C | HUMBARGER | B |
| HIGHROCK | D | HOCKINSON, DRAINED | B | | | HOTAN | C | HUMBIG | C |
| HIGHTOWER | C | HOCKLEY | C | HOMOSASSA | D | HOTCREEK | D | HUMBIRD | B |
| HIGHWOOD | C | HOCKLEY, GRADED | D | HONAUNAU | C | HOTEL | C | HUMBOLDT | D |
| HIHIMANU | B | HODA | C | HONCUT | B | HOTSPRINGS | B | HUMBOLDT, MODERATELY WET, SALINE-ALKALI | B |
| HIIBNER | C | HODEDO | C | HONDALE | D | HOUDEK | B | | |
| HIKO PEAK | B | HODENPYL | B | HONDOHO | B | HOUGH | B | | |
| HIKO SPRINGS | B | HODGE | A | HONEDYE | B | HOUGHTON | A/D | HUMBOLDT, | B |
| HILAIRE | B | HODGINS | B | HONEYDEW | C | HOUGHTON, PONDED | D | MODERATELY WET, SALINE | |
| HILAND | B | HODGSON | C | HONEYGROVE | B | HOUGHTONVILLE | C | | |
| HILDEBRECHT | C | HOEHNE | A | HONEYJONES | B | HOUK | C | HUMBOLDT, DRAINED, STRONGLY SALINE | B |
| HILDRETH | D | HOFFLAND | D | HONEYVILLE | C | HOULA | B | | |
| HILEA | D | HOFFMANVILLE | C | HONKER | D | HOULKA | D | HUMBOLDT, DRAINED, NONSALINE | B |
| HILES | B | HOEFSTADT | B | HONLAK | C | HOURGLASS | B | | |
| HILGER | B | HOFLY | C | HONLAK, DRAINED | B | HOUSE MOUNTAIN | D | HUMBOLDT, MODERATELY WET | B |
| HILGRAVE | B | HOGADERO | B | HONLU | B | HOUSER | D | | |
| HILIGHT | D | HOGANSBURG | B | HONN | B | HOUSEROCK | D | HUMBOLDT, DRAINED | B |
| HILINE | D | HOGBACK | C | HONOBIA | C | HOUSTAKE | C | HUMDUN | B |
| HILLBRICK | D | HOGG | C | HONOKAA | A | HOUSTON | D | HUME | C |
| HILLCO | B | HOGMALAT | D | HONOLUA | B | HOUSTON BLACK | D | HUMESTON | C/D |
| HILLEMANN | C | HOGRIS | B | HONOMANU | A | HOVDE | D | HUMKER | C |
| HILLERY | C | HOH | B | HONONEGAH | A | HOVEN | D | HUMMINGTON | C |
| HILLEY | B/D | HOHMANN | C | HONOULIULI | B | HOVENWEEP | C | HUMPHREYS | B |
| HILLFIELD | B | HOKO | C | HONTAS | B | HOVERT | D | HUMPTULIPS | B |
| HILLGATE | D | HOLBORN | C | HONTOON | B/D | HOVEY | C | HUNSKEL | C |
| HILLIARD | B | HOLBROOK | B | HONUAULU | A | HOWARD | A | HUN | B |
| HILLIARD, MODERATELY WELL DRAINED | C | HOLCOMB | D | HOOD | B | HOWARDSVILLE | A | HUNCHBACK | D |
| | | HOLDAWAY | D | HOODLE | B | HOWCAN | B | HUNDRAY | D |
| | | HOLDEN | B | HOODOO | D | HOWCREE | C | HUNEWILL | B |
| HILLON | C | HOLDER | B | HOODSPORT | C | HOWE | C | HUNGRY | C |

NOTES: TWO HYDROLOGIC SOIL GROUPS SUCH AS B/C INDICATES THE DRAINED/UNDRAINED SITUATION.
MODIFIERS SHOWN, E.G., BEDROCK SUBSTRATUM, REFER TO A SPECIFIC SOIL SERIES PHASE FOUND IN SOIL MAP LEGEND.

Table 2-2c.—Runoff curve numbers for other agricultural lands[1]

| Cover description | | Curve numbers for hydrologic soil group— | | | |
|---|---|---|---|---|---|
| Cover type | Hydrologic condition | A | B | C | D |
| Pasture, grassland, or range—continuous forage for grazing.[2] | Poor | 68 | 79 | 86 | 89 |
| | Fair | 49 | 69 | 79 | 84 |
| | Good | 39 | 61 | 74 | 80 |
| Meadow—continuous grass, protected from grazing and generally mowed for hay. | — | 30 | 58 | 71 | 78 |
| Brush—brush-weed-grass mixture with brush the major element.[3] | Poor | 48 | 67 | 77 | 83 |
| | Fair | 35 | 56 | 70 | 77 |
| | Good | [4]30 | 48 | 65 | 73 |
| Woods—grass combination (orchard or tree farm).[5] | Poor | 57 | 73 | 82 | 86 |
| | Fair | 43 | 65 | 76 | 82 |
| | Good | 32 | 58 | 72 | 79 |
| Woods.[6] | Poor | 45 | 66 | 77 | 83 |
| | Fair | 36 | 60 | 73 | 79 |
| | Good | [4]30 | 55 | 70 | 77 |
| Farmsteads—buildings, lanes, driveways, and surrounding lots. | — | 59 | 74 | 82 | 86 |

[1]Average runoff condition, and $I_a = 0.2S$.

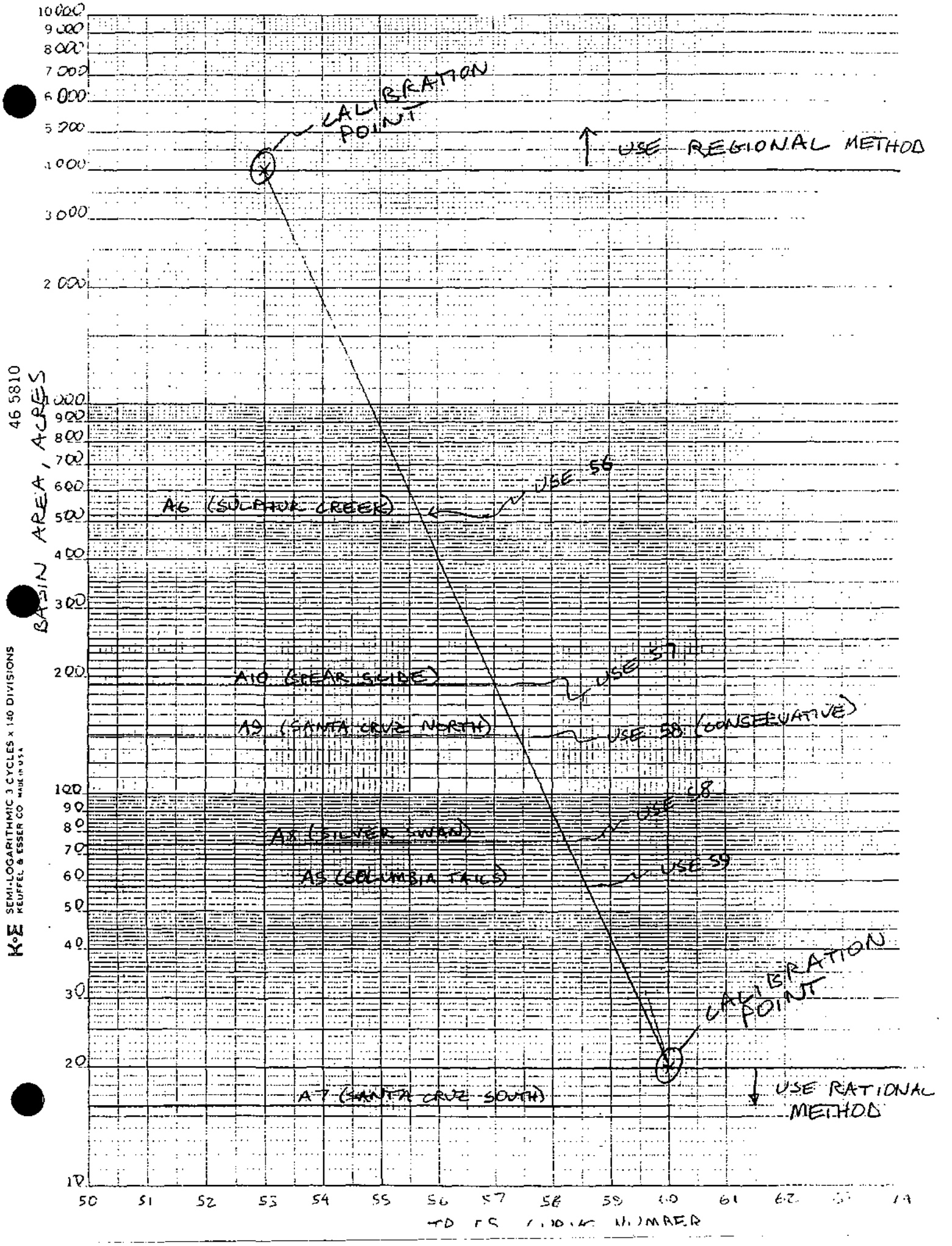
[2]*Poor:* <50% ground cover or heavily grazed with no mulch.
*Fair:* 50 to 75% ground cover and not heavily grazed.
*Good:* >75% ground cover and lightly or only occasionally grazed.

[3]*Poor:* <50% ground cover.
*Fair:* 50 to 75% ground cover.
*Good:* >75% ground cover.

[4]Actual curve number is less than 30; use CN = 30 for runoff computations.

[5]CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

[6]*Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
*Fair:* Woods are grazed but not burned, and some forest litter covers the soil.
*Good:* Woods are protected from grazing, and litter and brush adequately cover the soil.


BASIN AREA, ACRES
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
900
800
700
600
500
400
300
200
100
90
80
70
60
50
40
30
20
10
50
51
52
53
54
55
56
57
58
59
60
61
62
CALIBRATION POINT
USE REGIONAL METHOD
A6 (SULPHUR CREEK)
USE 56
A10 (BEAR SLIDE)
USE 57
A9 (SANTA CRUZ NORTH)
USE 58 (CONSERVATIVE)
A8 (SILVER SWAN)
USE 58
A5 (COLUMBIA FALLS)
USE 59
CALIBRATION POINT
A7 (SANTA CRUZ SOUTH)
USE RATIONAL METHOD
46 5810
K+E SEMI-LOGARITHMIC 3 CYCLES x 140 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

# Exhibit A-1, continued: Hydrologic soil groups for United States soils

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| FREEST | C | FULSHEAR | C | GAPCOT | D | GED | D | GILESPIE | D |
| FREESTONE | C | FULSTONE | D | GAPO | D | GEE | C | GILLAND | C |
| FREETOWN | D | FULTON | D | GAPO, DRAINED | C | GEEBURG | C | GILLENDER | D |
| FREEWATER | B | FULTS | D | GAPPMAYER | B | GEEMORE | C | GILLIAM | C |
| FREEZENER | B | FULWIDER | D | GARA | C | GEER | B | GILLIGAN | B |
| FREEZEOUT | B | FUNTER | D | GARBER | B | GEERTSEN | B | GILLS | C |
| FRELSBURG | D | FUQUAY | B | GARBO | B | GEFO | A | GILLSBURG | C |
| FREMONT | C | FURNISS | D | GARBUTT | B | GEISEL | B | GILMAN | B |
| FREN | B | FURSHUR | D | GARCEND | C | GEKE | C | GILMORE | C |
| FRENCH | C | FURY | D | GARCES | D | GELKIE | B | GILPAR | B |
| FRENCHCREEK | B | FURY, DRAINED | C | GARCIA | C | GEM | C | GILPIN | C |
| FRENCHJOHN | C | FUSULINA | B | GARCITAS | C | GEM, STONY | D | GILROY | C |
| FRENCHMAN | D | FUSUYAR | B | GARCON | C | GEMID | C | GILSTON | B |
| FRENCHTOWN | D | GAASTRA | C | GARDELLA | D | GENSON | B | GILT EDGE | D |
| FRESHWATER | D | GABALDON | B | GARDENA | B | GENAW | D | GINLETT | B |
| FRESNO, | D | GABBS | C | GARDINER | A | GENEGRAF | B | GINAT | D |
| SALINE-ALKALI | | GABBVALLY | D | GARDNER'S FORK | B | GENESEE | B | GINEX | D |
| FRESNO, THICK | C | GABEL | C | GARDNERVILLE | C | GENEVA | B | GINGER | D |
| SOLUM | | GABICA | D | GARDONE | A | GENOA | D | GINI | B |
| FREVA | B | GABINO | D | GAREY | B | GENOLA | B | GINLAND | D |
| FREZNIK | D | GACEY | D | GARFAN | B | GENTILLY | D | GINNIS | C |
| FRIANA | D | GACHADO | D | GARFIELD | C | GENTRY | D | GINSER | C |
| FRIANT | D | GACIBA | D | GARHILL | D | GEOCONDA | C | GIRARD | D |
| FRIDLO | C | GADDES | C | GARIPER | C | GEOHROCK | B | GIRARDOT | D |
| FRIEDLANDER | C | GADDY | A | GARITA | E | GEORGECREEK | B | GIRD | B |
| FRIEDMAN | C | GADSDEN | B | GARLAND | B | GEORGETOWN | D | GIST | D |
| FRIENDS | C | GADSDEN, WET | C | GARLET | E | GEORGEVILLE | B | GITAKUP | C |
| FRIENDSHIP | A | SUBSTRATUM | | GARLOCK | B | GEORGIA | C | GITAN | D |
| FRIES | D | GADWELL | C | GARMON | C | GEPFORD | D | GIVIN | C |
| FRIESLAND | B | GAGEBY | B | GARMORE | B | GEPP | B | GLACIERCREEK | A |
| FRIJOLES | B | GAGETOWN | B | GARNEL | D | GEPPERT | C | GLADDEN | B |
| FRINDLE | C/ | GAGIL | B | GARNER | D | GERALD | D | GLADEL | D |
| FRINES | C | GAHEE | B | GARNES | B | GERPER | D | GLADEVILLE | D |
| FRIO | B | GAIB | D | GARO | D | GERDRUM | D | GLADEWATER | D |
| FRIONA | C | GAILA | B | GARR | D | GERING | E | GLADSTONE | B |
| FRISTON | C | GAINES | C | GARRETSON | B | GERLACH | D | GLADWIN | A |
| FRIPP | A | GAINESBORO | C | GARRETT | B | GERLANE | B | GLASGOW | C |
| FRISCO | D | GAINESVILLE | A | GARRISON | B | GERLE | B | GLASSNER | D |
| FRISITE | B | GALATA | D | GARROCHALES | D | GERMANTOWN | B | GLEAN | B |
| FRITZ | B | GALBRETH | D | GARSID | C | GERMANY | B | GLEASON | B |
| FRITZELL | C | GALCHUTT | C | GARTCH | C | GERNER | C | GLEGE | C |
| FROBERG | D | GALE | B | GARVESON | C | GERONI | B | GLEN | B |
| FROOD | D | GALEN | B | GARVIN | D | GERRARD | C | GLENBAR | B |
| FROMMAN | C | GALEPPI | B | GARWIN | B/D | GERRARD, DRAINED | B | GLENBAR, WET | C |
| FROLIC | B | GALESTINA | C | GARZA | B | GERST | D | GLENBERG | B |
| FROLIC, | C | GALESTOWN | A | GARZONA | D | GESSIE | B | GLENBLAIR | C |
| ELEVATION<5000 | | GALEY | B | GAS CREEK | D | GESSNER | B/D | GLENBROOK | D |
| FROLIC, FLOODED | C | GALILEE | C | GASCONADE | D | GESTRIN | B | GLENCARB | B |
| FRONDORF | B | GALISTEO | C | GASIL | B | GETAWAY | B | GLENCARB, WET, | C |
| FRONTENAC | B | GALISTEO, | C | GASOLET | B | GETCHELL | C | SALINE | |
| FRONTIER | C | SALINE-ALKALI | | GASSAWAY | D | GETRAIL | D | GLENCOE | B/D |
| FROMTON | D | GALLAND | B | GASSVILLE | C | GETTYS | C | GLENCOE, PONDED | D |
| FROST | D | GALLATIN | C | GASTON | C | GETZVILLE | D | GLENDALE | B |
| FROZARD | C | GALLEGOS | B | GAT | B | GEWTER | C | GLENDALE, WET | C |
| FRUITA | B | GALLEN | B | GATES | B | GEYSER | C | GLENDALE, RARELY | C |
| FRUITFIELD | A | GALLIA | B | GATESON | C | GIBBLER | C | FLOODED | |
| FRUITHURST | C | GALLINE | B | GATEVIEW | B | GIBBON | B | GLENDERSON | B |
| FRUITLAND | B | GALLION | B | GATEWAY | C | GIBBONSCREEK | C | GLENDIVE | B |
| FRUITLAND, | C | GALLMAN | B | GATEWOOD | C | GIBBS | D | GLENDORA | A/D |
| MODERATELY WET | | GALLUP | B | GATLIN | B | GIBNET | C | GLENEDEN | D |
| FRUITLAND, WET | C | GALOO | C/D | GATOR | D | GIBSONVILLE | D | GLENELG | B |
| FRYE | C | GALT | D | GATTON | B | GIBWELL | C | GLENFORD | C |
| FRYEBURG | B | GALVA | B | GAULOY | B | GIDEON | C | GLENHALL | B |
| FT. DRUM | C | GALVESTON | A | GAULEY | C | GIELOW | C | GLENHAM | B |
| FT. GREEN | D | GALVEZ | C | GAVEL | C | GIFFORD | D | GLENMEN | B |
| FUBAR | C | GALVIN | D | GAVILAN | C | GIGGER | C | GLENMORA | C |
| FUBBLE | D | GALWAY | B | GAVINS | D | GILA | B | GLENNALLEN | C |
| FUEGO | C | GAMBLER | B | GAVIOTA | D | GILBERT | D | GLENOMA | B |
| FUEGOSTA | D | GAMBOA | B | GAY | B/D | GILBOA | B | GLENPOOL | A |
| FUERA | C | GANGER | C | GAYLESVILLE | D | GILBY | B | GLENRIO | D |
| FUGAWEE | B | GANADO | D | GAYLORD | C | GILCHRIST | A | GLENROSE | B |
| FUGHES | C | GANCE | C | GAYNOR | C | GILCO | B | GLENROSS | D |
| FULCHER | C | GANDO | D | GAYVILLE | D | GILCREST | B | GLENSTED | D |
| FULDA | C/D | GANIS | D | GAZELLE | D | GILEAD | C | GLENTON | B |
| FULLAM | C | GANNETT | D | GAZOS | C | GILES | B | GLENTON, WET | C |
| FULLER | D | GANSNER | C | GAZWELL | C | GILFORD | B/D | GLENTOSH | A |
| FULLERTON | B | GANSNER, PONDED | D | GEARHART | A | GILFORD, | D | GLENVIEW | B |
| FULNER | D | GANY | B | GEARY | B | STRATIFIED | | GLENVILLE | C |
| FULNER, DRAINED | C | GAPBUTTE | B | GEBSON | B | SUBSTRATUM | | GLENYON | B |

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# Exhibit A-1, continued: Hydrologic soil groups for United States soils

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| LANKIN | B | LARIAT | B | LAVINA | D | LEETONIA | C | LEW | B |
| LANO | C | LARIM | B | LAVON | C | LEEVAN | C | LEWBEACH | C |
| LANOILLE | B | LARIMER | B | LAWAI | B | LEFOR | B | LEWDLAC | D |
| LANONDI | B | LARIOSCAMP | D | LAWEN | B | LEGALL | B | LEWIS | D |
| LANONI | C | LARKIN | B | LAWET | B/D | LEGAULT | D | LEWISBERRY | B |
| LANONT | B | LARKSON | C | LAWET, | B | LEGGETT | C | LEWISBURG | C |
| LANONTA | D | LARMINE | C | SALINE-ALKALI | | LEGLER | B | LEWISTON | C |
| LANOOSE | D | LAROQUE | B | LAWLER | B | LEGORE | B | LEWISVILLE | B |
| LANOTTE | B | LAROSE | D | LAWNDALE | B | LEHEW | C | LEWKALB | C |
| LANOURE | C | LARRUPIN | B | LAWNWOOD | B/D | LEHIGH | C | LEX | B |
| LANPASAS | D | LARRY | D | LAWNWOOD, | D | LEHMANS | D | LEXINGTON | B |
| LANPHIER | B | LARRY, DRAINED | C | DEPRESSIONAL | | LEHR | B | LEXTON | B |
| LANPSHIRE | D | LARSON | D | LAWRENCE | C | LEICESTER | C | LEYBA | B |
| LANSON | B/D | LARTON | A | LAWRENCEVILLE | C | LEIDL | C | LEYDEN | C |
| LANARK | B | LARUE | A | LAYSHE | D | LEIGHCAN | B | LIBBINGS | D |
| LANCASTER | B | LARUSH | B | LAYSON | C | LEILEHUA | B | LIBEG | B |
| LANCE | B | LARVIE | D | LAYTHER | D | LEISY | B | LIBERAL | D |
| LAND | C | LAS | C | LAYTON | C | LELA | D | LIBORY | A |
| LAND, DRAINED | B | LAS ANIMAS | C | LAYYER | B | LELAND | D | LIBRARY | D |
| LANDAVASO | B | LAS FLORES | D | LAX | C | LEMAH | A | LIBUSE | C |
| LANDCO | C | LAS LUCAS | B | LAXAL | B | LEMBOS | C | LICHA | B |
| LANDER | C | LAS POSAS | C | LAXTON | C | LEMCO | C | LICK | B |
| LANDES | B | LAS VEGAS | D | LAYCOCK | B | LEMERT | D | LICKDALE | D |
| LANDLOW | C | LASA | A | LAYOINT | C | LEMETA | D | LICKING | C |
| LANDMAN | B | LASALLE | B | LAYTON | A | LEMING | C | LICKSKILLET | D |
| LANDSEND | C | LASAUSES | D | LAYVIEW | D | LEMITAR | D | LIDAN | C |
| LANE | C | LASCO | B | LAZAN | D | LEMM | B | LIDDELL | B/D |
| LANESBORO | C | LASIL | D | LAZEAR | D | LEMOLO | D | LIDDIEVILLE | B |
| LANEXA | D | LASKA | B | LE BAR | B | LEMOND | B/D | LIDY | B |
| LANEY | B | LASSEL | C | LE SUEUR | B | LEMONEX | C | LIEBERMAN | B |
| LANG | C | LASSEN | D | LEA | C | LEMOORE | C | LIEN | D |
| LANGFORD | C | LASSITER | B | LEADER | B | LEMPIRA | B | LIESNOI | D |
| LANGHEI | B | LASTANCE | B | LEADORE | B | LEN | C | LIGGET | B |
| LANGLADE | B | LATAH | D | LEADPOINT | C | LENA | A/D | LIGHTNING | D |
| LANGLOIS | D | LATAH, HIGH | C | LEADVALE | C | LENA, FLOODED | D | LIGNUM | C |
| LANGOLA | B | RAINFALL, DRAINED | | LEADVILLE | B | LENAPAH | D | LIGON | D |
| LANGRELL | B | LATAH, DRAINED | C | LEAF | D | LENAWEE | B/D | LIGURTA | B |
| LANGSPRING | B | LATAMCO | C | LEAFRIVER | A/D | LENAWEE, PONDED | D | LIHEN | A |
| LANGSTON | B | LATAMCO, WET | D | LEAHU | C | LENBERG | C | LIHUE | B |
| LANGTRY | D | LATANIER | D | LEAGUEVILLE | B/D | LENNEP | C | LIKES | A |
| LANIER | A | LATCH | A | LEAKSVILLE | D | LENOIR | D | LILAH | A |
| LANIGER | B | LATENE | B | LEAL | B | LENZ | B | LILBERT | B |
| LANIGER, GRAVELLY | C | LATES | C | LEALANDIC | D | LENZ, STONY | C | LILBOURN | B |
| LANKBUSH | B | LATEX | C | LEANNA | D | LENZ, VERY STONY | C | LILLINGS | B |
| LANKIN | C | LATHAM | D | LEANTO | D | LENZBURG | B | LILLINGTON | B |
| LANKTREE | C | LATHER | D | LEAPS | C | LEO | A | LILLYLANDS | C |
| LANOAK | B | LATHROP | B | LEATHAM | C | LEOLA | B | LILTEH | C |
| LANONA | B | LATIGO | B | LEATHERMAN | D | LEON | B/D | LILY | B |
| LANSDALE | B | LATINA | D | LEAVENWORTH | C | LEONARD | D | LIM | C |
| LANSDOWNE | C | LATIUM | D | LEAVERS | B | LEONARDO | B | LIMA | B |
| LANSING | B | LATON | D | LEAVITT | B | LEONARDTOWN | D | LIMBER | B |
| LANTERN | B | LATONIA | B | LEAVITTVILLE | B | LEONI | B | LIMEKILN | D |
| LANTIS | B | LATOUCHE | D | LEBAM | B | LEGUIEU | D | LIMERICK | C |
| LANTON | D | LATOUR | B | LEBANON | C | LERDAL | C | LIMERIDGE | D |
| LANTON, LOW | C | LATOURELL | B | LEBEAU | D | LERDO | C | LIMKING | B |
| PRECIPITATION | | LATTAS | D | LEBEC | B | LEROY | B | LIMON | C |
| LANTONIA | B | LATTY | D | LEBO | B | LERROW | C | LIMON, WET | D |
| LANTRY | B | LAUDERDALE | D | LEBSACK | C | LESMARA | B | LIMONES | B |
| LANTZ | D | LAUDERHILL | B/D | LECK KILL | B | LESHO | C | LIMPIA | C |
| LANVER | C | LAUFER | D | LECRAG | D | LESLIE | D | LINCO | B |
| LANYON | C/D | LAUGENOUR, LOAMY | C | LEDFORD | B | LESON | D | LINCOLN | A |
| LAP | D | SUBSTRATUM | | LEDGEFORK | A | LESPATE | C | LINDAAS | C/C |
| LAPARITA | C | LAUGENOUR, SILTY | B | LEDMOUNT | D | LESTER | B | LINDALE | C |
| LAPDUN | D | SUBSTRATUM | | LEDOV | B | LESVILL | B | LINDELL | C |
| LAPED | D | LAUGENOUR, DRAINED | B | LEDHU | C | LETA | C | LINDEN | B |
| LAPEER | B | LAUGHLIN | C | LEDUB | B | LETCHER | D | LINDER | B |
| LAPHAM | A | LAUMAIA | B | LEDWITH | B/D | LETHA | C | LINDLEY | C |
| LAPINE | A | LAUREL | D | LEE | D | LETHENT | D | LINDRITH | B |
| LAPLATTA | C | LAURELWOOD | B | LEEBENCH | D | LETHEY | A | LINDSIDE | C |
| LAPON | D | LAUREN | B | LEEDS | C | LETON | D | LINDSTROM | B |
| LAPORTE | D | LAURENTIEN | B | LEEFIELD | C | LETORT | B | LINDY | C |
| LAPOSA | C | LAVACREEK | B | LEEKO | C | LETRI | B/D | LINE | B |
| LAPVAI | B | LAVALLEE | B | LEEKO, WARM | B | LETTIA | B | LINEVILLE | C |
| LARAND | B | LAVATE | B | LEELANAU | A | LEVASY | C | LINGANORE | B |
| LARCHMOUNT | B | LAVEAGA | C | LEEMONT | D | LEVELTON | D | LINHART | A |
| LARDELL | C | LAVEEN | B | LEEPER | D | LEVELTON, DRAINED | C | LININGER | C |
| LAREDO | B | LAVENTANA | B | LEERAY | D | LEVERETT | C | LINKER | B |
| LARES | C | LAVERKIN | C | LEESBURG | B | LEVIATHAN | B | LINKUP | D |
| LARGO | B | LAVIC | B | LEESVILLE | B | LEVY | D | LINKVILLE | B |

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# Exhibit A-1, continued: Hydrologic soil groups for United States soils

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| HESCH | B | HILLSBORO | B | HOLDERMAN | C | HOODVIEW | B | HOWELL | C |
| HESPER | B | HILLSDALE | B | HOLDERNESS | C | HOOGDAL | C | HOWLAND | C |
| HESPERIA | B | HILLTO | B | HOLDINGFORD | C | HOOKS | B | HOWSON | C |
| HESPERUS | B | HILLWOOD | B | HOLDREGE | B | HOOKSAN | A | HOYE | B |
| HESSEL | B/D | HILMAR | D | HOLILLIPAM | A | HOOKTON | C | HOYLETON | C |
| HESSELBERG | D | HILMAR, DRAINED | B | HOLLAND | B | HOOLEHUA | B | HOYPUS | A |
| HESSELTINE | B | HILMOE | C | HOLLANDLAKE | B | HOOLY | C | HOYTVILLE | C/D |
| HESSING | B | HILO | A | HOLLINGER | E | HOOPAL | D | HUACHUCA | C |
| HESSLAN | C | HILOLO | D | HOLLIS | C/D | HOOPER | D | HUALAPAI | C |
| HESSON | C | HILT | B | HOLLISTER | D | HOOPESTON | B | HUB | B |
| HETERWA | C | HILTON | B | HOLLOMAN | D | HOOPLITE | D | HUBBARD | A |
| HETTINGER | C/D | HINCKLEY | A | HOLLOMEX | B | HOOSAN | B | HUBBARDTON | D |
| HEUSSER | C | HINDES | C | HOLLOW | C | HOOSEGOW | B | HUBBELL | B |
| HEUVELTON | C | HINESBURG | C | HOLLOWAY | E | HOOSIC | A | HUBERLY | D |
| HEWITT | D | HINKER | C | HOLLOWTREE | C | HOOSIERVILLE | C | HUBERT | B |
| HEXT | B | HINKLE | D | HOLLY | B/D | HOOSIMBIM | B | HUBLERSBURG | B |
| HEYDER | B | HINMAN | C | HOLLY, PONDED | D | HOOT | D | HUCKLEBERRY | C |
| HEYDLAUFF | B | HINSDALE | D | HOLLY SPRINGS | D | HOOTEN | D | HUCKLEBERRY, HIGH RAINFALL | B |
| HEYTOU | B | HIRAMSBURG | C | HOLLYWELL | B | HOPCO | C | HUDNUT | B |
| HEZEL | B | HIRIDGE | D | HOLLYWOOD | D | HOPDRAW | A | HUDSON | C |
| HI VISTA | C | HIRSCHDALE | C | HOLMAN | A | HOPEKA | D | HUECO | C |
| HIARC | C | HISEGA | C | HOLMDEL | C | HOPKINS | B | HUEL | A |
| HIBAR | C | HISKEY | B | HOLMES | B | HOPLAND | B | HUENEME | C |
| HIBBARD | C | HISLE | D | HOLOMAN | B | HOPLEY | B | HUENEME, | B |
| HIBBING | C | HITCHCOCK | B | HOLOMUA | B | HOPSONVILLE | C | HOODERATELY WET | |
| HIBERNIA | C | HITILO | A | HOLOPAW | B/D | HOOUIAM | B | HUENEME, DRAINED | B |
| HIBRITEN | B | HITT | B | HOLOPAW, DEPRESSIONAL | D | HORD | B | HUERFANO | D |
| HICKMAN | B | HIVAL | D | HOLOPAW, FREQUENTLY FLOODED | D | HOREB | C | HUEY | D |
| HICKORY | C | HIWAN | D | HOLSINE | B | HOREB, GRAVELLY SUBSTRATUM | B | HUFFINE | B |
| HICKS | B | HIWASSEE | B | HOLSTEIN | B | HORNELL | D | HUFFMAN | B |
| HICKSVILLE | B | HIWOOD | A | HOLSTON | B | HORNING | B | HUFFTON | B |
| HICKSVILLE, BEDROCK SUBSTRATUM | C | HIXTON | B | HOLT | B | HORNITOS | D | HUGGINS | C |
| HICOTA | B | HOADLY | C | HOLTER | B | HORNSBY | C | HUGHES | B |
| HIDALGO | B | HOBACKER | B | HOLTVILLE | C | HORNSVILLE | C | HUGHESVILLE | C |
| HIDATSA | B | HOBAN | B | HOLYOKE | C/D | HORRBERG | B | HUGO | B |
| HIDEAWAY | D | HOBBS | B | HOMA | C | HORSECAMP | D | HUGUS | B |
| HIDEWOOD | B/D | HOBCAW | D | HOME CAMP | C | HORSERIDGE | B | HUGUSTON | D |
| HIERRO | B | HOBERG | A | HOMELAKE | B | HORSESHOE | B | HUICHICA | C |
| HIGGINS | D | HOBIT | C | HOMELAND | C | HORSETHIEF | B | HUICHICA, PONDED | D |
| HIGGINSVILLE | C | HOBO | D | HOMER | B | HORSLEY | D | HUIKAU | A |
| HIGH GAP | C | HOBOG | D | HOMESTAKE | C | HORST | B | HUKILL | E |
| HIGHAMS | D | HOBONNY | D | HOMESTEAD | B | HORTONVILLE | B | HULETT | B |
| HIGHBANK | C | HOBSON | C | HOMEWOOD | C | HOSKIN | C | HULLS | C |
| HIGHCAMP | B | HOBUCKEN | D | HONDO | B | HOSKINNINI | D | HULLT | B |
| HIGHFIELD | B | HOCAR | D | HONEYCREEK | C | HOSLEY | D | HULUA | D |
| HIGHMOAN | B | HOCHHEIM | B | HONEYDEW | B | HOSMER | C | HUM | B |
| HIGHMORE | B | HOCKINSON | D | HONEYGROVE | C | HOSSICK | B | HUMACAO | B |
| HIGHPOINT | B | HOCKINSON, MODERATELY WET | C | HONEYJONES | C | HOSTAGE | B | HUMATAS | C |
| HIGHROCK | D | HOCKINSON, DRAINED | B | HONEYVILLE | B | HOT LAKE | C | HUMBARGER | B |
| HIGHTOWER | C | HOCKLEY | C | HONKER | C | HOTAW | C | HUMBIG | C |
| HIGHWOOD | C | HOCKLEY, GRADED | D | HONKLAK | D | HOTCREEK | D | HUMBIRD | B |
| HIHIMANU | B | HODA | C | HONKLAK, DRAINED | C | HOTEL | C | HUMBOLDT | D |
| HIIBNER | C | HODEDO | C | HONLU | B | HOTSPRINGS | B | HUMBOLDT, MODERATELY WET, SALINE-ALKALI | B |
| HIKO PEAK | B | HODENPYL | B | HONN | B | HOUDEK | B | HUMBOLDT, MONSALINE | B |
| HIKO SPRINGS | B | HODGE | A | HONOBIA | C | HOUGH | B | HUMBOLDT, MODERATELY WET | B |
| HILAIRE | B | HODGINS | B | HONOKAA | A | HOUGHTON | A/D | HUMBOLDT, DRAINED, STRONGLY SALINE | B |
| HILAND | B | HODGSON | C | HONOLUA | B | HOUGHTON, PONDED | D | HUMBOLDT, DRAINED, MONSALINE | B |
| HILDEBRECHT | C | HOENNE | A | HONOMANU | A | HOUGHTONVILLE | C | HUMBOLDT, MODERATELY WET | B |
| HILDRETH | D | HOFFLAND | D | HONONEGAH | A | HOUK | C | HUMBOLDT, DRAINED | B |
| HILEA | D | HOFFMANVILLE | C | HONOULIULI | B | HOULA | B | HUMDUM | B |
| HILES | B | HOEFSTADT | B | HONTAS | B | HOULKA | D | HUME | C |
| HILGER | B | HOFLY | C | HONTOON | B/D | HOURGLASS | B | HUMESTON | C/D |
| HILGRAVE | B | HOGADERO | B | HONUAULU | A | HOUSE MOUNTAIN | D | HUMKER | C |
| HILIGHT | D | HOGANSBURG | B | HOOD | B | HOUSER | D | HUMMINGTON | C |
| HILINE | D | HOGBACK | C | HOODDOO | D | HOUSEROCK | D | HUMPHREYS | B |
| HILLBRICK | D | HOGG | C | HOODSPORT | C | HOUSTAKE | C | HUMPTULIPS | B |
| HILLCO | B | HOGNALAT | D | HOOGDIEW | C | HOUSTON | D | HUMSKEL | C |
| HILLEMANN | C | HOGRIS | B | HOOKAPU | C | HOUSTON BLACK | D | HUN | B |
| HILLERY | C | HOH | B | HOOKER | C | HOVDE | D | HUNCHBACK | D |
| HILLET | B/D | HOHMANN | C | HOOKSTON | B | HOVEN | D | HUNDRAY | D |
| HILLFIELD | B | HOKO | C | HOOKUMPA | B | HOVENWEEP | C | HUNEWILL | B |
| HILLGATE | D | HOLBORN | C | HOOLEHUA | A | HOVERT | D | HUNGRY | C |
| HILLIARD | B | HOLBROOK | B | HOOLIMAN | B | HOVEY | C | | |
| HILLIARD, MODERATELY WELL DRAINED | C | HOLCOMB | D | HOOPA | A | HOWARD | A | | |
| HILLON | C | HOLDAWAY | D | HOOPER | B | HOWARDSVILLE | A | | |
| | | HOLDEN | B | HOOPER | B | HOWCAN | B | | |
| | | HOLDER | B | HOOPER | C | HOWCREE | C | | |
| | | | | HOOPER | C | HOWE | C | | |

NOTES: TWO HYDROLOGIC SOIL GROUPS SUCH AS B/C INDICATES THE DRAINED/UNDRAINED SITUATION.
MODIFIERS SHOWN, E.G., BEDROCK SUBSTRATUM, REFER TO A SPECIFIC SOIL SERIES PHASE FOUND IN SOIL MAP LEGEND.

**Table 2-2c.—Runoff curve numbers for other agricultural lands[1]**

| Cover description | | Curve numbers for hydrologic soil group— | | | |
|---|---|---|---|---|---|
| Cover type | Hydrologic condition | A | B | C | D |
| Pasture, grassland, or range—continuous forage for grazing.[2] | Poor | 68 | 79 | 86 | 89 |
| | Fair | 49 | 69 | 79 | 84 |
| | Good | 39 | 61 | 74 | 80 |
| Meadow—continuous grass, protected from grazing and generally mowed for hay. | — | 30 | 58 | 71 | 78 |
| Brush—brush-weed-grass mixture with brush the major element.[3] | Poor | 48 | 67 | 77 | 83 |
| | Fair | 35 | 56 | 70 | 77 |
| | Good | [4]30 | 48 | 65 | 73 |
| Woods—grass combination (orchard or tree farm).[5] | Poor | 57 | 73 | 82 | 86 |
| | Fair | 43 | 65 | 76 | 82 |
| | Good | 32 | 58 | 72 | 79 |
| Woods.[6] | Poor | 45 | 66 | 77 | 83 |
| | Fair | 36 | 60 | 73 | 79 |
| | Good | [4]30 | 55 | 70 | 77 |
| Farmsteads—buildings, lanes, driveways, and surrounding lots. | — | 59 | 74 | 82 | 86 |

[1]Average runoff condition, and $I_a = 0.2S$.

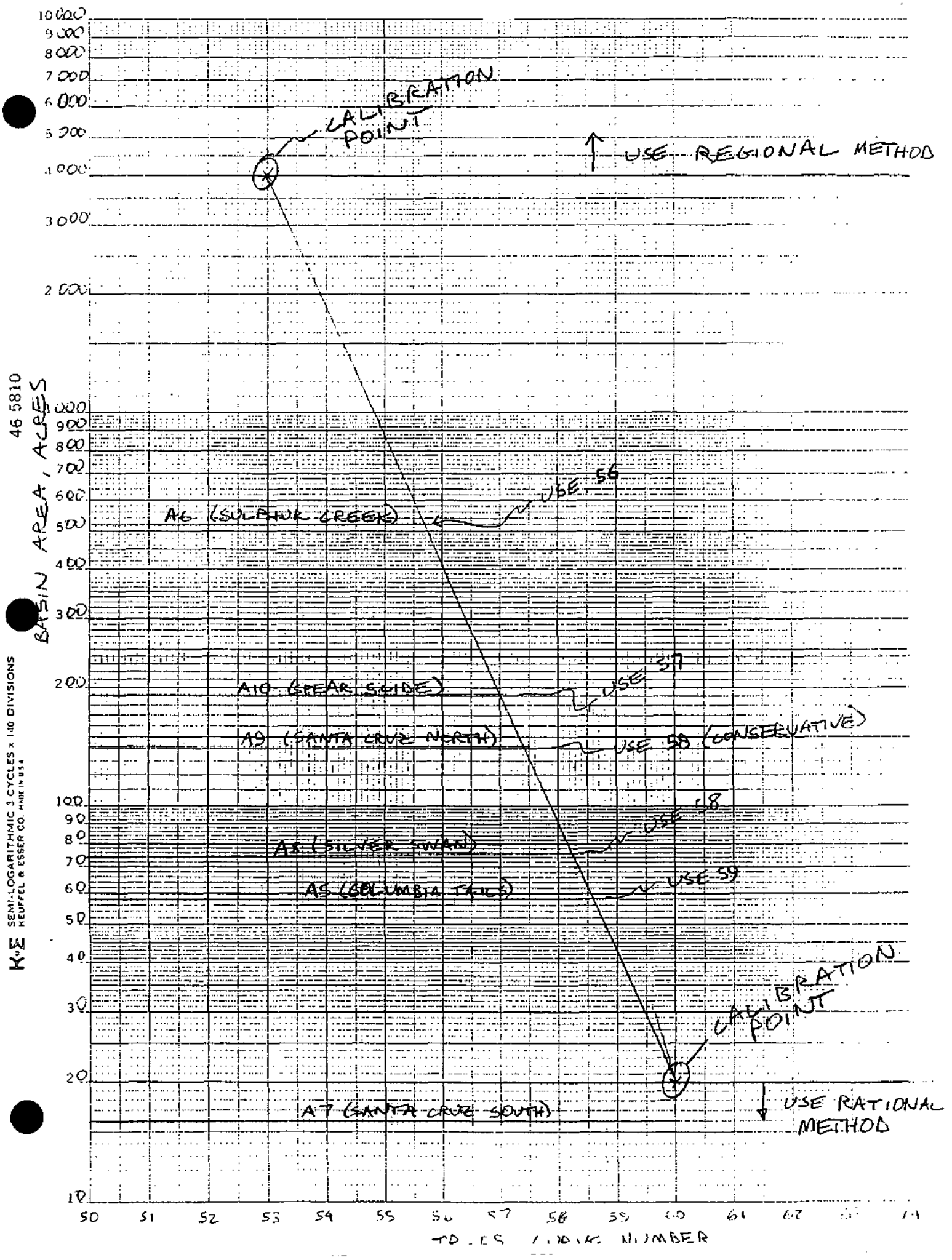
[2]*Poor:* <50% ground cover or heavily grazed with no mulch.
*Fair:* 50 to 75% ground cover and not heavily grazed.
*Good:* >75% ground cover and lightly or only occasionally grazed.

[3]*Poor:* <50% ground cover.
*Fair:* 50 to 75% ground cover.
*Good:* >75% ground cover.

[4]Actual curve number is less than 30; use CN = 30 for runoff computations.

[5]CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

[6]*Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
*Fair:* Woods are grazed but not burned, and some forest litter covers the soil.
*Good:* Woods are protected from grazing, and litter and brush adequately cover the soil.



BASIN AREA, ACRES
CALIBRATION POINT
USE REGIONAL METHOD
USE 56
A6 (SULPHUR CREEK)
USE 57
A10 (SPEAR SIDE)
A9 (SANTA CRUZ NORTH)
USE 58 (CONSERVATIVE)
USE 58
A8 (SILVER SWAN)
USE 59
A5 (COLUMBIA TAILS)
CALIBRATION POINT
A7 (SANTA CRUZ SOUTH)
USE RATIONAL METHOD
46 5810
K+E SEMI-LOGARITHMIC 3 CYCLES x 140 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

**Attachment B1A-5**
**Regional Regression Methodology**

COLORADO WATER CONSERVATION BOARD
COLORADO DEPARTMENT OF NATURAL RESOURCES

TECHNICAL MANUAL NO. 1

# MANUAL FOR ESTIMATING FLOOD CHARACTERISTICS OF NATURAL-FLOW STREAMS IN COLORADO

*By* Jerald F. McCain *and* Robert D. Jarrett

U.S. Geological Survey

*Prepared in cooperation with the*

*U.S. GEOLOGICAL SURVEY*

Colorado Water Conservation Board
1845 Sherman Street
Denver, Colorado 80203

*1976*

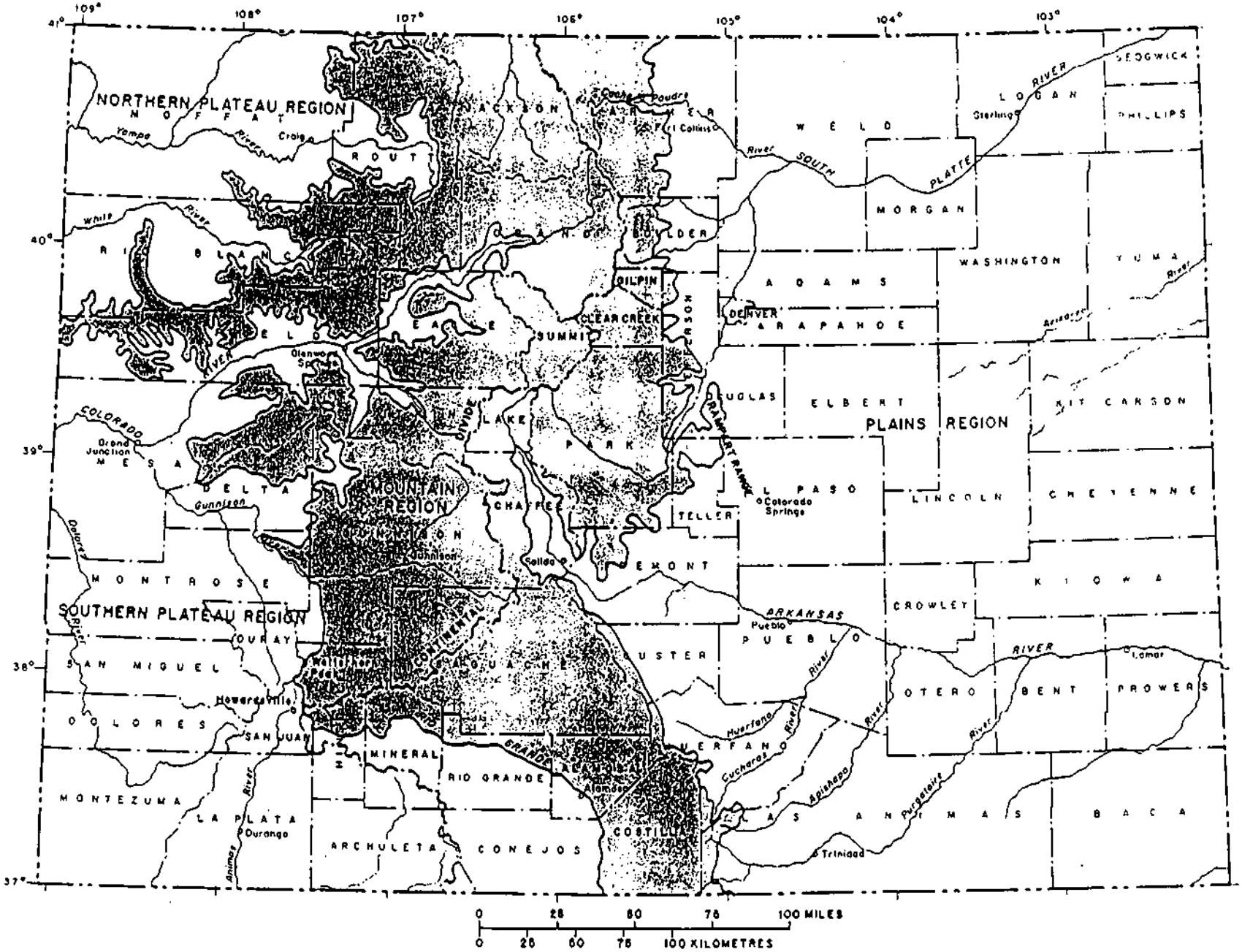



Figure 2.--Flood-characteristic regions in Colorado.

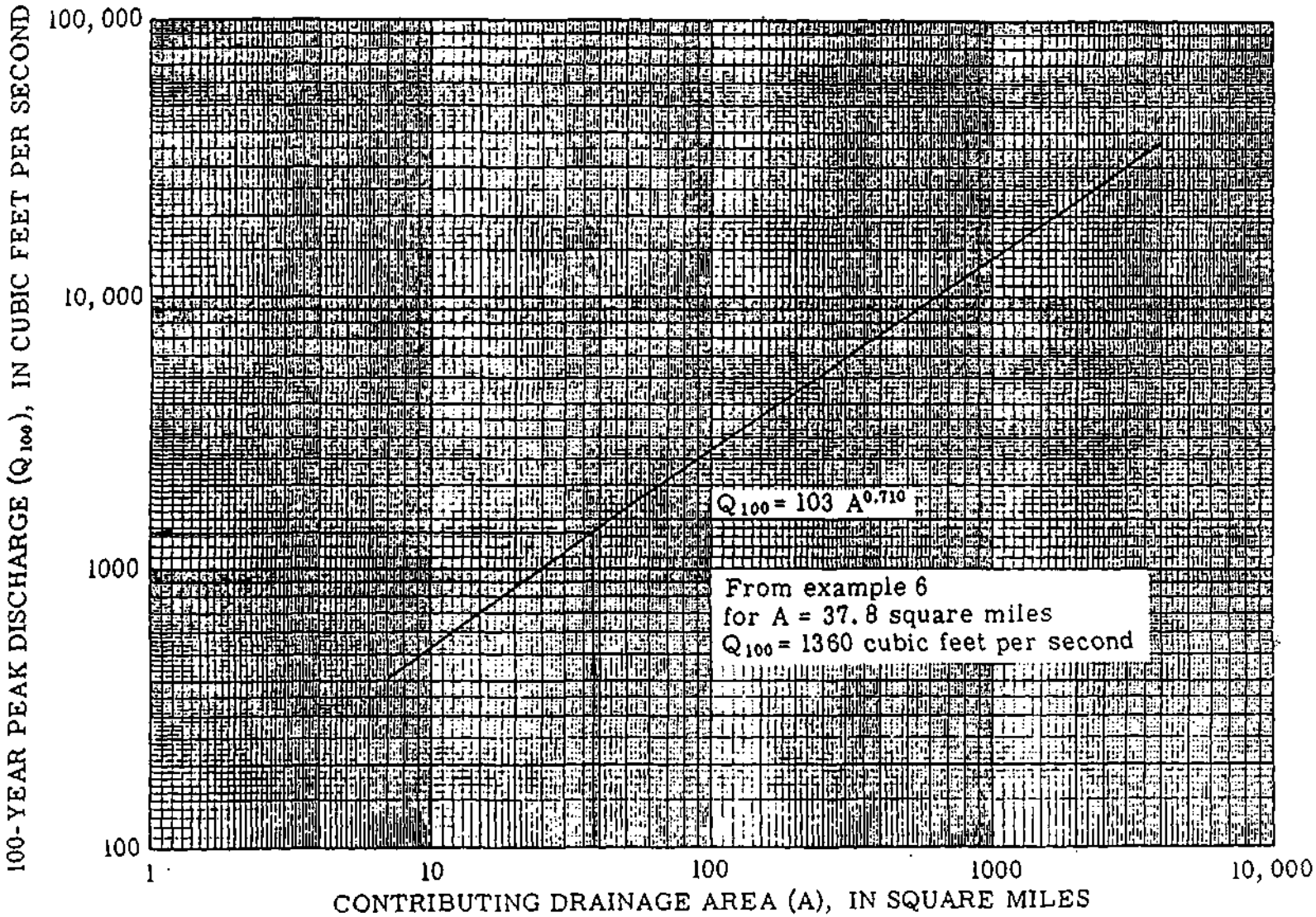



Figure 9.--Relation of 100-year peak discharge to contributing drainage area for the Southern Plateau Region.

**Attachment B1A-6**
**Calculations**

## *Summary of Results*

Job: 101.9502
Project: Rico
By: ACJ
Location: Silver Creek
Basin: A3

**Regional Regression Analyses**

| | | |
|---|---|---|
| Basin Area: | 154 acres | 0.24 sq. mi. |
| Q: | 37.5 cfs | |

**TR-55 Method**

Q: 72.0 cfs

**Rational Method**

Q: 98.1 cfs

GRAPHICAL PEAK DISCHARGE METHOD Version 2.00

Project : Rico Technical Services User: ACJ Date: 07-31-95
County : Dolores State: CO Checked: ____ Date: _____
Subtitle: Basin A3

Data: Drainage Area : 154 Acres
Runoff Curve Number : 57
Time of Concentration: 0.19 Hours
Rainfall Type : II
Pond and Swamp Area : NONE

| Storm Number | 1 |
|---|---|
| Frequency (yrs) | 100 |
| 24-Hr Rainfall (in) | 3.75 |
| Ia/P Ratio | 0.40 |
| Runoff (in) | 0.51 |
| Unit Peak Discharge (cfs/acre/in) | 0.906 |
| Pond and Swamp Factor 0.0% Ponds Used | 1.00 |
| Peak Discharge (cfs) | 72 |

## *Time of Concentration by TR-55 Methodology*

Job: 101.9502
Subject: Rico
By: ACJ
Location: Silver Creek
Basin: A3

Storm analyzed: 100 yr 6 hr

A. Sheet Flow

| | | | | |
|---|---|---|---|---|
| 1. Surface description | Woods | | | |
| 2. Manning's RC (n) | 0.4 | | | |
| 3. Flow length, L | 150 | ft (MAX IS 300) | | |
| 4. rainfall | 5.1 | in | Suggested: | 5.1 in |
| Beginning Elevation | 10939 | | | |
| Ending Elevation | 10850 | | | |
| 5. Land slope, s | 0.59 | ft/ft | | |
| 6. Tt = 0.007(nl)^.8/(p2^.5*s^.4) | 0.101 | hr | 6.1 | min |

B. Shallow Concentrated Flow

| | | | | |
|---|---|---|---|---|
| 7. Surface description | Unpaved | | | |
| 8. Flow length, L | 350 | ft | | |
| Beginning Elevation | 10850 | | | |
| Ending Elevation | 10600 | | | |
| 9. Watercourse slope, s | 0.71 | ft/ft | | |
| 10. Average Velocity, V | 2.3 | ft/s | | |
| 11. Tt= L/(3600V) | 0.042 | hr | 2.5 | min |

C. Channel Flow

| | | | | |
|---|---|---|---|---|
| Q (base flow from u/s subarea) | 0 | | | |
| Q (calculated - guess on first iteration) | 18 | (use about 1/4 of calculated Q at end of channel): | | 24.4 cfs |
| Q (total) | 18 | | | |
| Q (adjust flow area so to match this Q to abo | 18.1 | | | |
| 12. Cross section flow area, a | 1.4 | ft2 | | |
| 13. Wetted perimeter, pw | 3.8 | ft (calculated) | Assumes V channel, 2H:1V) | |
| 14. Hydraulic radius, r=a/pw | 0.38 | ft | | |
| Beginning Elevation | 10600 | | | |
| Ending Elevation | 9300 | | | |
| 15. Channel slope, s | 0.65 | | | |
| 16. Mannings RC, n | 0.05 | | | |
| 17. V=1.49[(r^2/3)s^.5]/n | 12.55 | ft/s | | |
| 18. Flow Length | 2000 | ft | | |
| 19. Tt= L/3600V | 0.04 | hr | 2.7 | min |

D. Subarea Tc

| | | | | |
|---|---|---|---|---|
| 20. Tt | 0.19 | hr | 11.3 | min |

E. Basin Statistics

| | | |
|---|---|---|
| Elevation Drop: | 1639 | ft |
| Horizontal Flow Length: | 2500 | ft |

file SH1-1

| | |
|---|---|
| **Re:** | Design Q, 100 yr, 6 hour design storm |
| **Location:** | Silver Creek |
| **Basin:** | A3 |

**Inputs**

| | | |
|---|---|---|
| Storm Recurrence Interval | 100 | yrs |
| Runoff Coefficient (C) | 0.10 | |
| Basin Area: | 154 | acres |
| Maximum Length of water travel: | 2500 | ft |
| TR-55 calculated time of concentration: | 11.1 | min |
| Time of concentration factor: | 2.0 | (for use in adjusting Kirpich formula) |

Rainfall Intensity-Duration Curve

| Duration (D, hrs) | (min) | I(in/hr) | dI/dD |
|---|---|---|---|
| 0.083 | 5 | 6.75 | -17.76 |
| 0.167 | 10 | 5.27 | -9.96 |
| 0.250 | 15 | 4.44 | -5.44 |
| 0.500 | 30 | 3.08 | -2.26 |
| 1.000 | 60 | 1.95 | -2.26 |

**Work Area**

Antecedent Precipitation Factors

| Recurrence Interval (yrs) | Ca |
|---|---|
| 2 | 1 |
| 10 | 1 |
| 25 | 1.1 |
| 50 | 1.2 |
| 100 | 1.25 |

| | |
|---|---|
| Ikey | 0.166667 |
| Ibase | 5.27 |
| Idelta | -9.96 |

**Results**

| | | | | | |
|---|---|---|---|---|---|
| Height drop of water travel: | 1639 | ft | | | |
| Antecedent Precipitation Factor (Ca) | 1.25 | | | | |
| C * Ca | 0.13 | | | | |
| Basin Slope: | 65.6% | | | | |
| Time of Concentration (Tc): | 0.13 | hrs | 7.6 | min | (Kirpich formula) |
| Tc for analysis: | 0.18 | hrs | 11.1 | min | (max of Kirpich or TR-55) |
| Average Water Velocity: | 5.5 | ft/s | | | |
| Intensity (I) | 5.1 | in/hr | | | |
| Q (=CCaIA) | 98.1 | cfs | | | |

## *Time of Concentration by TR-55 Methodology*

Tc for Rational

Job: 101.9502
Project: Rico
By: ACJ
Location: Silver Creek
Basin: A3

Storm analyzed: 100 yr 6 hr

A. Sheet Flow

| | | | | |
|---|---|---|---|---|
| 1. Surface description | Woods | | | |
| 2. Manning's RC (n) | 0.4 | | | |
| 3. Flow length, L | 150 | ft (MAX IS 300) | | |
| 4. rainfall | 5.1 | in | Suggested: | 5.1 in |
| Beginning Elevation | 10939 | | | |
| Ending Elevation | 10850 | | | |
| 5. Land slope, s | 0.59 | ft/ft | | |
| 6. Tt = 0.007(nl)^.8/(p2^.5*s^.4) | 0.101 | hr | 6.1 min | |

B. Shallow Concentrated Flow

| | | | |
|---|---|---|---|
| 7. Surface description | Unpaved | | |
| 8. Flow length, L | 350 | ft | |
| Beginning Elevation | 10850 | | |
| Ending Elevation | 10600 | | |
| 9. Watercourse slope, s | 0.71 | ft/ft | |
| 10. Average Velocity, V | 2.3 | ft/s | |
| 11. Tt= L/(3600V) | 0.042 | hr | 2.5 min |

C. Channel Flow

| | | | | |
|---|---|---|---|---|
| Q (base flow from u/s subarea) | 0 | | | |
| Q (calculated - guess on first iteration) | 24.5 | (use about 1/4 of calculated Q at end of channel): | | 24.5 cfs |
| Q (total) | 24.5 | | | |
| Q (adjust flow area so to match this Q to a | 24.5 | | | |
| 12. Cross section flow area, a | 1.8 | ft2 | | |
| 13. Wetted perimeter, pw | 4.3 | ft (calculated) | Assumes V channel, 2H:1V) | |
| 14. Hydraulic radius, r=a/pw | 0.43 | ft | | |
| Beginning Elevation | 10600 | | | |
| Ending Elevation | 9300 | | | |
| 15. Channel slope, s | 0.65 | | | |
| 16. Mannings RC, n | 0.05 | | | |
| 17. V=1.49[(r^2/3)s^.5]/n | 13.55 | ft/s | | |
| 18. Flow Length | 2000 | ft | | |
| 19. Tt= L/3600V | 0.04 | hr | 2.5 min | |

D. Subarea Tc

| | | | |
|---|---|---|---|
| 20. Tt | 0.18 | hr | 11.1 min |

E. Basin Statistics

| | | |
|---|---|---|
| Elevation Drop: | 1639 | ft |
| Horizontal Flow Length: | 2500 | ft |

file SH1-1

## Summary of Results

Job: 101.9502
Project: Rico
By: ACJ
Location: Argentine Tailings
Basin: Pile runoff Area A

**Regional Regression Analyses**

| | | |
|---|---|---|
| Basin Area: | 5.3 acres | 0.01 sq. mi. |
| Q: | 3.4 cfs | |

**Rational Method**

| | |
|---|---|
| Q: | 12.3 cfs |

| | |
|---|---|
| **Job:** | 101.9502 |
| **Project:** | Rico Technical Services |
| **By:** | ACJ |
| **Re:** | Design Q, 100 yr, 6 hour design storm |
| **Location:** | Argentine Tailings 0 |
| **Basin:** | Pile runoff Area A |

**Inputs**

| | | |
|---|---|---|
| Storm Recurrence Interval | 100 | yrs |
| Runoff Coefficient (C) | 0.50 | |
| Basin Area: | 5.3 | acres |
| Maximum Length of water travel: | 1050 | ft |
| TR-55 calculated time of concentration: | 23.0 | min |
| Time of concentration factor: | 2.0 | (for use in adjusting Kirpich formula) |

Rainfall Intensity-Duration Curve

| Duration (D, hrs) | (min) | I(in/hr) | dI/dD |
|---|---|---|---|
| 0.083 | 5 | 6.75 | -17.76 |
| 0.167 | 10 | 5.27 | -9.96 |
| 0.250 | 15 | 4.44 | -5.44 |
| 0.500 | 30 | 3.08 | -2.26 |
| 1.000 | 60 | 1.95 | -2.26 |

**Work Area**

Antecedent Precipitation Factors

| Recurrence Interval (yrs) | Ca |
|---|---|
| 2 | 1 |
| 10 | 1 |
| 25 | 1.1 |
| 50 | 1.2 |
| 100 | 1.25 |

| | |
|---|---|
| Ikey | 0.25 |
| Ibase | 4.44 |
| Idelta | -5.44 |

**Results**

| | | | | |
|---|---|---|---|---|
| Height drop of water travel: | 20 | ft | | |
| Antecedent Precipitation Factor (Ca) | 1.25 | | | |
| C * Ca | 0.63 | | | |
| Basin Slope: | 1.9% | | | |
| Time of Concentration (Tc): | 0.25 | hrs | 15.2 min | (Kirpich formula) |
| Tc for analysis: | 0.38 | hrs | 23.0 min | (max of Kirpich or TR-55) |
| Average Water Velocity: | 1.2 | ft/s | | |
| Intensity (I) | 3.7 | in/hr | | |
| Q (=CCaIA) | 12.3 | cfs | | |

## *Time of Concentration by TR-55 Methodology*

Job: 101.9502
Project: Rico
By: ACJ
Location: Argentine Tailings
Basin: Pile runoff Area A

Storm analyzed: 100 yr 6 hr

A. Sheet Flow

| | | | | |
|---|---|---|---|---|
| 1. Surface description | Rock Mul | | | |
| 2. Manning's RC (n) | 0.3 | | | |
| 3. Flow length, L | 100 | ft (MAX IS 300) | | |
| 4. rainfall | 3.7 | in | Suggested: | 3.7 in |
| Beginning Elevation | 9315 | | | |
| Ending Elevation | 9313 | | | |
| 5. Land slope, s | 0.0200 | ft/ft | | |
| 6. Tt = 0.007(nl)^.8/(p2^.5*s^.4) | 0.264 | hr | 15.9 | min |

B. Shallow Concentrated Flow

| | | | | |
|---|---|---|---|---|
| 7. Surface description | Unpaved | | | |
| 8. Flow length, L | 300 | ft | | |
| Beginning Elevation | 9313 | | | |
| Ending Elevation | 9308 | | | |
| 9. Watercourse slope, s | 0.02 | ft/ft | | |
| 10. Average Velocity, V | 2.3 | ft/s | | |
| 11. Tt= L/(3600V) | 0.036 | hr | 2.2 | min |

C. Channel Flow

| | | | | |
|---|---|---|---|---|
| Q (base flow from u/s subarea) | 0 | | | |
| Q (calculated - guess on first iteration) | 3.1 | (use about 1/4 of calculated Q at end of channel): | | 3.1 cfs |
| Q (total) | 3.1 | | | |
| Q (adjust flow area so to match this Q to a | 3.1 | | | |
| 12. Cross section flow area, a | 1.4 | ft2 | | |
| 13. Wetted perimeter, pw | 3.7 | ft (calculated) | Assumes V channel, 2H:1V) | |
| 14. Hydraulic radius, r=a/pw | 0.37 | ft | | |
| Beginning Elevation | 9308 | | | |
| Ending Elevation | 9295 | | | |
| 15. Channel slope, s | 0.02 | | | |
| 16. Mannings RC, n | 0.05 | | | |
| 17. V=1.49[(r^2/3)s^.5]/n | 2.18 | ft/s | | |
| 18. Flow Length | 650 | ft | | |
| 19. Tt= L/3600V | 0.08 | hr | 5.0 | min |

D. Subarea Tc

| | | | | |
|---|---|---|---|---|
| 20. Tt | 0.38 | hr | 23.0 | min |

E. Basin Statistics

| | | |
|---|---|---|
| Elevation Drop: | 20 | ft |
| Horizontal Flow Length: | 1050 | ft |

| | |
|---|---|
| **Job:** | 101.9502 |
| **Project:** | Rico Technical Services |
| **By:** | ACJ |
| **Re:** | Design Q, 100 yr, 6 hour design storm |
| **Location:** | Argentine Tailings 0 |
| **Basin:** | Pile runoff Area A and B |

**Inputs**

| | | |
|---|---|---|
| Storm Recurrence Interval | 100 | yrs |
| Runoff Coefficient (C) | 0.50 | |
| Basin Area: | 10.3 | acres |
| Maximum Length of water travel: | 1650 | ft |
| TR-55 calculated time of concentration: | 27.5 | min |
| Time of concentration factor: | 2.0 | (for use in adjusting Kirpich formula) |

Rainfall Intensity-Duration Curve

| Duration (D, hrs) | (min) | I(in/hr) | dI/dD |
|---|---|---|---|
| 0.083 | 5 | 6.75 | -17.76 |
| 0.167 | 10 | 5.27 | -9.96 |
| 0.250 | 15 | 4.44 | -5.44 |
| 0.500 | 30 | 3.08 | -2.26 |
| 1.000 | 60 | 1.95 | -2.26 |

**Work Area**

Antecedent Precipitation Factors

| Recurrence Interval (yrs) | Ca |
|---|---|
| 2 | 1 |
| 10 | 1 |
| 25 | 1.1 |
| 50 | 1.2 |
| 100 | 1.25 |

| | |
|---|---|
| Ikey | 0.25 |
| Ibase | 4.44 |
| Idelta | -5.44 |

**Results**

| | | | | |
|---|---|---|---|---|
| Height drop of water travel: | 85 | ft | | |
| Antecedent Precipitation Factor (Ca) | 1.25 | | | |
| C * Ca | 0.63 | | | |
| Basin Slope: | 5.2% | | | |
| Time of Concentration (Tc): | 0.24 | hrs | 14.7 min | (Kirpich formula) |
| Tc for analysis: | 0.46 | hrs | 27.5 min | (max of Kirpich or TR-55) |
| Average Water Velocity: | 1.9 | ft/s | | |
| Intensity (I) | 3.3 | in/hr | | |
| Q (=CCaIA) | 21.3 | cfs | | |

## *Time of Concentration by TR-55 Methodology*

Job: 101.9502
Project: Rico
By: ACJ
Location: Argentine Tailings
Basin: Pile runoff Area A and B

Storm analyzed: 100 yr 6 hr

A. Sheet Flow

| | | | | |
|---|---|---|---|---|
| 1. Surface description | Rock Mul | | | |
| 2. Manning's RC (n) | 0.3 | | | |
| 3. Flow length, L | 100 | ft (MAX IS 300) | | |
| 4. rainfall | 3.2 | in | Suggested: | 3.3 in |
| Beginning Elevation | 9315 | | | |
| Ending Elevation | 9313 | | | |
| 5. Land slope, s | 0.0200 | ft/ft | | |
| 6. Tt = 0.007(nl)^.8/(p2^.5*s^.4) | 0.284 | hr | 17.1 | min |

B. Shallow Concentrated Flow

| | | | | |
|---|---|---|---|---|
| 7. Surface description | Unpaved | | | |
| 8. Flow length, L | 300 | ft | | |
| Beginning Elevation | 9313 | | | |
| Ending Elevation | 9308 | | | |
| 9. Watercourse slope, s | 0.02 | ft/ft | | |
| 10. Average Velocity, V | 2.3 | ft/s | | |
| 11. Tt= L/(3600V) | 0.036 | hr | 2.2 | min |

C. Channel Flow

| | | | | |
|---|---|---|---|---|
| Q (base flow from u/s subarea) | 0 | | | |
| Q (calculated - guess on first iteration) | 5.3 | (use about 1/4 of calculated Q at end of channel): | | 5.3 cfs |
| Q (total) | 5.3 | | | |
| Q (adjust flow area so to match this Q to a | 5.4 | | | |
| 12. Cross section flow area, a | 2.2 | ft2 | | |
| 13. Wetted perimeter, pw | 4.6 | ft (calculated) | Assumes V channel, 2H:1V) | |
| 14. Hydraulic radius, r=a/pw | 0.46 | ft | | |
| Beginning Elevation | 9308 | | | |
| Ending Elevation | 9230 | | | |
| 15. Channel slope, s | 0.02 | (note:slope set at 2% for majority of channel) | | |
| 16. Mannings RC, n | 0.05 | | | |
| 17. V=1.49[(r^2/3)s^.5]/n | 2.52 | ft/s | | |
| 18. Flow Length | 1250 | ft | | |
| 19. Tt= L/3600V | 0.14 | hr | 8.3 | min |

D. Subarea Tc

| | | | | |
|---|---|---|---|---|
| 20. Tt | 0.46 | hr | 27.5 | min |

E. Basin Statistics

| | | |
|---|---|---|
| Elevation Drop: | 85 | ft |
| Horizontal Flow Length: | 1650 | ft |

## *Summary of Results*

Job: 101.9502
Project: Rico
By: ACJ
Location: Argentine Tailings
Basin: Pile runoff Area A,B and C

**Regional Regression Analyses**

| | | |
|---|---|---|
| Basin Area: | 11.5 acres | 0.02 sq. mi. |
| Q: | 5.9 cfs | |

**Rational Method**

| | |
|---|---|
| Q: | 21.8 cfs |

## *Time of Concentration by TR-55 Methodology*

Job: 101.9502
Project: Rico
By: ACJ
Location: Argentine Tailings
Basin: Pile runoff Area A,B and C

Storm analyzed: 100 yr 6 hr

A. Sheet Flow

| | | | | |
|---|---|---|---|---|
| 1. Surface description | Rock Mul | | | |
| 2. Manning's RC (n) | 0.3 | | | |
| 3. Flow length, L | 100 | ft (MAX IS 300) | | |
| 4. rainfall | 3 | in | Suggested: | 3.0 in |
| Beginning Elevation | 9315 | | | |
| Ending Elevation | 9313 | | | |
| 5. Land slope, s | 0.0200 | ft/ft | | |
| 6. Tt = 0.007(nl)^.8/(p2^.5*s^.4) | 0.294 | hr | 17.6 min | |

B. Shallow Concentrated Flow

| | | | |
|---|---|---|---|
| 7. Surface description | Unpaved | | |
| 8. Flow length, L | 300 | ft | |
| Beginning Elevation | 9313 | | |
| Ending Elevation | 9308 | | |
| 9. Watercourse slope, s | 0.02 | ft/ft | |
| 10. Average Velocity, V | 2.3 | ft/s | |
| 11. Tt= L/(3600V) | 0.036 | hr | 2.2 min |

C. Channel Flow

| | | | | |
|---|---|---|---|---|
| Q (base flow from u/s subarea) | 0 | | | |
| Q (calculated - guess on first iteration) | 5.4 | (use about 1/4 of calculated Q at end of channel): | | 5.4 cfs |
| Q (total) | 5.4 | | | |
| Q (adjust flow area so to match this Q to a | 5.4 | | | |
| 12. Cross section flow area, a | 2.2 | ft2 | | |
| 13. Wetted perimeter, pw | 4.6 | ft (calculated) | Assumes V channel, 2H:1V) | |
| 14. Hydraulic radius, r=a/pw | 0.46 | ft | | |
| Beginning Elevation | 9308 | | | |
| Ending Elevation | 9200 | | | |
| 15. Channel slope, s | 0.02 | (note:slope set at 2% for majority of channel) | | |
| 16. Mannings RC, n | 0.05 | | | |
| 17. V=1.49[(r^2/3)s^.5]/n | 2.52 | ft/s | | |
| 18. Flow Length | 1750 | ft | | |
| 19. Tt= L/3600V | 0.19 | hr | 11.6 min | |

D. Subarea Tc

| | | | |
|---|---|---|---|
| 20. Tt | 0.52 | hr | 31.4 min |

E. Basin Statistics

| | | |
|---|---|---|
| Elevation Drop: | 115 | ft |
| Horizontal Flow Length: | 2150 | ft |

| | |
|---|---|
| Job: | 101.9502 |
| Project: | Rico Technical Services |
| By: | ACJ |

| | |
|---|---|
| Re: | Design Q, 100 yr, 6 hour design storm |
| Location: | Argentine Tailings 0 |
| Basin: | Pile runoff Area A,B and C |

**Inputs**

| | | |
|---|---|---|
| Storm Recurrence Interval | 100 | yrs |
| Runoff Coefficient (C) | 0.50 | |
| Basin Area: | 11.5 | acres |
| Maximum Length of water travel: | 2150 | ft |
| TR-55 calculated time of concentration: | 31.4 | min |
| Time of concentration factor: | 2.0 | (for use in adjusting Kirpich formula) |

Rainfall Intensity-Duration Curve

| Duration (D, hrs) | (min) | I(in/hr) | dI/dD |
|---|---|---|---|
| 0.083 | 5 | 6.75 | -17.76 |
| 0.167 | 10 | 5.27 | -9.96 |
| 0.250 | 15 | 4.44 | -5.44 |
| 0.500 | 30 | 3.08 | -2.26 |
| 1.000 | 60 | 1.95 | -2.26 |

**Work Area**

Antecedent Precipitation Factors

| Recurrence Interval (yrs) | Ca |
|---|---|
| 2 | 1 |
| 10 | 1 |
| 25 | 1.1 |
| 50 | 1.2 |
| 100 | 1.25 |

| | |
|---|---|
| Ikey | 0.5 |
| Ibase | 3.08 |
| Idelta | -2.26 |

**Results**

| | | | | | |
|---|---|---|---|---|---|
| Height drop of water travel: | 115 | ft | | | |
| Antecedent Precipitation Factor (Ca) | 1.25 | | | | |
| C * Ca | 0.63 | | | | |
| Basin Slope: | 5.3% | | | | |
| Time of Concentration (Tc): | 0.30 | hrs | 17.7 | min | (Kirpich formula) |
| Tc for analysis: | 0.52 | hrs | 31.4 | min | (max of Kirpich or TR-55) |
| Average Water Velocity: | 2.0 | ft/s | | | |
| Intensity (I) | 3.0 | in/hr | | | |
| Q (=CCaIA) | 21.8 | cfs | | | |

## *Summary of Results*

Job: 101.9502
Project: Rico
By: ACJ
Location: Silver Creek
Basin: 0

**Regional Regression Analyses**

| | | | |
|---|---|---|---|
| Basin Area: | 4000 | acres | 6.25 sq. mi. |
| Q: | 378.4 | cfs | |

**TR-55 Method**

| | | |
|---|---|---|
| Q: | 408.0 | cfs |

**Rational Method**

| | | |
|---|---|---|
| Q: | 1205.2 | cfs |

GRAPHICAL PEAK DISCHARGE METHOD Version 2.00

Project : rico User: acj Date: 07-28-95
C[illegible] : dOLORES State: co Checked: ____ Date: _____
S[illegible]tle:

Data: Drainage Area : 6.25 Sq Mi
Runoff Curve Number : 53
Time of Concentration: 0.98 Hours
Rainfall Type : II
Pond and Swamp Area : NONE

| Storm Number | 1 |
|---|---|
| Frequency (yrs) | 100 |
| 24-Hr Rainfall (in) | 3.75 |
| Ia/P Ratio | 0.47 |
| Runoff (in) | 0.36 |
| Unit Peak Discharge (cfs/sqmi/in) | 181 |
| Pond and Swamp Factor 0.0% Ponds Used | 1.00 |
| Peak Discharge (cfs) | 408 |

## *Time of Concentration by TR-55 Methodology*

Job: 101.9502
Project: Rico
By: ACJ
Location: Silver Creek
Basin:

Storm analyzed: 100 yr 6 hr

A. Sheet Flow

| | | | | | |
|---|---|---|---|---|---|
| 1. Surface description | Woods | | | | |
| 2. Manning's RC (n) | 0.4 | | | | |
| 3. Flow length, L | 300 | ft (MAX IS 300) | | | |
| 4. rainfall | 2.4 | in | | Suggested: | 2.4 in |
| Beginning Elevation | 12681 | | | | |
| Ending Elevation | 12440 | | | | |
| 5. Land slope, s | 0.80 | ft/ft | | | |
| 6. Tt = 0.007(nl)^.8/(p2^.5*s^.4) | 0.227 | hr | 13.6 | min | |

B. Shallow Concentrated Flow

| | | | | |
|---|---|---|---|---|
| 7. Surface description | Unpaved | | | |
| 8. Flow length, L | 1500 | ft | | |
| Beginning Elevation | 12440 | | | |
| Ending Elevation | 12000 | | | |
| 9. Watercourse slope, s | 0.29 | ft/ft | | |
| 10. Average Velocity, V | 2.3 | ft/s | | |
| 11. Tt= L/(3600V) | 0.181 | hr | 10.9 | min |

C. Channel Flow

| | | | | | |
|---|---|---|---|---|---|
| Q (base flow from u/s subarea) | 0 | | | | |
| Q (calculated - guess on first iteration) | 301.3 | (use about 1/4 of calculated Q at end of channel): | | | 301.3 cfs |
| Q (total) | 301.3 | | | | |
| Q (adjust flow area so to match this Q to a | 302.1 | | | | |
| 12. Cross section flow area, a | 21.1 | ft2 | | | |
| 13. Wetted perimeter, pw | 14.5 | ft (calculated) | | Assumes V channel, 2H:1V) | |
| 14. Hydraulic radius, r=a/pw | 1.45 | ft | | | |
| Beginning Elevation | 12000 | | | | |
| Ending Elevation | 9200 | | | | |
| 15. Channel slope, s | 0.14 | | | | |
| 16. Mannings RC, n | 0.05 | | | | |
| 17. V=1.49[(r^2/3)s^.5]/n | 14.32 | ft/s | | | |
| 18. Flow Length | 20000 | ft | | | |
| 19. Tt= L/3600V | 0.39 | hr | 23.3 | min | |

D. Subarea Tc

| | | | | |
|---|---|---|---|---|
| 20. Tt | 0.80 | hr | 47.8 | min |

E. Basin Statistics

| | | |
|---|---|---|
| Elevation Drop: | 3481 | ft |
| Horizontal Flow Length: | 21800 | ft |

file SH1-1

## *Time of Concentration by TR-55 Methodology*

Job: 101.9502
Project: Rico
By: ACJ
Location: Silver Creek
Basin:

Storm analyzed: 100 yr 6 hr

A. Sheet Flow

| | | | | |
|---|---|---|---|---|
| 1. Surface description | Woods | | | |
| 2. Manning's RC (n) | 0.4 | | | |
| 3. Flow length, L | 300 | ft (MAX IS 300) | | |
| 4. rainfall | 1.6 | in | Suggested: | 1.6 in |
| Beginning Elevation | 12681 | | | |
| Ending Elevation | 12440 | | | |
| 5. Land slope, s | 0.80 | ft/ft | | |
| 6. Tt = 0.007(nl)^.8/(p2^.5*s^.4) | 0.278 | hr | 16.7 | min |

B. Shallow Concentrated Flow

| | | | | |
|---|---|---|---|---|
| 7. Surface description | Unpaved | | | |
| 8. Flow length, L | 1500 | ft | | |
| Beginning Elevation | 12440 | | | |
| Ending Elevation | 12000 | | | |
| 9. Watercourse slope, s | 0.29 | ft/ft | | |
| 10. Average Velocity, V | 2.3 | ft/s | | |
| 11. Tt= L/(3600V) | 0.181 | hr | 10.9 | min |

C. Channel Flow

| | | | | |
|---|---|---|---|---|
| Q (base flow from u/s subarea) | 0 | | | |
| Q (calculated - guess on first iteration) | 94 | (use about 1/4 of calculated Q at end of channel): | | 200.1 cfs |
| Q (total) | 94 | | | |
| Q (adjust flow area so to match this Q to a | 94.0 | | | |
| 12. Cross section flow area, a | 8.8 | ft2 | | |
| 13. Wetted perimeter, pw | 9.4 | ft (calculated) | Assumes V channel, 2H:1V) | |
| 14. Hydraulic radius, r=a/pw | 0.94 | ft | | |
| Beginning Elevation | 12000 | | | |
| Ending Elevation | 9200 | | | |
| 15. Channel slope, s | 0.14 | | | |
| 16. Mannings RC, n | 0.05 | | | |
| 17. V=1.49[(r^2/3)s^.5]/n | 10.68 | ft/s | | |
| 18. Flow Length | 20000 | ft | | |
| 19. Tt= L/3600V | 0.52 | hr | 31.2 | min |

D. Subarea Tc

| | | | | |
|---|---|---|---|---|
| 20. Tt | 0.98 | hr | 58.8 | min |

E. Basin Statistics

| | | |
|---|---|---|
| Elevation Drop: | 3481 | ft |
| Horizontal Flow Length: | 21800 | ft |

file SH1-1

| | |
|---|---|
| **Job:** | 101.9502 |
| **Project:** | Rico Technical Services |
| **By:** | ACJ |
| **Re:** | Design Q, 100 yr, 6 hour design storm |
| **Location:** | Silver Creek 0 |
| **Basin:** | 0 |

**Inputs**

| | | |
|---|---|---|
| Storm Recurrence Interval | 100 | yrs |
| Runoff Coefficient (C) | 0.10 | |
| Basin Area: | 4000 | acres |
| Maximum Length of water travel: | 21800 | ft |
| TR-55 calculated time of concentration: | 47.8 | min |
| Time of concentration factor: | 2.0 | (for use in adjusting Kirpich formula) |

Rainfall Intensity-Duration Curve

| Duration (D, hrs) | (min) | I(in/hr) | dI/dD |
|---|---|---|---|
| 0.083 | 5 | 6.75 | -17.76 |
| 0.167 | 10 | 5.27 | -9.96 |
| 0.250 | 15 | 4.44 | -5.44 |
| 0.500 | 30 | 3.08 | -2.26 |
| 1.000 | 60 | 1.95 | -2.26 |

**Work Area**

Antecedent Precipitation Factors

| Recurrence Interval (yrs) | Ca |
|---|---|
| 2 | 1 |
| 10 | 1 |
| 25 | 1.1 |
| 50 | 1.2 |
| 100 | 1.25 |

| | |
|---|---|
| Ikey | 0.5 |
| Ibase | 3.08 |
| Idelta | -2.26 |

**Results**

| | | | | |
|---|---|---|---|---|
| Height drop of water travel: | 3481 | ft | | |
| Antecedent Precipitation Factor (Ca) | 1.25 | | | |
| C * Ca | 0.13 | | | |
| Basin Slope: | 16.0% | | | |
| Time of Concentration (Tc): | 1.15 | hrs | 69.3 min | (Kirpich formula) |
| Tc for analysis: | 0.80 | hrs | 47.8 min | (max of Kirpich or TR-55) |
| Average Water Velocity: | 5.2 | ft/s | | |
| Intensity (I) | 2.4 | in/hr | | |
| Q (=CCaIA) | 1205.2 | cfs | | |

## *Summary of Results*

Job: 101.9502
Project: Rico
By: ACJ
Location: Argentine Tailings
Basin: Pile runoff Area A and B

**Regional Regression Analyses**

| | | |
|---|---|---|
| Basin Area: | 10.3 acres | 0.02 sq. mi. |
| Q: | 5.5 cfs | |

**Rational Method**

| | |
|---|---|
| Q: | 21.3 cfs |

# B1B SILVER CREEK HYDROLOGY

MEMORANDUM

TO: FILE

PROJECT: RICO SITE
ENVIRONMENTAL SUPPORT
SERVICES

FROM: GEA

JOB: 101-9502

DATE: 5/8/95

RE: VALIDATION OF HYDROLOGIC REPORTS AT THE RICO SITE

Review of Existing Hydrologic Studies

Overview
Two existing reports address the hydrology of the Dolores River Basin in the Rico area .

1.) Flood Hazard Areas Anaconda Mining Sites
Dolores River And Silver Creek
Rico, Colorado
Dames and Moore, January 1981

2.) Report on Environmental liability Assessment
of Rico-Argentine Mining Company
Rico, Colorado
Camp Dresser & McKee (CDM)
September 1979

FLOOD MAGNITUDE ANALYSIS OF THE DOLORES RIVER AND SILVER CREEK.

Dames and Moore:

The Dames and Moore report's objective was to determine the floods with recurrence intervals of 2, 10, 50, 100, 200, 500 intervals, the Standard Project Flood, and define the flood plain for the 100 year and SPF at the mine sites under existing conditions. Several methodologies were used to determine flood estimates within the range of frequencies listed above.

A.) Floods with Return Periods

1.) Frequency analysis: Annual maximum flows from the USGS gage below Rico (USGS No.09165000) were used to develop flood estimates with the specified recurrence intervals. At that point in time (1980) the gage had a data record of 29 years. Appropriate methodologies were used to assess the adequacy of the data set

for statistical analyses. These included tests for: reliability, trends, shifts and independence. Analysis indicated the presence of one low outlier and data was correspondingly adjusted. A Log Pearson Type III distribution was used in the analysis. Peak flows from the frequency analysis were then adjusted according to the expected probability method. Results are shown in Table 1.

2.) Regional Regression Analysis: Regression equations developed from regional data by the Colorado Water Conservation Board associate annual flood peaks as a function of drainage basin area. This methodology was used both on the Dolores River and Silver Creek. Table 1 contains the results.

3.) Snowpack Water Equivalent Regression Analysis: A regression analysis was performed using snow water content on April 1 and annual flood peaks as parameters. Data records from three snow course sites in the Dolores river basin were utilized. Record lengths for the snow sites were 45 years, 36 years and 45 years. A frequency analysis was then conducted using a Log Pearson Type III distribution to determine snow-water contents for given return periods. The assumption was then made that the given water content and return period would produce a flood having the same return period. These water contents were then used in the regression equation correlating flows with snow water content. Results are listed in Table 1.

4.) Hec-1 Analysis: A Hec-1 analysis was conducted using the Degree - Day Method to generate a basin hydrograph from the snow melt runoff. Two simulations for two return periods were conducted. One used the water content with a 10 year and 100 year return period in conjunction with the mean temperature. The other simulation used the mean water content with temperatures having return periods of 10 years and 100 years. Hec-1 input files were not provided in the report therefore no review of input data was conducted. Results are listed in Table 1.

B.) Standard Project Flood: In order to estimate the SPF a Hec-1 analysis was conducted for the Dolores River and Silver Creek using the PMP to generate the PMF. The SPF was then taken as 50% of the PMF. While the snowmelt was identified as the mechanism for annual floods the PMF was based upon a rainfall induced event. The PMP was obtained from the "Army Corps of Engineers Hydrometeorlogical Report No. 49". Results are listed in Table 1

Camp Dresser & McKee

The CDM report's purpose was to determine necessary corrective measures needed to correct the former mining and manufacturing site in Rico. A portion of this study addressed peak flows with return periods for Silver Creek and the Dolores River.

A.) Floods with Return Periods

1.) Frequency Analysis: No apparent frequency analysis was conducted by CDM on the Rico gage data. CDM does provide a an exceedence curve (Figure 2) based upon flow records from the Dolores River below Rico gage. No reference/discussion is provided on the development or source of Figure 2. Data from Figure 2 is used in the regional regression analysis.

2.) Regional Regression Analysis: CDM used two regional regression methods to estimate peak flows for Silver Creek and the Dolores River. They confined their estimate to the flood with a 100 year return period. Both regional regression analyses relate peak flows with a specified return period to drainage basin area. One analysis was conducted by CDM the other by the State of Colorado Water Conservation Board. Limited information is provided on the development of the CDM analysis. Results are presented in Table 2.

Comments

The Dames and Moore report provides a rigorous peak flow analysis using several different methodologies. Certain assumptions used in the analyses have weaknesses (i.e. flood frequency equal to the snow-water content/temperature frequency). However the overall agreement between methods indicate estimates are reasonable.

The CDM peak flow analysis is not as robust or documented as well as the analysis conducted by Dames and Moore but yields similar results for the return periods examined. CDM's overall agreement with the Dames and Moore estimates provides additional confidence for the peak flow estimates.

Both reports identify the annual floods on the Dolores and Silver Creek as snow-melt induced. Report data from the USGS Dolores River Below Rico indicate annual maximum flows occur in the spring from May 3 through June 19. There is one annual maximum in the data record which occurred in the fall (9/6/70) of 1930 cfs indicating the event was most likely rain induced. CDM's report notes that regionally most annual floods are snow-melt induced during the spring but are smaller in magnitude than the infrequent floods during September and October which would be rain induced. This is also stated in the State of Colorado's Technical Manual No. 1 for the Southern Plateau Region. The SPF and the PMF would most likely be rain induced.

For floods on the Dolores River with return periods the frequency analysis conducted by Dames and Moore provides the best estimate because it is based upon actual data.
For floods on Silver Creek it is necessary to use estimates based upon the regional regression analysis. Considering the good agreement between the regional regression analysis and the frequency analysis for the Dolores River, the regional regression methodology should yield a reasonable peak flow estimate on Silver Creek.

Hec-2 Review

Dames and Moore conducted a Hec-2 analysis for the Dolores River and Silver Creek for the 100 year and the SPF events. Both subcritical and supercritical simulations were conducted. Input/output (I/O) data were reviewed in detail for the 100 year subcritical profile. The review considered:

- Output Error Statements
- Reach lengths and Cross Section Spacing
- Mannings n Values
- Expansion/Contraction Coefficients
- Bridge Routines
- Discharge Changes at Stream Junctions
- Supercritical Reaches

Lack of input data in an ASCII format somewhat limited the review.

Output for the subcritical profiles is generally free from any significant errors. Cross-section spacing appears adequate. Cross-sections are orientated looking upstream, opposite the standard downstream orientation. Overbank reach lengths are the same as the channel reach lengths in effect simulating a straight flood channel. This does not represent the actual system nor the cross-sections illustrated in Plates 7 through 13. Reach lengths should represent changes in direction of the mass flow path. Mannings n values appear reasonable but should be validated through photographs or a field visit. Expansion and contraction coefficients were not adjusted for bridge locations. The sensitivity of the profile simulation to these expansion contraction coefficients varies based upon the velocities. Usually changes in the expansion/contraction coefficients result in small changes in flood stage. Normal bridge routines were used throughout the profile simulation, including the culverts on Silver Creek (n values were changed through the culvert to represent coated metal). Output data indicates the bridge near the Santa Cruz mine would be overtopped during the 100 year flood as well as the culverts in Silver Creek. No discharge adjustment is made at the junction of Silver Creek and the Dolores, therefore profile calculations upstream of the Silver Creek/Dolores confluence represent the full magnitude of the 100 year flood (i.e. includes contribution from Silver Creek, a conservative simplification). Output data indicates supercritical flow in Silver Creek reach adjacent to the upper three ponds (this reach includes velocities of 40 fps during the 100 year flood). Output for the Dolores profile indicates a supercritical reach immediately downstream of the Route 145 bridge.

Comments

The profile analysis appears to yield reasonable results for existing conditions in 1979. The most significant weakness is in the representation of the overbank reach lengths which fails to account for changing flow path lengths in the overbank areas. As these reach lengths are used to calculate energy losses between cross-sections, this could effect computed water surface elevations. Recommended expansion/contraction coefficients should be utilized

anywhere significant expansions or contractions exist.

For preliminary design the existing analyses should be adequate for final design refinements may be necessary.

Recommended Additional Work

Assuming the Dolores River USGS gage has been active since 1980, the additional data would increase the data record by almost 50% (14 years). Revaluating the frequency analysis would provide the best estimate for peak flows with return periods.

Any revisions/updates to the State of Colorado's regional regression analysis should be utilized to provide the best estimate for the Silver Creek peak flows with return frequencies.

If a design flood other than the 100 year or the SPF is chosen additional profile simulations will be required.

Changes/improvements in the Silver Creek channel and their affect on the profile and channel velocities should be investigated.

Any design features encroaching on the flood plain should be simulated.

Summary

Two reports containing hydrologic analyses were reviewed for adequacy. Both contained flood frequency analyses that were in good agreement utilizing several methodologies. Thus the flood frequency estimates are considered to be reasonable values based upon strong analyses. An updated flood frequency analysis is recommended based upon the additional record length of flow data on the Dolores River Rico gage. The Dames and Moore report also conducted a river profile analysis using the Hec-2 model. Profiles were calculated for the 100 year flood and the SPF on the Dolores river and Silver Creek. The simulations have some deficiencies but appear adequate for preliminary design work. Design flows other than the 100 year and the SPF and/or design features encroaching into the flood plain will require modification of the existing simulations.

05/12/95

TABLE 1
DOLORES RIVER PEAK FLOW SUMMARY

DAMES AND MOORE

| RETURN PERIOD (YRS) | PEAK FLOWS FREQUENCY ANALYSIS LP III PEAK FLOW (CFS) | EXPECTED PROBABILITY (CFS) | PEAK FLOWS REGIONAL REGRESSION ANALYSIS AREA DEPENDENT (ST. OF COLO.) (CFS) | WATER CONTENT DEPENDENT (CFS) | HEC-1 ANALYSIS VARYING TEMPERATURE (CFS) | VARYING WATER CONTENT (CFS) | PMF (CFS) | SPF (CFS) |
|---|---|---|---|---|---|---|---|---|
| 2 | 1249 | 1249 | 1280 | 1230 | | | | |
| 10 | 1871 | 1920 | 1865 | 1752 | 1942 | 1837 | | |
| 50 | 2395 | 2480 | 2390 | 2028 | | | | |
| 100 | 2604 | 2720 | 2690 | 2120 | 3064 | 2014 | | |
| 200 | 2810 | 2960 | 3100 | 2192 | | | | |
| 500 | 3075 | 3400 | 3783 | 2275 | | | | |
| > 10000 | | | | | | | 15846 | 7900 |

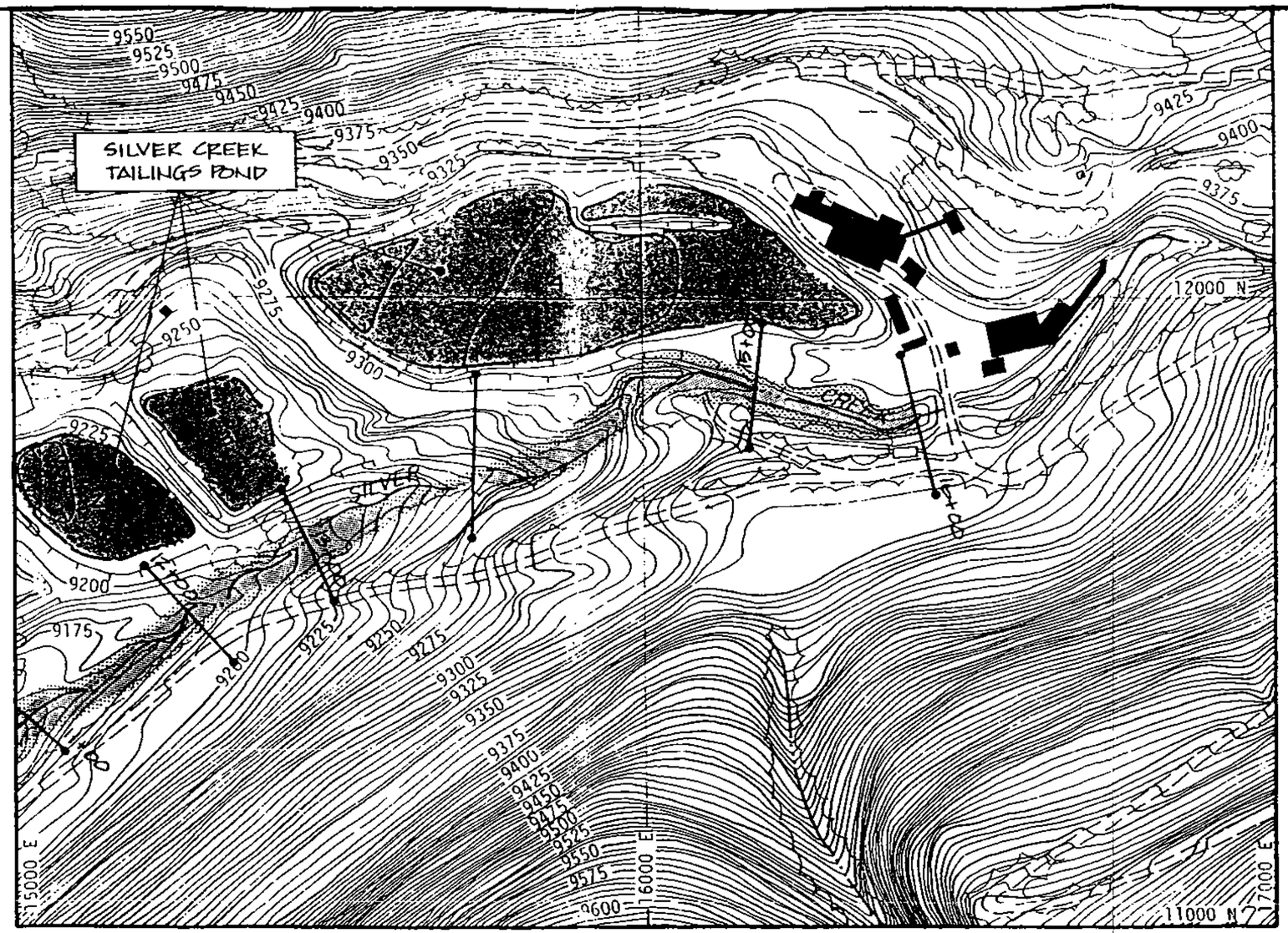
CAMP DRESSER AND McKEE

| RETURN PERIOD (YRS) | PEAK FLOWS REGIONAL REGRESSION ANALYSIS AREA DEPENDENT CDM (CFS) | ST OF COLO (CFS) |
|---|---|---|
| 2 | | |
| 10 | | |
| 50 | | |
| 100 | 2700 | 2862 |
| 200 | | |
| 500 | | |

TABLE 2

SILVER CREEK PEAK FLOW SUMMARY

| | DAMES AND MOORE | | | CAMP DRESSER AND McKEE | |
|---|---|---|---|---|---|
| RETURN PERIOD | REGRESSION ANALYSIS | HEC-1 | | PEAK FLOWS REGIONAL REGRESSION ANALYSIS | |
| | AREA DEPENDENT (ST. OF COLO.) | PMF | SPF | AREA DEPENDENT | |
| | | | | CDM | ST OF COLO |
| (YRS) | (CFS) | (CFS) | (CFS) | (CFS) | (CFS) |
| 2 | 200 | | | | |
| 10 | 305 | | | | |
| 50 | 456 | | | | |
| 100 | 528 | | | 530 | 494 |
| 200 | 600 | | | | |
| 500 | 703 | | | | |
| > 10000 | | 4000 | 2000 | | |




Dames & Moore, 1981

NOTES

1 Horizontal and vertical datum based on Anaconda coordinate system

2 Limits of overflow may vary due to accuracy of topographic mapping

SCALE IN FEET

200 100 0 200 400

1" = 200'

CONTOUR INTERVAL = 5 FEET

MAP FROM INTRASEARCH TOPOGRAPHIC MAP
DATE: AUGUST 17, 1980

FLOODPLAIN LIMITS

LOW WATER CHANNEL | 100 YEAR FLOOD | STANDARD PROJECT FLOOD

POND AREA

555+00 CROSS SECTION

N

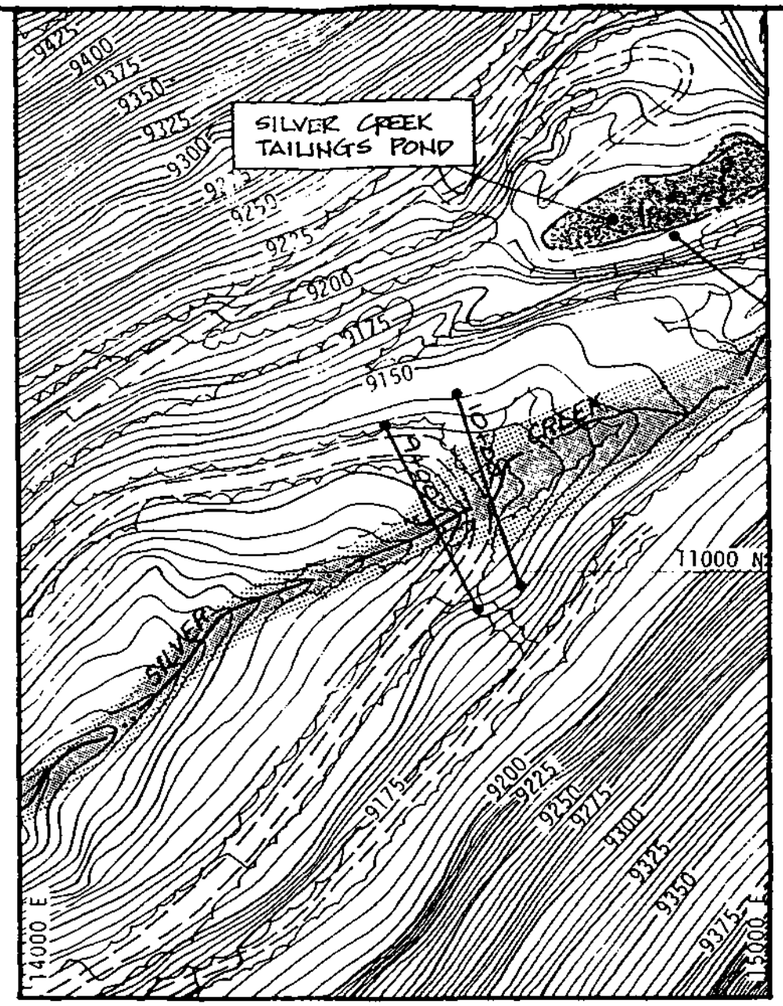
INDEX MAP LOCATION

FLOODED AREAS

SILVER CREEK
RICO, COLORADO

DECEMBER, 1980

Dames & Moore




Dames & Moore, 1981

NOTES

1. Horizontal and vertical datum based on Anaconda coordinate system
2. Limits of overflow may vary due to accuracy of topographic mapping

SCALE IN FEET

200 100 0 200 400

1" = 200'

CONTOUR INTERVAL = 5 FEET

MAP FROM INTRASEARCH TOPOGRAPHIC MAP
DATE: AUGUST 17, 1980

FLOODPLAIN LIMITS

LOW WATER CHANNEL | 100 YEAR FLOOD | STANDARD PROJECT FLOOD

POND AREA

555+00 CROSS SECTION

N

INDEX MAP LOCATION

# FLOODED AREAS

SILVER CREEK
RICO, COLORADO
DECEMBER, 1980

Dames & Moore

# B2 HYDRAULIC FACILITIES

ARMY COE 1991 METHOD
SILVER CREEK - 100 YR Q

$V_{cv}$ = 12 FPS AT HEC-2 STA 1000 (SUPERCRITICAL)

$\left.\begin{array}{l} R = 150 \\ W = 50 \end{array}\right\} \Rightarrow V_{ss}/V_{cv} = 1.5$ FROM PLATE B-33

$V_{ss} = (1.5)(12) = 18$ FPS

$Y = 3$ FT

$$D_{30} = S_f C_s C_v C_T Y \left\{ \left(\frac{\gamma_w}{\gamma_s - \gamma_w}\right)^{1/2} \frac{V_{ss}}{\sqrt{K_1 g Y}} \right\}^{2.5}$$

$S_f = 1.1$
$C_s = 0.3$
$C_v = 1.283 - 0.2 \log(R/W)$ FOR CURVED CHANNEL
$C_T = 1$
$Y = 3$
$\gamma_w = 62.4$ lb/ft$^3$
$\gamma_s = 165$ lb/ft$^3$

$K_1 = \sqrt{\dfrac{1 - \sin^2\theta}{\sin^2\phi}}$ WHERE $\theta = \tan^{-1} 1/2 = 26.6° \approx 30°$
$\phi = 40°$ (REPOSE ANGLE)

$K_1 = 1.35$

$C_v = 1.283 - 0.2 \log(3) = 1.19$

$$D_{30} = (1.1)(0.3)(1.19)(1)(3) \left\{ 0.78 \left(\frac{18}{\sqrt{(1.35)(32.2)(3)}}\right) \right\}^{2.5}$$

$\underline{\underline{D_{30} = 1.97 \text{ FT}}}$ FOR OUTSIDE BEND (CURVED SECTION)

FOR STRAIGHT CHANNEL SECTION $C_v = 1$
$\Rightarrow$

$\underline{\underline{D_{30} = 1.66 \text{ FT}}}$ FOR STRAIGHT AND INSIDE CURVATURE SECTION

# ESA Consultants

JOB NO. 101 9502 SUBJECT RIP RAP GRADATION SHEET NO. ____ OF ____

PROJECT RICO SILVER CREEK BY GEH DATE 6-22-95

USE SIMONS & SENTURK GRADATION METHOD

OUTSIDE BEND

$$D_{30} = 0.65\, D_{50} \Rightarrow D_{50} = \frac{D_{30}}{0.65} = \frac{1.97}{0.65} = 3.03 \text{ FT}$$

STRAIGHT AND INSIDE CURVATURE

$$D_{30} = 0.65\, D_{50} \Rightarrow D_{50} = \frac{1.66}{0.65} = 2.55 \text{ FT}$$

SOURCE FILE :SCRIPRAP.WQ2
07/27/95
RIPRAP GRADATION FOR FLOOD PROTECTION DIKES ON SILVER CREEK
BASED ON ARMY COE 1991 METHOD AND SIMONS AND SENTURK GRADATION

| | D30 (FT) | D50 (FT) |
|---|---|---|
| STRAIGHT CHANNEL 1V:2H | 1.66 | 2.55 |
| CURVED CHANNEL 1V:2H | 1.97 | 3.03 |

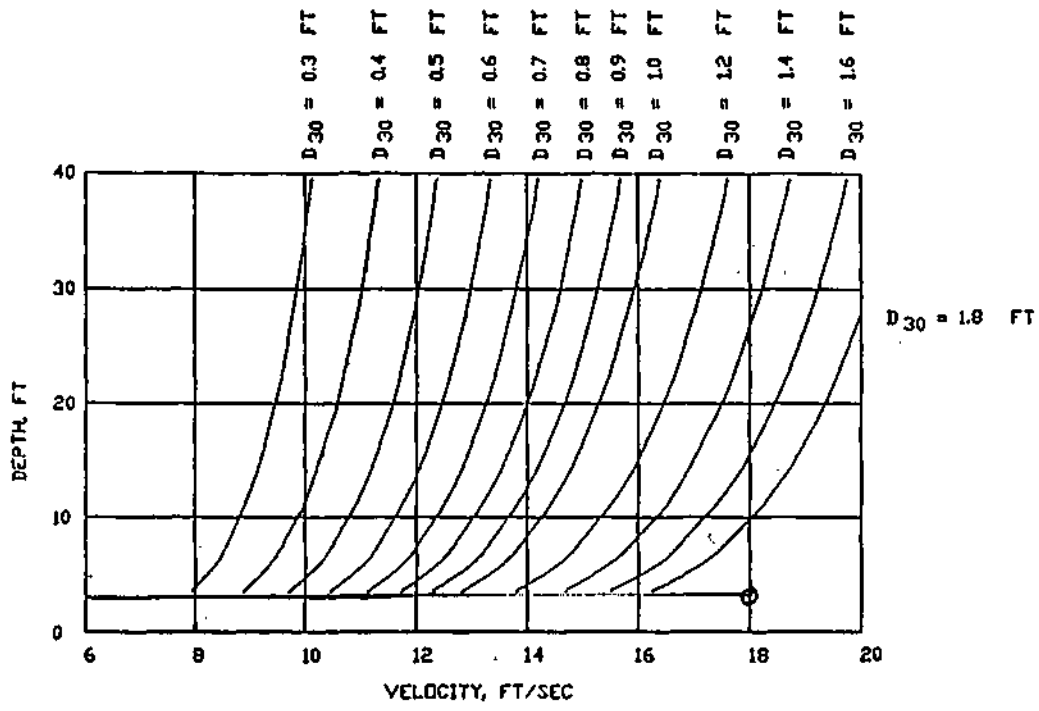
| STRAIGHT CHANNEL SECTION | | | CURVED CHANNE |
|---|---|---|---|
| %FINER | D50 COEFF | 1V:2H PARTICLE SIZE (IN) | 1V:2H PARTICLE SIZE (IN) |
| 0 | 0.25 | 7.6615385 | 9.0923077 |
| 10 | 0.35 | 10.726154 | 12.729231 |
| 20 | 0.5 | 15.323077 | 18.184615 |
| 30 | 0.65 | 19.92 | 23.64 |
| 40 | 0.8 | 24.516923 | 29.095385 |
| 50 | 1 | 30.646154 | 36.369231 |
| 60 | 1.2 | 36.775385 | 43.643077 |
| 70 | 1.6 | 49.033846 | 58.190769 |
| 90 | 1.8 | 55.163077 | 65.464615 |
| 100 | 2 | 61.292308 | 72.738462 |

SOURCE FILE: SFRIPRAP.WQ2
FILE TO CALCULATE RIPRAP BASED UPON THE SAFETY FACTOR METHOD
REFERENCE: FISKE, HIGH AND WITTLER;DESIGN OF RIPRAP EROSION MITIGATION SYSTE
WESTERN MINING CONFERENCE, NOVEMBER 1993

| INPUT | RAD | | |
|---|---|---|---|
| THETA | 0.462512 | | |
| PHI | 0.698132 | | |
| Gs | 2.65 | | |
| s | 0.08 | 0.07983 | (LAMBDA) |
| GAMMA | 62.4 | | |
| D50 | 6 | | |
| Y | 3 | | |

| OUTPUT | | | |
|---|---|---|---|
| SHEER ST | 14.976 | | |
| NADA | 0.509091 | | 617.76 |
| NADA' | 0.378954 | | |
| BETA | 0.430823 | 24.68433 | 0.459617 |

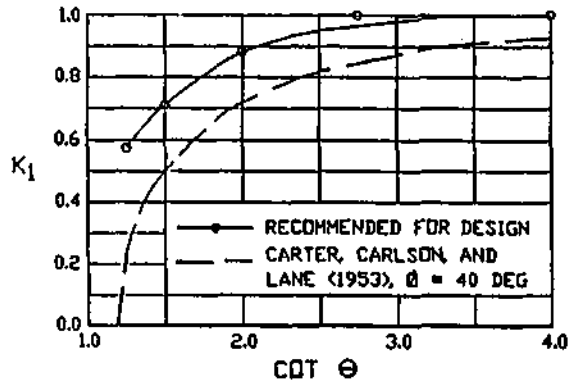
| | |
|---|---|
| SF | 1.038061 |

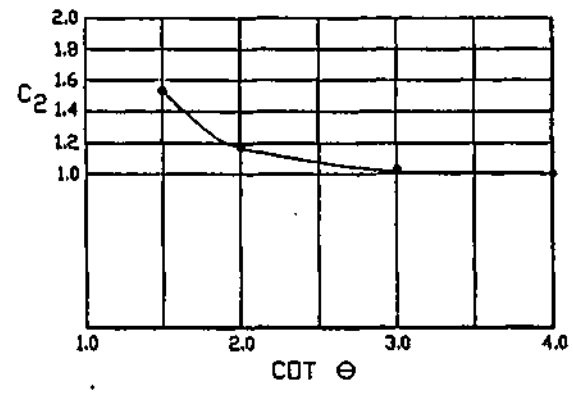



NOTE: APPLICABLE TO THICKNESS $1D_{100}$ (max) AND CHANNEL BOTTOMS OR SIDE SLOPES FLATTER THAN OR EQUAL TO 1V ON 4H. STONE WEIGHT 165 pcf, $C_S$ = 0.30, $C_V$ = $C_T$ = 1.0 $S_f$ = 1.1 BASED ON EQUATION 3-3.

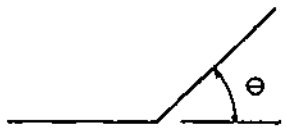
DEPTH-AVERAGED VELOCITY
VS D30
AND DEPTH

PLATE B-37




$K_1$ = SIDE SLOPE CORRECTION COEFFICIENT FOR USE IN EQUATION 3-3 ONLY.



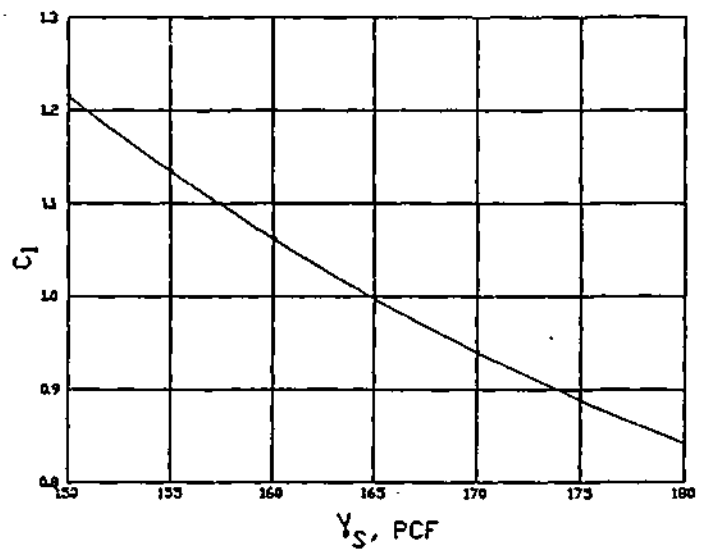

$D_{30}$ = $C_2$*($D_{30}$ FROM PLATE 37)

WHERE $C_2$ = CORRECTION FOR SIDE SLOPE ANGLE

NOTE : DO NOT MAKE THIS CORRECTION IF $D_{30}$ COMPUTED FROM EQUATION 3-3.

CORRECTION FOR SIDE SLOPE ANGLE

PLATE B-39




$D_{30}$ = $C_1$ *($D_{30}$ FROM PLATE 37)

WHERE $C_1$ = CORRECTION FOR UNIT STONE WEIGHT

NOTE: DO NOT MAKE THIS CORRECTION IF
$D_{30}$ COMPUTED FROM EQUATION 3-3

CORRECTION FOR UNIT STONE WEIGHT

PLATE B-38

# B3 GEOTECHNICAL DATA

# ESA Consultants

JOB NO. 101.9502.040 SUBJECT Silver Cr. Tailings - Material Properties Summary for Tailings Material. SHEET NO. 1 OF

PROJECT Rico BY DJM DATE 5-23-95

D.M Geotech (1981)

| | Boring | Depth (ft) | Description | $G_s$ | $\gamma_d$ (pcf) | w (%) | S (%) | e | Su or τ (psf) |
|---|---|---|---|---|---|---|---|---|---|
| Pond 1 West | B-9 | 20 | Grey Fine Sandy SILT | 3.2 | 106 | 13 | 47 | 0.88 | |
| | | 30 | " | [3.2] | 122 | 17 | 85 | 0.64 | |
| | | 40 | Grey Clayey SILT | [3.1] | 107 | 19 | 73 | 0.81 | |
| | | 50 | " | [3.1] | 107 | 24 | 92 | 0.81 | |
| | | 60 | " | 3.1 | 91 | 35 | 96 | 1.13 | 510* |
| | | 70 | " | [3.1] | 111 | 28 | 117? | 0.74 | 730* |
| | B-24 | 5 | Grey Silty Fine SAND | 3.6 | 133 | 4 | 21 | 0.69 | 820** (1000) |
| | | 15 | Grey Fine Sandy SILT | [3.1] | 106 | 9 | 34 | 0.83 | |
| | | 20 | " | 3.1 | 105 | 9 | 33 | 0.84 | 1740** (2500) |
| | | 40 | Grey Clayey SILT | [3.1] | 93 | 36 | 103 | 1.08 | |
| | | 50 | " | [3.1] | 97 | 34 | 106 | 1.00 | |
| | | 60 | " | [3.1] | 104 | 29 | 104 | 0.86 | |
| | B-26 | 5 | Grey Clayey SILT | [3.1] | 106 | 23 | 86 | 0.83 | |
| | | 15 | " | [3.1] | 88 | 39 | 101 | 1.20 | |
| Pond 1 South | B-23 | 15 | Br/Grey Fine Sandy SILT | [3.6] | 133 | 20 | 104 | 0.69 | |
| | | 25 | Grey " | [3.9] | 146 | 6? | 35 | 0.67 | |
| | | 35 | | 3.9 | 148 | 16 | 97 | 0.65 | 3100** (4000) |
| | | 36 | | [3.9] | 122 | 21 | 82 | 1.00 | |
| Pond 3 | B-21 | 5 | Br/Yel Sandy SILT; Silty SAND | 3.1 | 92 | 20 | 56 | 1.10 | |
| | | 10 | Br/Grey " " | [3.1] | 109 | 8 | 32 | 0.78 | |
| | | 17 | " " " | [3.1] | 102 | 10 | 35 | 0.90 | |
| | | 20 | Grey Clayey SILT | [3.1] | 91 | 38 | 105 | 1.13 | |
| | | 21 | " | [3.1] | 83 | 44 | 102 | 1.33 | |
| | | 26 | " | [3.1] | 93 | 37 | 106 | 1.08 | |
| | B-11 | 20 | Grey Fine Sandy SILT | 3.5 | 115 | 11 | 43 | 0.90 | 1200** (1500) |
| | | 30 | " (w/some clay) | [3.5] | 136 | 14 | 81 | 0.61 | |

| | | $G_s$ | $\gamma$ |
|---|---|---|---|
| Ave Values | Pond 1 (W) Sandy SILT | 3.15 | 123 |
| | (W) Clayey SILT | 3.1 | 130 |
| | (S) Sandy SILT | 3.9 | 158 |
| | Pond 3 (ML-SM) | 3.1 | 113 |
| | Clayey SILT | | 124 |
| | Sandy SILT | 3.5 | 141 |

* UU Triaxial

** Direct Shear (unfavorable)

# ESA Consultants

JOB NO. _____ SUBJECT _____ SHEET NO. 2 OF 2

PROJECT _____ BY _____ DATE _____

| | Boring | Depth (ft) | Description | $G_s$ | $\gamma_d$ (pcf) | w (%) | S (%) | e | |
|---|---|---|---|---|---|---|---|---|---|
| Pond 2 | B-22 | 6 | Silty, Clayey GRAVEL w/Sand | [2.7] | 111 | 13 | 68 | 0.52 | |
| | | 26 | Grey Clayey SILT | 3.3 | 95 | 35 | 99 | 1.17 | |
| | | 27 | " | [3.3] | 107 | 29 | 103 | 0.93 | |
| | | 37 | " w/Sand | [3.3] | 120 | 18 | 83 | 0.72 | |
| Pond 4 | B-18 | 6 | Br Sandy SILT | [3.1] | 115 | 22 | 100 | 0.68 | |
| | | 10 | Red/Br Sandy GRAVEL | 2.7 | 118 | 12 | 76 | 0.43 | 1340** (1000) |
| | B-19 | 13 | Br. Sandy SILT | [3.1] | 117 | 15 | 71 | 0.65 | |
| | B-20 | 14 | Br/Grey Silty fine SAND | 2.9 | 122 | 7 | 42 | 0.48 | $\phi' = 40°$ $c' = 0$ |

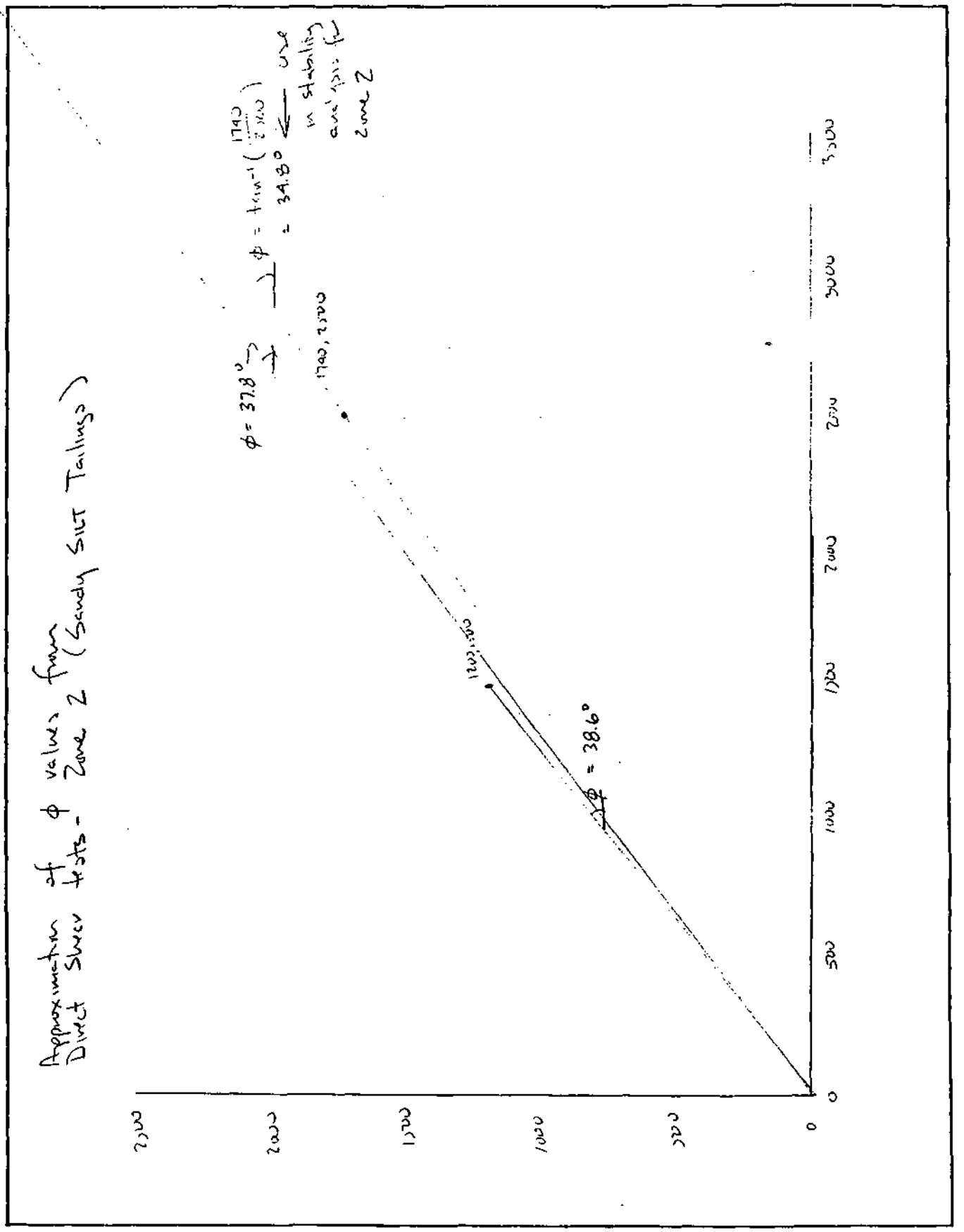
Ave. Values

| | | $G_s$ | $\gamma$ | |
|---|---|---|---|---|
| Pond 4 | Silty GRAVEL w/ Sand | 2.7 | 129 pcf | (Level) |
| | Br Sandy SILT | [3.1] | | |

# ESA Consultants

JOB NO. 101.9502 SUBJECT Shear Strength SHEET NO. 1 OF 1

PROJECT Rico Estimates - Silver Cu. Tailings BY DJM DATE 5-29-



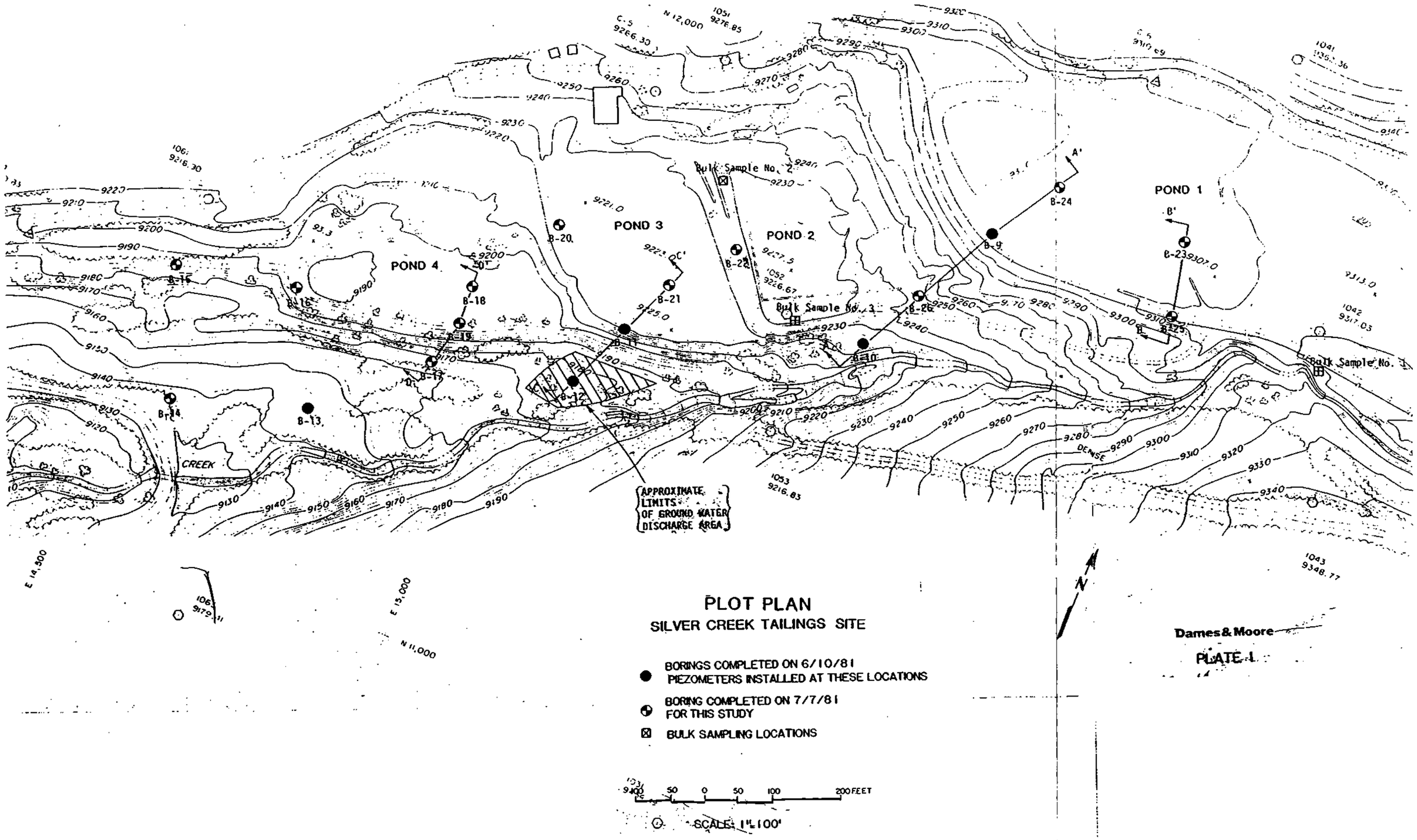
## REFERENCES


Camp, Dresser & McKee Inc. 1979. Report on Environmental Liability Assesment of Rico-Argentine Mining Company, Rico, Colorado; report prepared for Anaconda Copper Company, Denver, Colorado. September.

Dames and Moore. 1981a. Report, Geotechnical and Hydrologic Investigations, St. Louis Adit Site, Silver Creek Tailings Site, Silver Creek Pipeline Route, Rico, Colorado for Anaconda Copper Company. August 28.

Dames and Moore. 1981b. Report, Geotechnical Investigation and Design, Silver Creek Tailings Stabilization and Expansion, Rico, Colorado for Anaconda Copper Company. October 9.

Geotek Inc. 1979. Drilling and Laboratory Testing, Rico, Dolores County, Colorado; report prepared for Anaconda Copper Company, Denver, Colorado. August 17.




# PLOT PLAN

## SILVER CREEK TAILINGS SITE

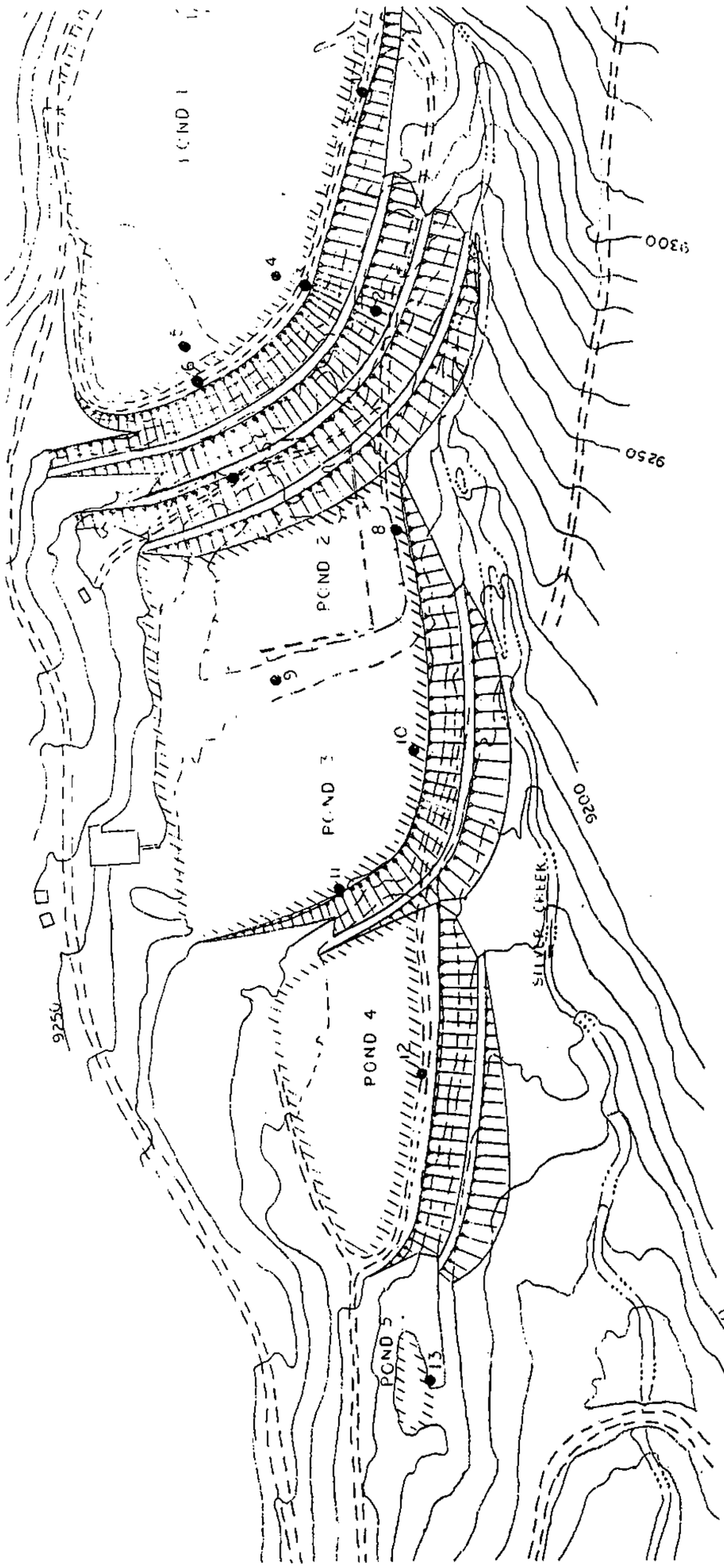
● BORINGS COMPLETED ON 6/10/81 PIEZOMETERS INSTALLED AT THESE LOCATIONS

⊕ BORING COMPLETED ON 7/7/81 FOR THIS STUDY

⊠ BULK SAMPLING LOCATIONS

Dames & Moore

PLATE 1




EMBANKMENT PLAN - SILVER CREEK

SCALE 1"=100'

10' CONTOUR INTERVAL BASED ON AERIEL SURVEY 1979.

● DENOTES BORING LOCATION

ANACONDA COPPER COMPANY

SILVER CREEK PROPOSED CHANNEL IMPROVEMENTS

EMBANKMENT PLAN

| Date | Ch'k'd. | Revision |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

Designed by: R. W.
Drawn by: R. W.
Checked by: T. S.
Approved by: J. O.
Date: SEPT. 27, 1979
Scale:

CAMP DRESSER & McKEE INC.
One Center Plaza
Boston, Massachusetts 02108

CDM
environmental engineers, scientists, planners, & management consultants

SHEET NO. 1

7[illegible]30840

Pond 1

Silver Cr. / Argentine Area

TABLE A-1

PIEZOMETER INSTALLATION DATA

| Boring | Total Standpipe Length (Feet) | Stickup Above Existing Ground Surface (Feet) | Slotted Interval Below Ground Surface (Feet) |
|---|---|---|---|
| B-9 | 72.7 | 0.5 | 67.2 - 72.2 |
| B-10 | 13.8 | 0.5 | 11.3 - 13.3 |
| B-11 | 37.3 | 0.5 | 32.8 - 36.8 |
| B-12 | 9.0 | 4.5 | 3.5 - 4.5 |
| B-13 | 7.3 | 0.5 | 5.8 - 6.8 |

TABLE A-2

SUMMARY OF PIEZOMETER READINGS

| | Water Level Below Ground Surface (Feet) | | | |
|---|---|---|---|---|
| Boring | 6-11-81 | 6-30-82 | 7-7-82 | 7-29-81 |
| B-9 | 69.0 | 71.0 | 71.0 | Dry |
| B-10 | - | 12.1 | 12.2 | 12.9 |
| B-11 | 34.9 | 36.0 | 36.0 | 36.3 |
| B-12 | 0.4 | 0.8* | 0.6* | 0.4* |
| B-13 | 3.8 | 1.8 | 2.0 | 1.8 |

*Water level above ground surface

# BORING B-9

SURFACE ELEVATION 9305

COORDINATES

| OTHER TESTS | STRENGTH TEST RESULTS: TYPE OF TEST | CONFINING PRESSURE (psf) | PEAK SHEAR STRENGTH (psf) | % PASSING NO. 200 SIEVE | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LL (%) | PL (%) | PI (%) | SAMPLING: BLOW COUNT | SAMPLE TYPE | DEPTH IN FEET | SYMBOLS | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | 0 | GW | BROWN SANDY GRAVEL WITH CLAY LOOSE |
| | | | | | | | | | | 6 | SPT | 5 | SP | BROWN FINE SAND WITH A TRACE OF SILT LOOSE |
| | | | | | | | | | | P | D | 10 | GW | BROWN SANDY GRAVEL WITH CLAY LOOSE TO MEDIUM DENSE |
| | | | | | | | | | | 6 | SPT | 15 | SP | GREY FINE SAND WITH SILT LOOSE |
| $G_s$=3.2 | DIRECT SHEAR | 2500 | 2000 | 62 | 106 | 13 | | | | P | D | 20 | ML | GREY FINE SANDY SILT LOOSE |
| | | | | | | | | | | 6 | | 25 | ML | |
| | | | | | | | | | | P | D | 30 | ML | GRADES WITH LENSES OF SILT |
| PERMEABILITY k=8 x $10^{-5}$ cm/sec | | | | | 122 | 17 | | | | | | | | |
| | | | | | | | | | | 10 | SPT | 35 | ML | |
| | | | | | 107 | 19 | 29 | 19 | 10 | P | D | 40 | ML | GREY CLAYEY SILT SOFT GREY SANDY SILT |
| | | | | | | | | | | 6 | SPT | 45 | ML | GRADES WITH ALTERNATING LENSES AND LAYERS OF CLAYEY SILT |
| | | | | | 107 | 24 | | | | P | D | 50 | ML | GREY AND YELLOW BROWN MOTTLED SANDY CLAYEY SILT SOFT |
| | | | | | | | | | | 8 | SPT | 55 | ML | GREY CLAYEY SILT SOFT |
| $G_s$=3.1 | UNCONSOLIDATED UNDRAINED TRIAXIAL TEST | 7000 | 510* | | 91 | 35 | 32 | 26 | 6 | | | 60 | ML | COLORS WITH ALTERNATING BROWN AND GREY |
| PERMEABILITY k=8 x $10^{-7}$ cm/sec | | | | | 114 | 27 | | | | P | D | | | |
| | | | | | | | | | | 8 | SPT | 65 | ML | |
| | UNCONSOLIDATED UNDRAINED TRIAXIAL TEST | 8500 | 730* | | 111 | 28 | | | | P | D | 70 | ML | |
| | | | | | | | | | | 28 | SPT | 75 | SM | GREY SILTY SAND WITH SOME CLAY MEDIUM DENSE TO DENSE BORING COMPLETED AT 76.0 FEET ON 6/9/81 WATER LEVEL ENCOUNTERED AT 69 FEET ON 6/11/81 PIEZOMETER INSTALLED |

*SHEAR STRENGTHS REPORTED AT 5% STRAIN

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- SPT - STANDARD SPLIT-SPOON
- D - DAMES & MOORE "D" SAMPLER

NOTE:

1. THE SOIL CONDITIONS ARE DESCRIBED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM, PLATE A-2.
2. BLOW COUNT HAS BEEN TAKEN AS THE NUMBER OF BLOWS REQUIRED TO DRIVE A SAMPLER TO ONE FOOT PENETRATION USING A 140 POUND WEIGHT FALLING 30 INCHES.
3. ELEVATIONS ARE APPROXIMATE AS TAKEN FROM TOPOGRAPHIC MAP

# LOG OF BORING

DAMES & MOORE

## BORING B-10

SURFACE ELEVATION 9225

COORDINATES

| OTHER TESTS | STRENGTH TEST RESULTS: TYPE OF TEST | CONFINING PRESSURE (psf) | PEAK SHEAR STRENGTH (psf) | % PASSING NO 200 SIEVE | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LL (%) | PL (%) | PI (%) | SAMPLING: BLOW COUNT | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 10 | SPT |
| | | | | | | | | | | 58/9" | SPT |
| | | | | | | | | | | 12 | SPT |

DEPTH IN FEET: 0, 5, 10, 15, 20

SAMPLING

SYMBOLS

DESCRIPTION

BROWN CLAYEY GRAVEL WITH SOME SAND

BROWN SILTY FINE COARSE SAND WITH GRAVEL MEDIUM DENSE

BORING COMPLETED AT 15 FEET ON 6/9/81

WATER ENCOUNTERED AT 13.5 FEET ON 6/9/81

PIEZOMETER INSTALLED

## BORING B-11

SURFACE ELEVATION 9221

COORDINATES

| OTHER TESTS | STRENGTH TEST RESULTS: TYPE OF TEST | CONFINING PRESSURE (psf) | PEAK SHEAR STRENGTH (psf) | % PASSING NO 200 SIEVE | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LL (%) | PL (%) | PI (%) | SAMPLING: BLOW COUNT | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 11 | SPT |
| | | | | | | | | | | 14/3" | T |
| | | | | | | | | | | 8 | SPT |
| $G_s$=3.5 GRADATION | DIRECT SHEAR | 1500 | 1200 | 58 | 115 | 11 | | | | P | D |
| | | | | | | | | | | 11 | SPT |
| | | | | 46 | 136 | 14 | | | | P | D |
| | | | | | | | | | | 22 | SPT |

DEPTH IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

SAMPLING

SYMBOLS

DESCRIPTION

BROWN AND YELLOW BROWN SILTY FINE SAND LOOSE

BROWN AND GREY SILTY SAND WITH SOME CLAY MEDIUM DENSE

GREY FINE SANDY SILT WITH SOME CLAY LOOSE

GREY FINE SANDY SILT LOOSE TO MEDIUM DENSE

GRADES WITH LENSES AND LAYERS OF CLAYEY SILT

GRADES WITH GRAVEL

AUGER REFUSAL AT 37 FEET

BORING COMPLETED AT 37 FEET ON 6/10/81

WATER LEVEL ENCOUNTERED AT 34.9 FEET ON 6/10/81

PIEZOMETER INSTALLED

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- ☐ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- SPT - STANDARD SPLIT-SPOON
- D - DAMES & MOORE "D" SAMPLER

NOTE:
SEE PLATE A - 1A

# LOG OF BORING

DAMES & MOORE

# BORING B-23

SURFACE ELEVATION 9307

COORDINATES

| OTHER TESTS | STRENGTH TEST RESULTS: TYPE OF TEST | CONFINING PRESSURE (psf) | PEAK SHEAR STRENGTH (psf) | % PASSING NO. 200 SIEVE | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LL (%) | PL (%) | PI (%) | SAMPLING: BLOW COUNT | SAMPLE TYPE | DEPTH IN FEET | SAMPLING | SYMBOLS | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | 0 | | ML | BROWN FINE SANDY SILT LOOSE<br>GRADES WITH SOME GRAVEL<br>GRADES WITH PIECES OF WOOD AT 3 FEET |
| | | | | 11 | | | | | | 31/1" | U | 5 | | GM | BROWN SILTY GRAVEL WITH SAND MEDIUM DENSE |
| | | | | | | | | | | 14 | SPT | 10 | | | GRADES WITH RUSTED IRON AND WOOD |
| | | | | 34 | 133 | 20 | 30 | 24 | 6 | 38 | U | 15 | | | BROWN & GREY FINE SANDY SILT MEDIUM DENSE<br>GRADES WITH WOOD FRAGMENTS |
| | | | | | | | | | | 22 | SPT | 20 | | | GRADES PREDOMINANTLY GREY |
| | | | | | 146 | 6 | | | | P | T | 25 | | ML | |
| | | | | | | | | | | 22 | SPT | 30 | | | |
| SPECIFIC GRAVITY Gs = 3.9 | DIRECT SHEAR | 4000 | 3100 | 24 | 148<br>122 | 16<br>21 | | | | P | T | 35 | | | GRADES WITH LESS SAND |
| | | | | | | | | | | P* | SPT | 40 | | ML | GREY CLAYEY SILT SOFT |
| | | | | | | | | | | 60/5"<br>60/3-1/2"<br>56 | U<br>U<br>U | 45 | | GM | BROWN & GREY SILTY GRAVEL WITH SAND MEDIUM DENSE TO DENSE<br>AUGER REFUSAL<br>BORING COMPLETED AT 47.5 FEET ON 7/5/81 |
| | | | | | | | | | | | | 50 | | | |
| | | | | | | | | | | | | 55 | | | |
| | | | | | | | | | | | | 60 | | | |
| | | | | | | | | | | | | 65 | | | |
| | | | | | | | | | | | | 70 | | | |

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED
- P* - SAMPLER ADVANCED UNDER WEIGHT OF THE ROD

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- SPT - STANDARD SPLIT-SPOON

NOTE:

SEE PLATE A-1A

# LOG OF BORING

DAMES & MOORE

# BORING B-24

SURFACE ELEVATION 9302

COORDINATES

| OTHER TESTS | STRENGTH TEST RESULTS: TYPE OF TEST | CONFINING PRESSURE (psf) | PEAK SHEAR STRENGTH (psf) | % PASSING NO. 200 SIEVE | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LL (%) | PL (%) | PI (%) | SAMPLING: BLOW COUNT | SAMPLE TYPE | DEPTH IN FEET | SAMPLING | SYMBOLS | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | 0 | | SM | GREY SILTY FINE SAND LOOSE |
| SPECIFIC GRAVITY Gs = 3.6 | DIRECT SHEAR | 1000 | 820 | 14 | 133 | 4 | | | | P | T | 5 | | | |
| | SEE PLATE A-6B | | | | | | | | | | | | | | |
| | | | | | | | | | | 6 | SPT | 10 | | | GREY FINE SANDY SILT LOOSE |
| | | | | | 106 | 9 | | | | 13 | U | 15 | | ML | |
| SPECIFIC GRAVITY Gs = 3.1 | DIRECT SHEAR | 2500 | 1740 | | 105 | 9 | | | | P | T | 20 | | | |
| | | | | | | | | | | 10 | U | 25 | | | COLORS YELLOW BROWN |
| | | | | | | | | | | P | T | 30 | | | GREY CLAYEY SILT SOFT |
| | | | | | | | | | | 5 | U | 35 | | | GRADES WITH SOME SAND |
| | | | | | 93 | 36 | | | | P | T | 40 | | | |
| | | | | | | | | | | 70 | U | 45 | | ML | |
| | | | | | 97 | 34 | | | | P | T | 50 | | | GRADES WITH LESS SAND |
| | | | | | 104 | 29 | | | | 21 | U | 55 | | | GRADES LOOSE TO MEDIUM DENSE |
| | | | | | | | | | | P | T | 60 | | GM | BROWN & GREY SILTY GRAVEL WITH SAND LOOSE TO MEDIUM DENSE |
| | | | | | | | | | | 160/4-1/2" | U | 65 | | | GRADES WITH ROOTS AND PIECES OF WOOD<br>AUGER REFUSAL<br>BORING COMPLETED AT 65.5 FEET ON 7/6/81 |
| | | | | | | | | | | | | 70 | | | |

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- SPT - STANDARD SPLIT-SPOON

NOTE:
SEE PLATE A-1A

# LOG OF BORING

DAMES & MOORE

# BORING B-25

SURFACE ELEVATION 9309

COORDINATES

| OTHER TESTS | STRENGTH TEST RESULTS: TYPE OF TEST | CONFINING PRESSURE (psf) | PEAK SHEAR STRENGTH (psf) | % PASSING NO. 200 SIEVE | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LL (%) | PL (%) | PI (%) | SAMPLING: BLOW COUNT | SAMPLE TYPE | DEPTH IN FEET |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | 0 |
| SPECIFIC GRAVITY Gs = 3.1 | DIRECT SHEAR | 2000 | 2030 | | 118 | 6 | | | | 18 | U | 5 |
| | | | | | | | | | | 17 | U | 10 |
| GRADATION | | | | 11 | | | | | | 22 | U | 15 |
| | | | | | | | | | | 54 | U | 20 |
| SPECIFIC GRAVITY Gs = 3.0 | DIRECT SHEAR | 3000 | 3350 | | 113 | 9 | | | | 34 | U | 25 |
| | | | | | | | | | | 56/ 9-1/2" | U | 30 |
| | | | | | | | | | | 12 | U | 35 |
| | | | | | 108 | 30 | | | | P | T | 40 |
| | | | | | | | | | | 89/ 9-1/4" | U | 45 |
| | | | | | | | | | | 100/ 6-1/2" | U | 50 |
| | | | | | | | | | | | | 55 |
| | | | | | | | | | | | | 60 |
| | | | | | | | | | | | | 65 |
| | | | | | | | | | | | | 70 |

SAMPLING

| SYMBOLS | DESCRIPTION |
|---|---|
| | BROWN SILTY GRAVEL WITH SAND LOOSE TO MEDIUM DENSE |
| | COLORS GREY |
| | GRADES WITH GREY SANDY SILT INTRUSIONS MEDIUM DENSE |
| | GREY CLAYEY SILT SOFT |
| | BROWN SILTY & CLAYEY GRAVEL WITH SAND MEDIUM DENSE TO DENSE |
| | AUGER REFUSAL<br>BORING COMPLETED AT 51 FEET ON 7/78 |

KEY

- INDICATES UNDISTURBED SAMPLE
- INDICATES DISTURBED SAMPLE
- INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- SPT - STANDARD SPLIT-SPOON

NOTE:

SEE PLATE A-1A

# LOG OF BORING

DAMES & MOORE

# BORING B-26

SURFACE ELEVATION 9244
COORDINATES

| OTHER TESTS | STRENGTH TEST RESULTS: TYPE OF TEST | CONFINING PRESSURE (psf) | PEAK SHEAR STRENGTH (psf) | % PASSING NO. 200 SIEVE | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LL (%) | PL (%) | PI (%) | SAMPLING: BLOW COUNT | SAMPLE TYPE | DEPTH IN FEET | SAMPLING SYMBOLS | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | 0 | | BROWN & YELLOW BROWN FINE SANDY SILT |
| | | | | | | | | | | | | | | GREY CLAYEY SILT WITH SOME SAND SOFT |
| | | | | | | | | | | | | 5 | | |
| | | | | | 106 | 23 | | | | P | T | | | |
| | | | | | | | | | | 6 | U | | | |
| | | | | | | | | | | | | 10 | | |
| | | | | | | | | | | P | T | | | |
| | | | | | | | | | | | | 15 | | |
| | | | | | 88 | 39 | | | | 8 | U | | | |
| | | | | | | | | | | | | 20 | | BROWN SILTY GRAVEL WITH SAND MEDIUM DENSE GRADES WITH INTRUSIONS OF GREY SANDY SILT |
| | | | | | | | | | | 52 | U | | | |
| | | | | | | | | | | | | 25 | | GREY SANDY SILT GRADES OUT |
| | | | | | | | | | | 100/3" | U | | | |
| | | | | | | | | | | | | 30 | | COLORS REDDISH BROWN BORING COMPLETED AT 31.5 FEET ON 7/7/81 |
| | | | | | | | | | | 83 | U | | | |
| | | | | | | | | | | | | 35 | | |
| | | | | | | | | | | | | 40 | | |
| | | | | | | | | | | | | 45 | | |
| | | | | | | | | | | | | 50 | | |
| | | | | | | | | | | | | 55 | | |
| | | | | | | | | | | | | 60 | | |
| | | | | | | | | | | | | 65 | | |
| | | | | | | | | | | | | 70 | | |

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- SPT - STANDARD SPLIT-SPOON

NOTE:
SEE PLATE A-1A

# LOG OF BORING

DAMES & MOORE

# BORING 1

SURFACE ELEVATION _____

| DEPTH IN FEET | BLOW COUNT | SAMPLES | SYMBOLS | DESCRIPTIONS |
|---|---|---|---|---|
| 0 | | | | FILL CONSISTING OF COBBLES, BOULDERS, GRAVEL, SOME SAND, LITTLE SILT-CLAY, MOIST (DIKE MATERIAL) |
| | 33 | ■ | | GRADING WITH LESS BOULDERS AND COBBLES BELOW 5 FEET |
| 10 | 25 | ■ | | |
| | 25 | ■ | | GRADING WITH SOME WOOD FROM 16 TO 21 FEET |
| 20 | 27 | ■ | | GRADING WITH SOME VERY MOIST TO WET INTRUSIONS OF FINE SAND AND SILT AT 17 TO 19 FEET |
| | 37 | ■ | | GRADING WITH MORE BOULDERS BELOW 26 FEET |
| 30 | 56 | ■ | | FILL CONSISTING OF SILT WITH LENSES OF FINE, SILTY SAND, TRACE TO SOME CLAY, VERY MOIST, MEDIUM STIFF (MILL TAILINGS) |
| | 19 | ■ | | |
| 40 | P | ■ | | |
| 50 | 11 | ■ | | |
| | P | ■ | | |
| 60 | 104 | ■ | | GRAVEL, COBBLES AND BOULDERS, LITTLE SAND, LITTLE SILT-CLAY, WET (MIXTURE OF ALLUVIUM AND COLLUVIUM) |
| | 114 | ■ | | AUGER REFUSAL AT 66 FEET |
| 70 | | | | |

BORING COMPLETED ON 7-21-79

GROUNDWATER OBSERVED AT A DEPTH OF 62-1/2 FEET ON 7-21-79

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# BORING 2

SURFACE ELEVATION _____

| DEPTH IN FEET | BLOW COUNT | SAMPLES | SYMBOLS | DESCRIPTIONS |
|---|---|---|---|---|
| 0 | | | | FILL CONSISTING OF COBBLES, BOULDERS, GRAVEL, SOME SAND, LITTLE SILT-CLAY, MOIST |
| | 2<br>35/0 | | | TOPSOIL CONSISTING OF LOOSE, BROWN SILT, VERY MOIST GRAVEL, COBBLES AND BOULDERS, LITTLE SAND, LITTLE SILT-CLAY, VERY MOIST (MIXTURE OF ALLUVIUM AND COLLUVIUM) |
| 10 | | | | AUGER REFUSAL AT 7 FEET |

BORING COMPLETED ON 7-21-79

NO GROUNDWATER ENCOUNTERED AT TIME OF DRILLING

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# BORING 3

SURFACE ELEVATION _____

| DEPTH IN FEET | BLOW COUNT | SAMPLES | SYMBOLS | DESCRIPTIONS |
|---|---|---|---|---|
| 0 | | | | FILL CONSISTING OF COBBLES, GRAVEL, SOME SAND, LITTLE TO SOME SILT, MOIST (DIKE MATERIAL) |
| | 13 | | | |
| 10 | 9 | | | |
| | P | | | FILL CONSISTING OF SILT WITH LENSES OF FINE, SILTY SAND, TRACE TO SOME CLAY, VERY MOIST, MEDIUM STIFF (MILL TAILINGS) |
| 20 | 3 | | | GRADING TO SOFT AT 20 FEET |
| | 6 | | | |
| 30 | P | | | |
| | 18 | | | |
| 40 | 6 | | | GRADING VERY MOIST TO WET BELOW 40 FEET |
| | P | | | |
| 50 | 13 | | | |
| | 8 | | | |
| 60 | | | | |
| | P | | | GRADING TO STIFF BELOW 65 FEET |
| 70 | 35 | | | |
| | 85/5 | | | GRAVEL, COBBLES AND BOULDERS, SOME SAND, LITTLE SILT-CLAY, WET (MIXTURE OF ALLUVIUM AND COLLUVIUM) |
| 80 | | | | |

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# BORING 3 CONT.

SURFACE ELEVATION _____

| DEPTH IN FEET | BLOW COUNT | SAMPLES | SYMBOLS | DESCRIPTIONS |
|---|---|---|---|---|
| 80 | | | | |
| | 92/6 | | | |
| | 42 | | | |
| 90 | | | | |
| | 125/6 | | | |
| | NX CORE 37 % RECOVERY | | | |
| 100 | | | | |

BORING COMPLETED ON 7-20-79

GROUNDWATER ENCOUNTERED AT A DEPTH OF 65-1/2 FEET ON 7-20-79 AND 74-1/2 FEET ON 7-24-79

GEOTEK Consultants, Inc.

# BORING 4

SURFACE ELEVATION _____

| DEPTH IN FEET | BLOW COUNT | SAMPLES | SYMBOLS | DESCRIPTIONS |
|---|---|---|---|---|
| 0 | | | | FILL CONSISTING OF SILT WITH LENSES AND LAYERS OF FINE, SILTY SAND, TRACE TO SOME CLAY, MOIST TO VERY MOIST, MEDIUM STIFF (MILL TAILINGS) |
| | P | | | |
| 10 | 7 | | | GRADING TO A SILTY, FINE TO MEDIUM SAND AT 10 FEET |
| | 6 | | | |
| 20 | 7 | | | |
| | 11 | | | |
| 30 | 8 | | | GRADING WITH SOME FINE SAND AT 30 FEET |
| | 11 | | | |
| 40 | P | | | |
| | 11 | | | GRADING VERY MOIST TO WET BELOW 45 FEET |
| 50 | 11 | | | |
| | P | | | |
| 60 | 11 | | | |
| | 14 | | | GRADING WITH SOME CLAY AND TRACE OF FINE SAND AT 65 FEET |
| 70 | 130/3 | | | GRAVEL, COBBLES AND BOULDERS, SOME SAND AND FINES, WET (MIXTURE OF ALLUVIUM AND COLLUVIUM) |
| | | | | AUGER REFUSAL AT 72 FEET |
| 80 | | | | BORING COMPLETED ON 7-23-79 |
| | | | | GROUNDWATER OBSERVED AT A DEPTH OF 69 FEET ON 7-23-79 |

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# BORING 5

SURFACE ELEVATION _____

| DEPTH IN FEET | BLOW COUNT | SAMPLES | SYMBOLS | DESCRIPTIONS |
|---|---|---|---|---|
| 0 | | | | FILL CONSISTING OF SILT, LITTLE TO SOME CLAY, TRACE OF FINE SAND, VERY MOIST, SOFT TO MEDIUM STIFF (MILL TAILINGS) |
| | 2 | | | |
| 10 | P | | | |
| | 2 | | | |
| 20 | 8 | | | GRADING TO MEDIUM STIFF FROM 19 TO 26 FEET |
| | | | | GRADING VERY MOIST TO WET BELOW 26 FEET |
| 30 | 2 | | | |
| | 2 | | | GRADING TO MEDIUM STIFF FROM 37 TO 44 FEET |
| 40 | 15 | | | |
| | P | | | |
| 50 | 3 | | | GRADING TO MEDIUM STIFF BELOW 54 FEET |
| 60 | 14 | | | |
| | 70 | | | GRAVEL WITH COBBLES, SOME SAND, LITTLE SILT-CLAY, WET (MIXTURE OF ALLUVIUM AND COLLUVIUM) |
| 70 | 125/3 | | | GRADING WITH SOME BOULDERS BELOW 69 FEET |
| | NX CORE 75 % RECOVERY | | | AUGER REFUSAL AT 73 FEET |
| 80 | | | | BORING COMPLETED ON 7-24-79 |
| | | | | GROUNDWATER OBSERVED AT A DEPTH OF 67 FEET ON 7-24-79 |

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# BORING 6

SURFACE ELEVATION _____

| DEPTH IN FEET | BLOW COUNT | SAMPLES | SYMBOLS | DESCRIPTIONS |
|---|---|---|---|---|
| 0 | | | | |
| | 8 | | | FILL CONSISTING OF GRAVEL, COBBLES, BOULDERS AND SAND, SOME SILT-CLAY, MOIST (DIKE MATERIAL) |
| 10 | 28 | | | GRADING TO A SILT-CLAY WITH SOME GRAVEL FROM 5 TO 8-1/2 FEET |
| | P | | | FILL CONSISTING OF SILT WITH LAYERS AND LENSES OF FINE, SILTY SAND, TRACE TO LITTLE CLAY, VERY MOIST, MEDIUM STIFF (MILL TAILINGS) |
| 20 | 5 | | | |
| | 7 | | | |
| 30 | P | | | |
| | 6 | | | |
| 40 | 10 | | | |
| | P | | | |
| 50 | 5 | | | GRADING VERY MOIST TO WET BELOW 50 FEET |
| | 11 | | | |
| 60 | P | | | |
| | 8 | | | |
| 70 | 13 | | | |
| | 122 | | | GRAVEL, COBBLES AND BOULDERS, SOME SAND, TRACE SILT-CLAY, WET (MIXTURE OF ALLUVIUM AND COLLUVIUM) |
| 80 | 43 | | | |

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| DEPTH IN FEET | BLOW COUNT | SAMPLES | SYMBOLS | BORING 6 CONT. | DESCRIPTIONS | SURFACE ELEVATION |
|---|---|---|---|---|---|---|
| 80 | | | | | | |
| | 250/½ | | | | AUGER REFUSAL AT 86 FEET | |
| 90 | | | | | | |

BORING COMPLETED ON 7-18-79

GROUNDWATER OBSERVED AT A DEPTH OF 75 FEET ON 7-18-79

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# BORING 7

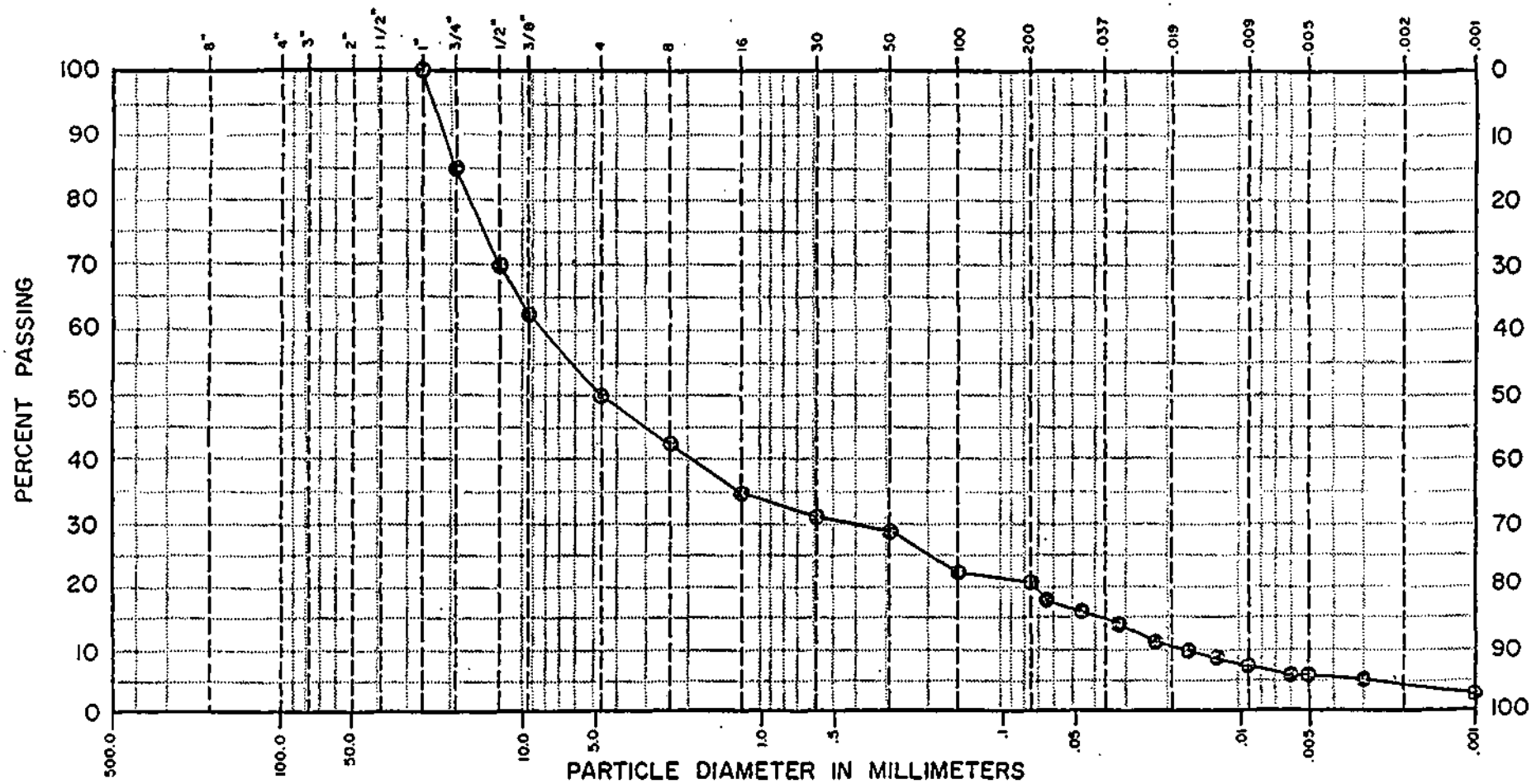
SURFACE ELEVATION _____

| DEPTH IN FEET | BLOW COUNT | SAMPLES | SYMBOLS | DESCRIPTIONS |
|---|---|---|---|---|
| 0 | | | | |
| | P | | | FILL CONSISTING OF VARIOUS MIXTURES OF SAND AND SILT, LITTLE TO SOME CLAY, VERY MOIST, MEDIUM STIFF (MILL TAILINGS) |
| 10 | 5 | | | GRADING WET AT 9-1/2 FEET<br>GRADING WITH SOME WOOD AT 10 FEET |
| | 6 | | | |
| 20 | 8 | | | GRADING WITH SOME WOOD AT 20 FEET |
| | 93 | | | GRAVEL, COBBLES, BOULDERS AND SAND, LITTLE SILT-CLAY, WET (MIXTURE OF ALLUVIUM AND COLLUVIUM) |
| 30 | 102 | | | AUGER REFUSAL AT 32-1/2 FEET |
| 40 | | | | |

BORING COMPLETED ON 7-22-79

GROUNDWATER ENCOUNTERED AT A DEPTH OF 9.5 FEET ON 7-24-79

GEOTEK Consultants, Inc.




| COBBLES TO BOULDERS | Coarse | Fine | Coarse | Medium | Fine | CLAY (Plastic) TO SILT (Non-Plastic) |
|---|---|---|---|---|---|---|
| | GRAVEL | | SAND | | | |

| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 1 | | 10 | | | | | DIKE MATERIAL |

GEOTEX, Inc.

GRADATION ANALYSIS

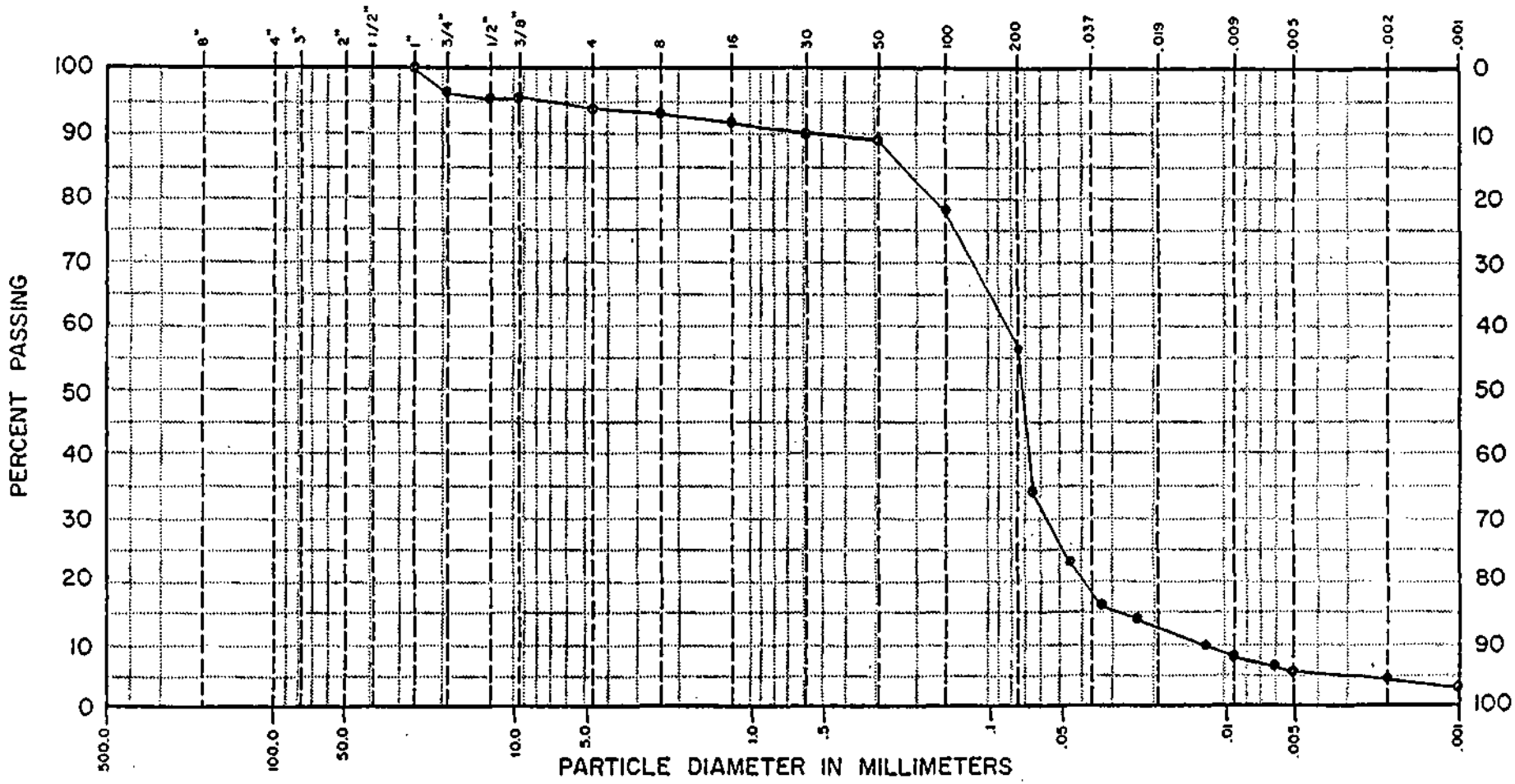
DRAWN BY: SS

JOB NO. 16991

DATE: 8/17/79

PLATE 30

L-7. 1/76




| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 1 | | 40 | | | | | MILL TAILINGS |

GEOTEK, Inc.

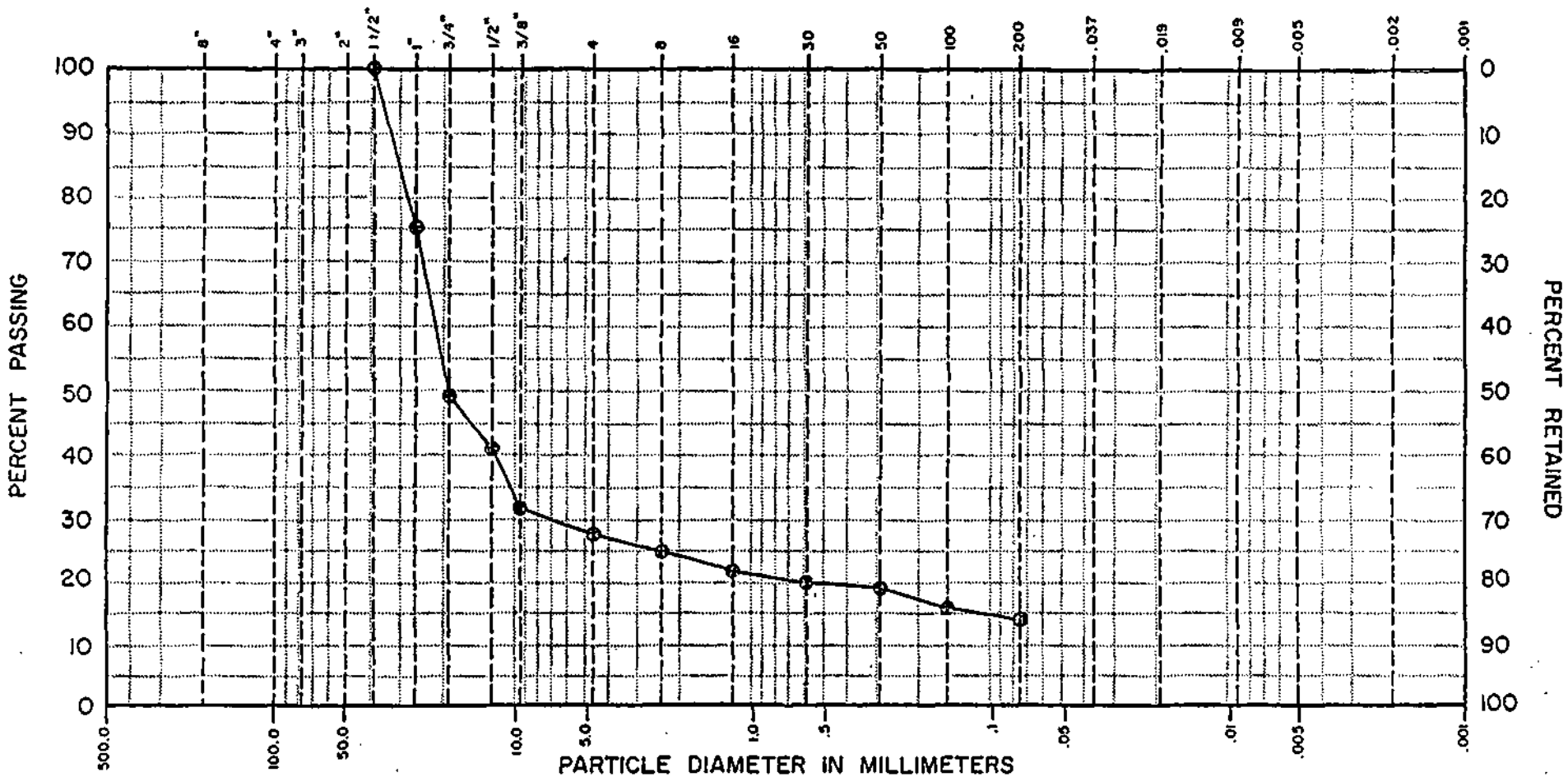
GRADATION ANALYSIS

DRAWN BY: KM

JOB NO. 16991

DATE: 8/17/79

PAGE 31




| COBBLES TO BOULDERS | GRAVEL | | SAND | | | CLAY (Plastic) TO SILT (Non-Plastic) |
|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | |

| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 1 | | 60 | | | | | MIXTURE OF ALLUVIUM AND COLLUVIUM |

GEOTEK, Inc.

GRADATION ANALYSIS

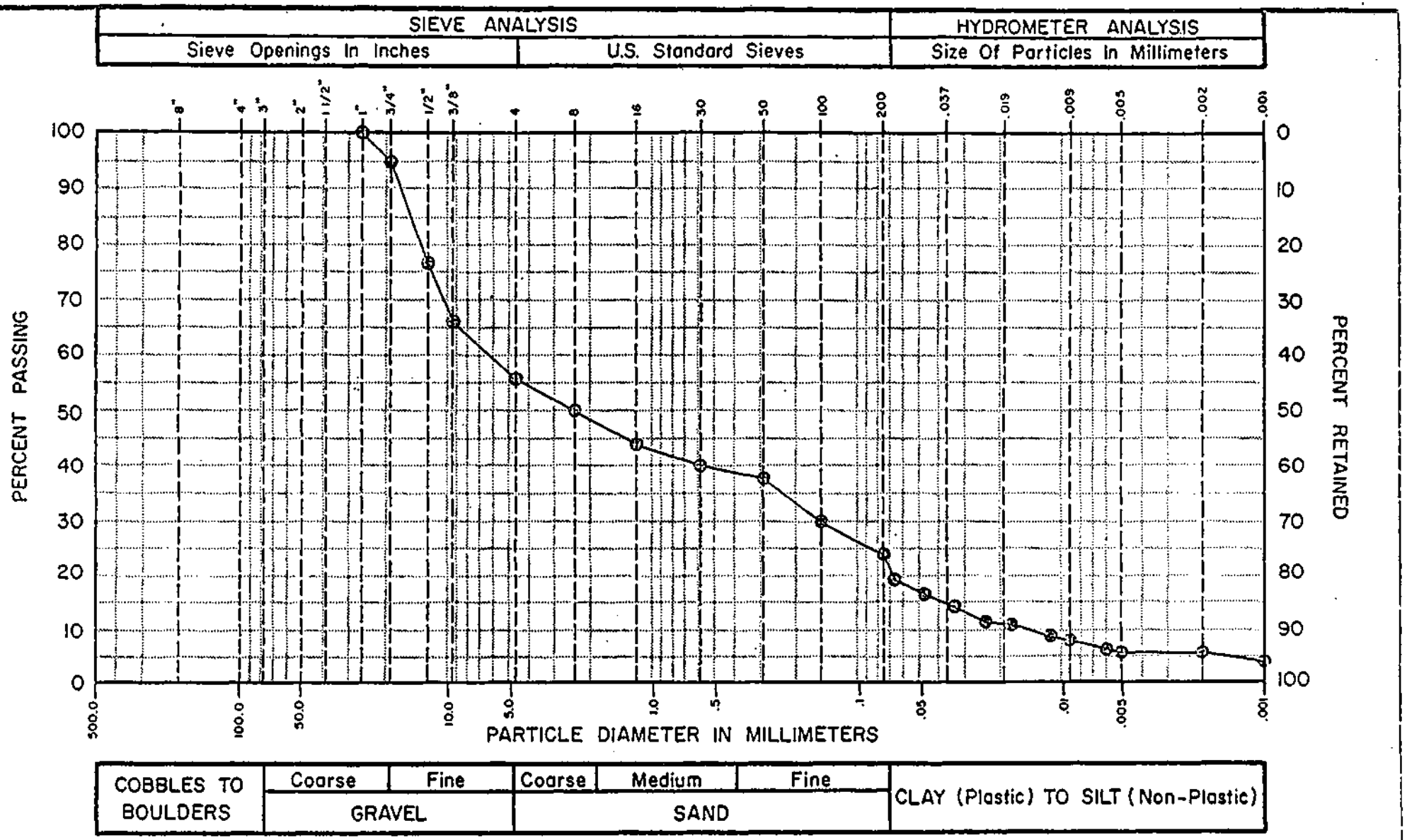
DRAWN BY: SS

JOB NO. 16991

DATE: 8/17/79

PLATE 32

-7 1/76




| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 3 | | 10 | | | | | DIKE MATERIAL |

GEOTEK, Inc.

GRADATION ANALYSIS

DRAWN BY: SS

JOB NO. 16991

DATE: 8/17/79

PAGE 33

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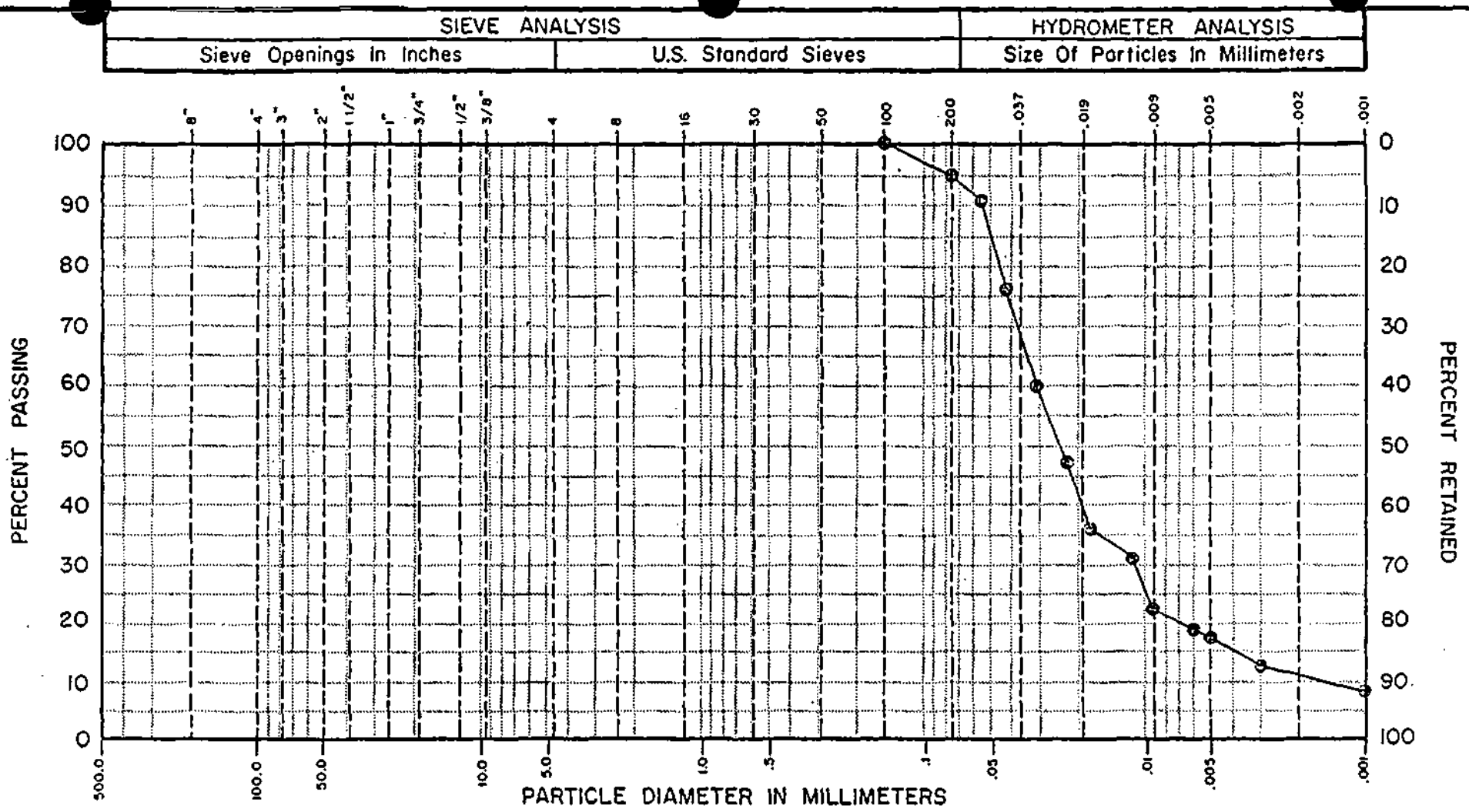



| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 1 | | 50 | | | | | MILL TAILINGS |

GEOTEK, Inc.

GRADATION ANALYSIS

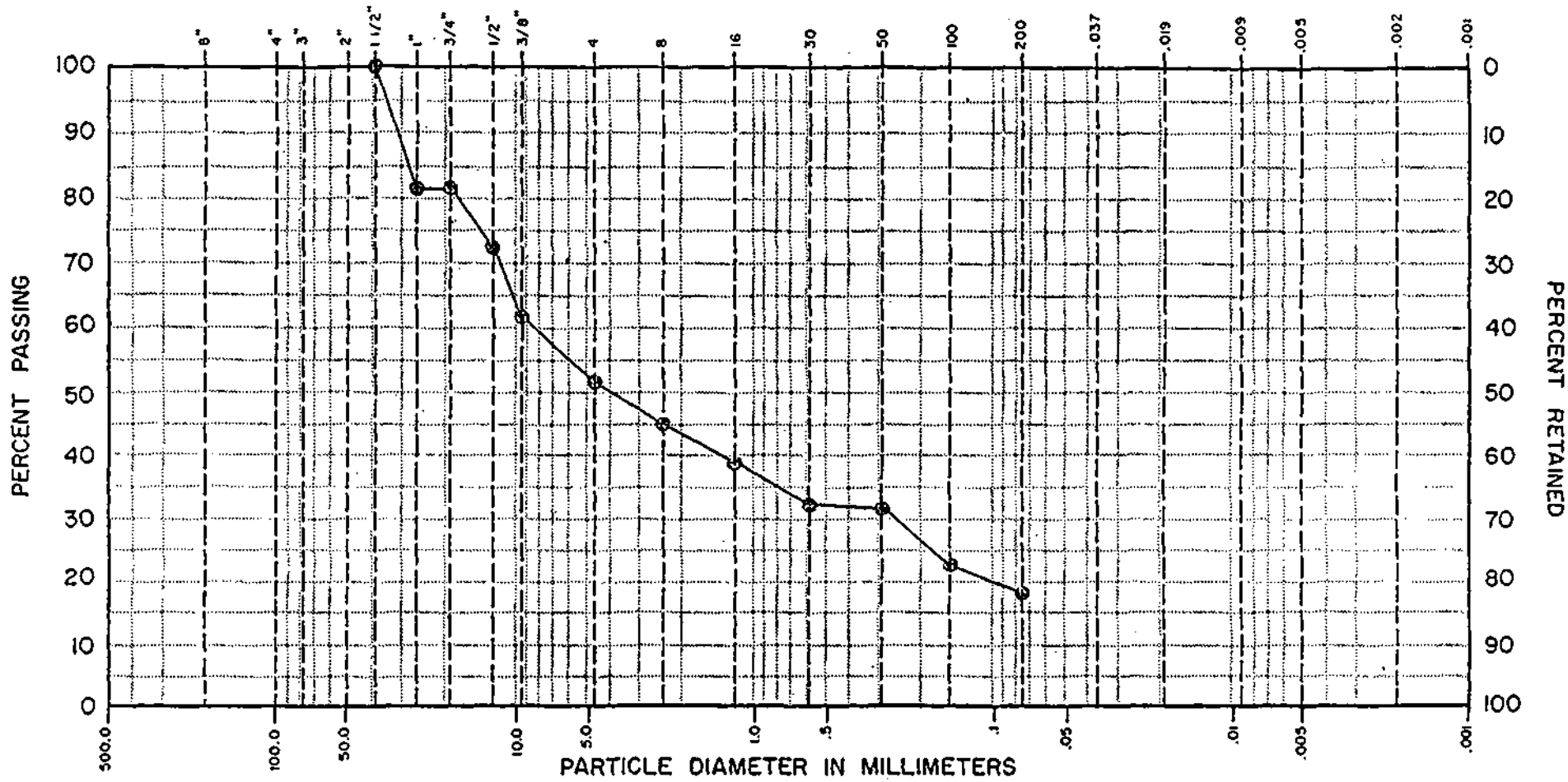
DRAWN BY: [illegible]

JOB NO. 16991

DATE: 8/17/79

PLATE 34

L-7. 1/76




| COBBLES TO BOULDERS | Coarse | Fine | Coarse | Medium | Fine | CLAY (Plastic) TO SILT (Non-Plastic) |
|---|---|---|---|---|---|---|
| | GRAVEL | | SAND | | | |

| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 3 | | 85 | | | | | MIXTURE OF ALLUVIUM AND COLLUVIUM |

GEOTEK, Inc.

GRADATION ANALYSIS

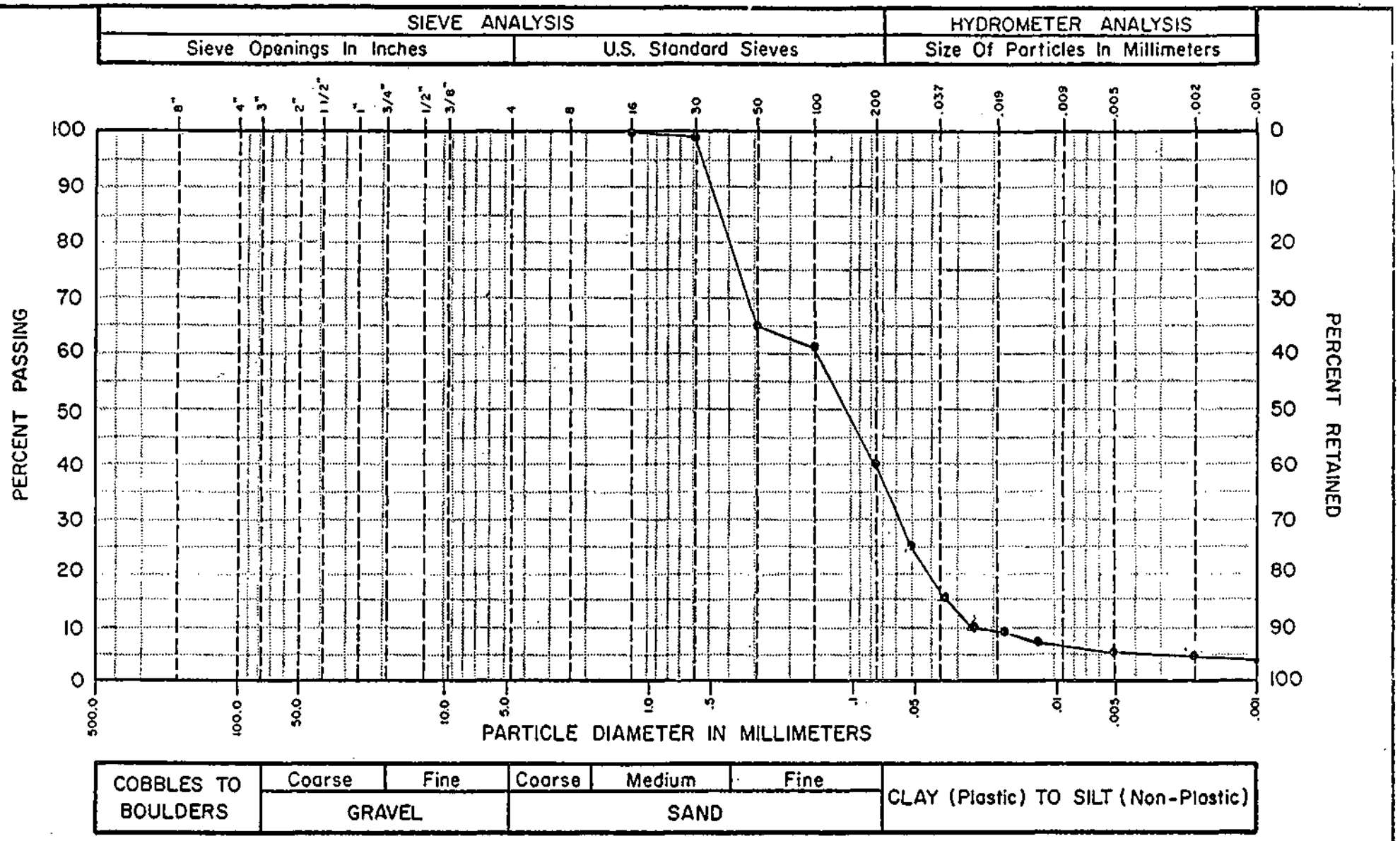
DRAWN BY: SS

JOB NO. 16991

DATE: 8/17/79

PLATE 35

L-7 1/76




| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 4 | | 10 | | | | | MILL TAILINGS |

GEOTEK, Inc.

GRADATION ANALYSIS

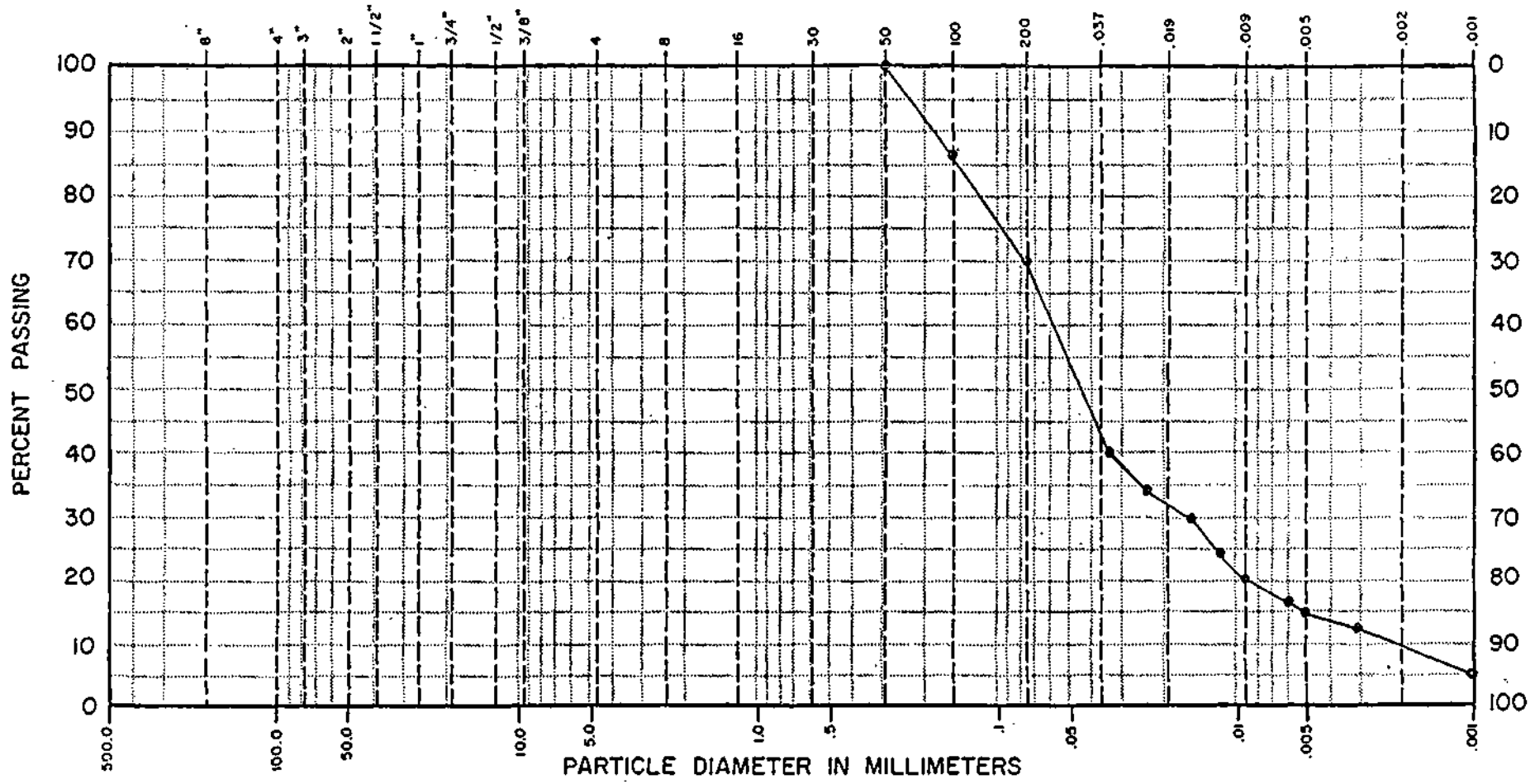
DRAWN BY: KM

JOB NO. 16991

DATE: 8/17/79

PLATE 36

L-7. 1/76




| COBBLES TO BOULDERS | Coarse | Fine | Coarse | Medium | Fine | CLAY (Plastic) TO SILT (Non-Plastic) |
|---|---|---|---|---|---|---|
| | GRAVEL | | SAND | | | |

| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 4 | | 30 | | | | | MILL TAILINGS |

**GEOTEK, Inc.**

GRADATION ANALYSIS

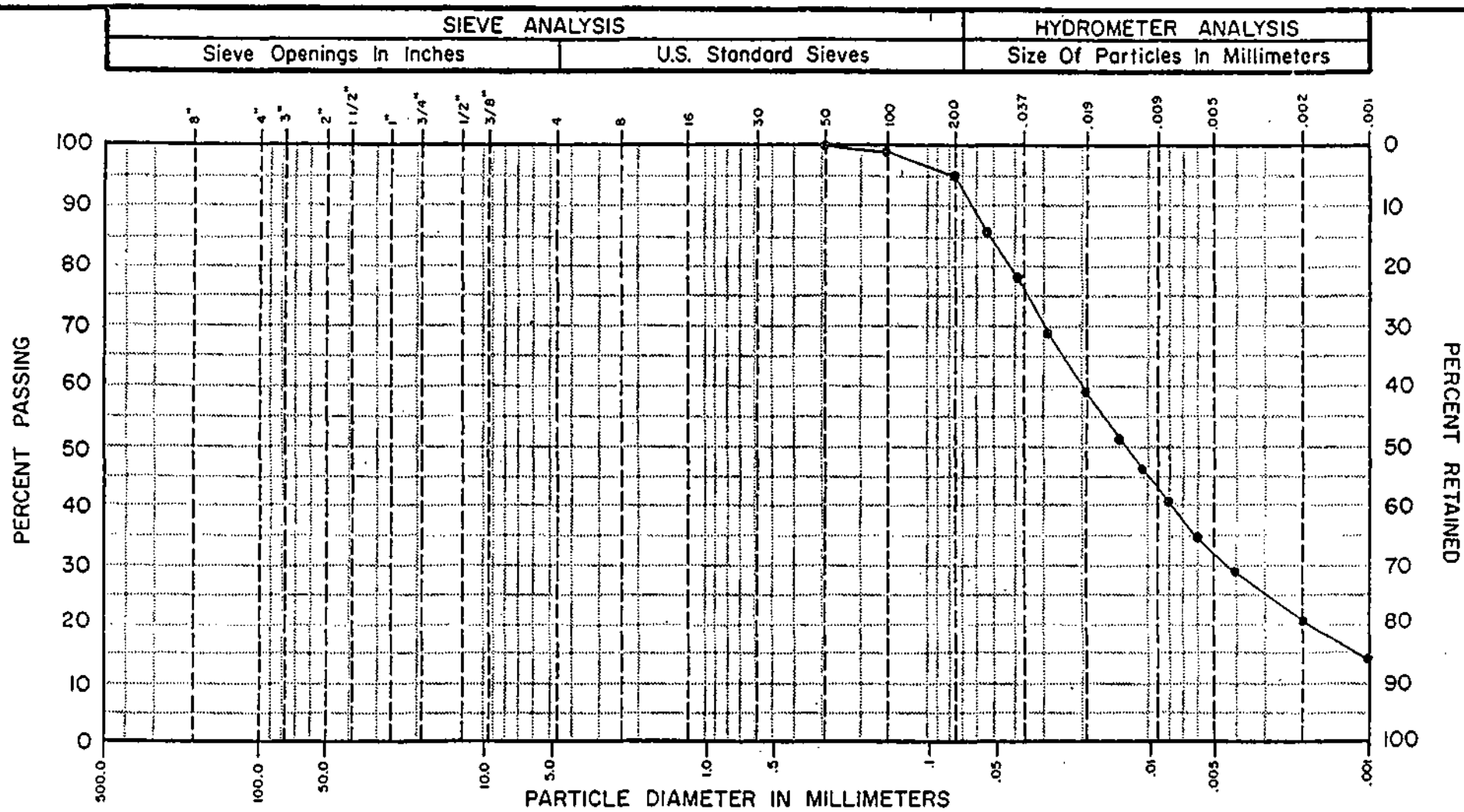
DRAWN BY: KM

DATE: 8/17/79

JOB NO. 16991

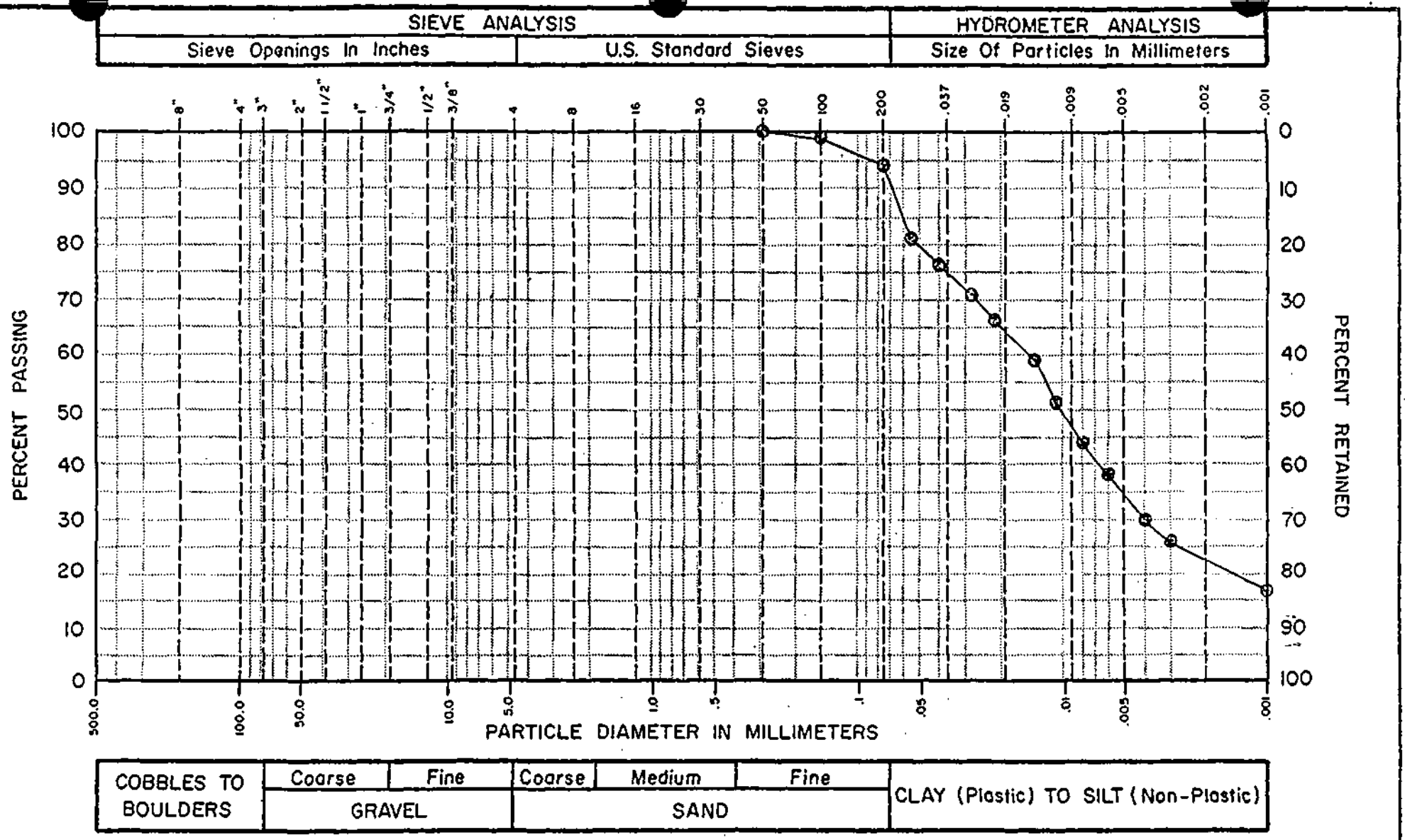
PLATE 37

L-7 1/76




| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION | GEOTEK, Inc. | |
|---|---|---|---|---|---|---|---|---|---|
| 4 | | 55 | | | | | MILL TAILINGS | GRADATION ANALYSIS | |
| | | | | | | | | DRAWN BY: KM | JOB NO. 16991 |
| | | | | | | | | DATE: 8/17/79 | PLATE 38 |

.7 1/76




| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 4 | | 65 | | | | | MILL TAILINGS |

GEOTEK, Inc.

GRADATION ANALYSIS

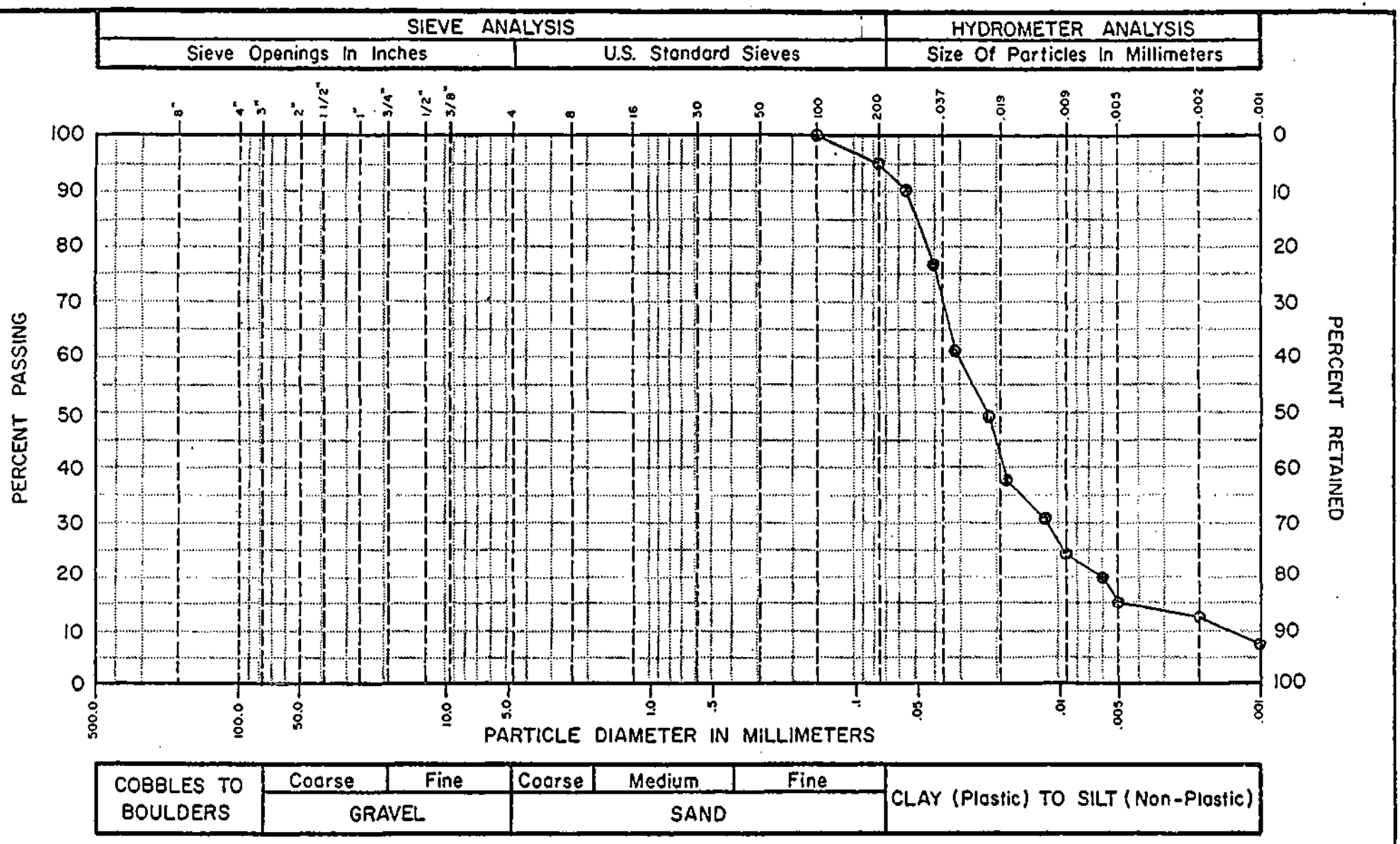
DRAWN BY: SS

JOB NO. 16991

DATE: 8/17/79

PLATE 39

1:7 1/76




| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 5 | | 5 | | | | | MILL TAILINGS |

GEOTEK, Inc.

GRADATION ANALYSIS

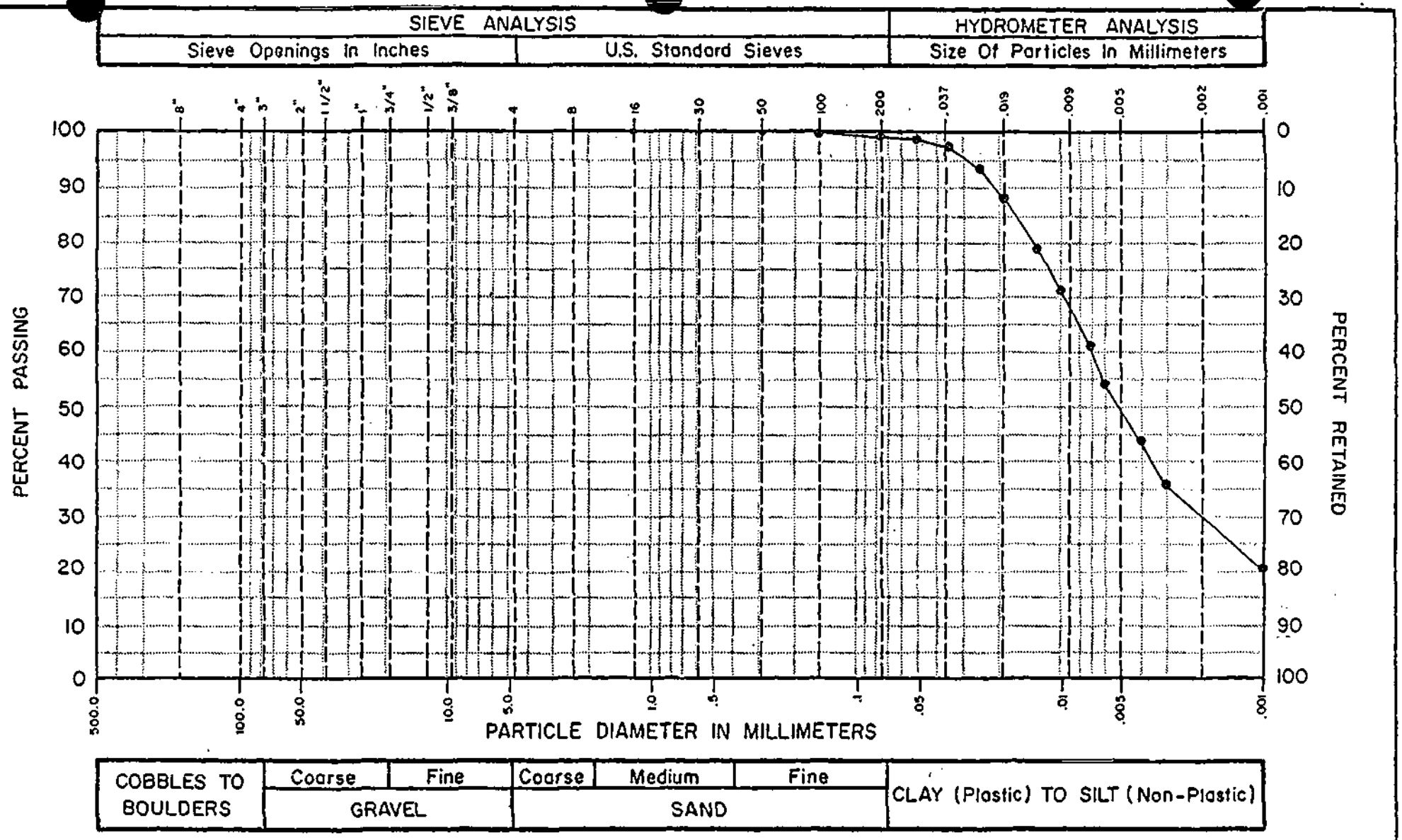
DRAWN BY: SS

JOB NO. 16991

DATE: 8/17/79

PLATE 40

1-7 1/76




| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| | 5 | 30 | | | | | MILL TAILINGS |

GEOTEK, Inc.

GRADATION ANALYSIS

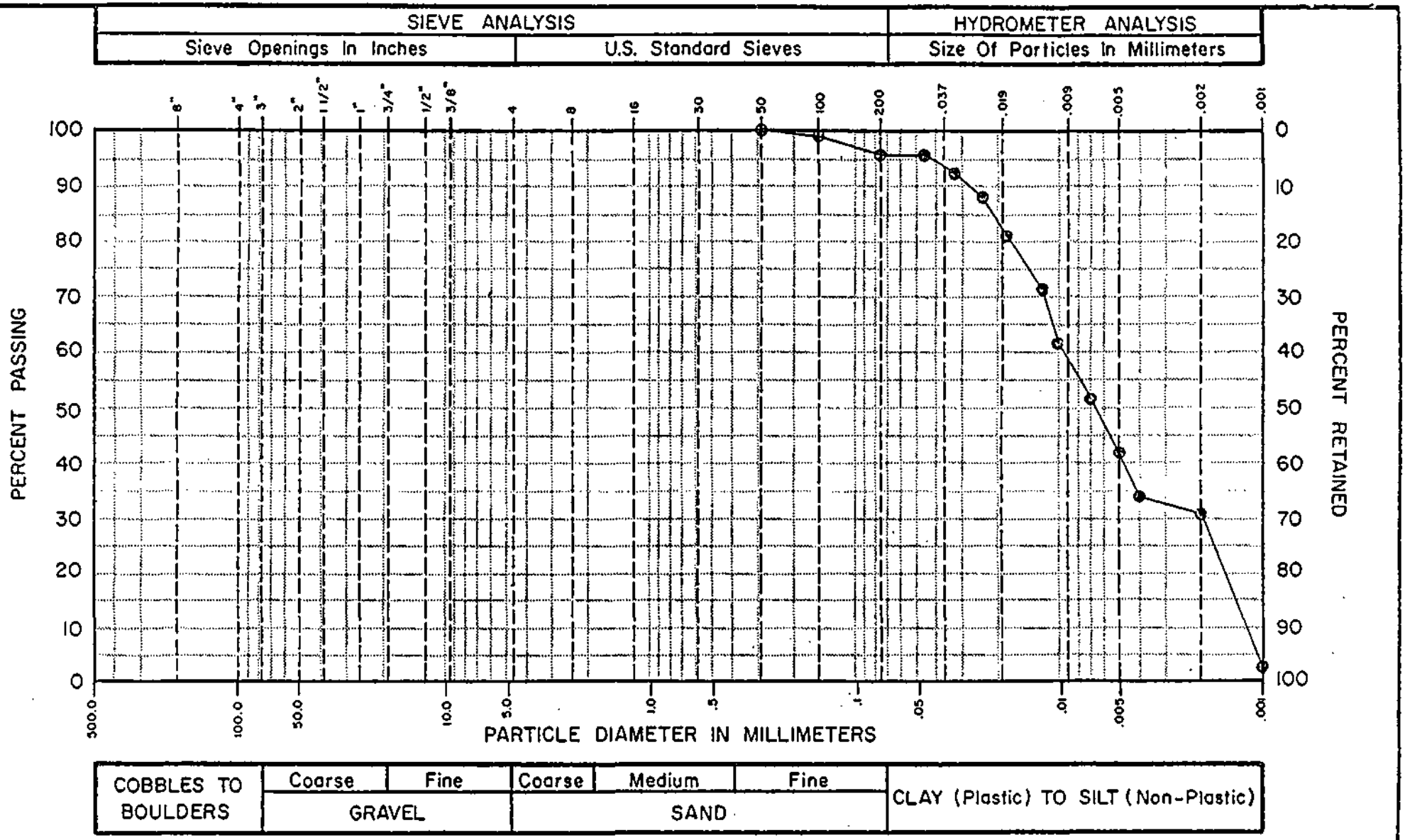
DRAWN BY: KM

JOB NO. 16991

DATE: 8/17/79

PLATE 41

1-7, 1/76




| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 5 | | 50 | | | | | MILL TAILINGS |

GEOTEK, Inc.

GRADATION ANALYSIS

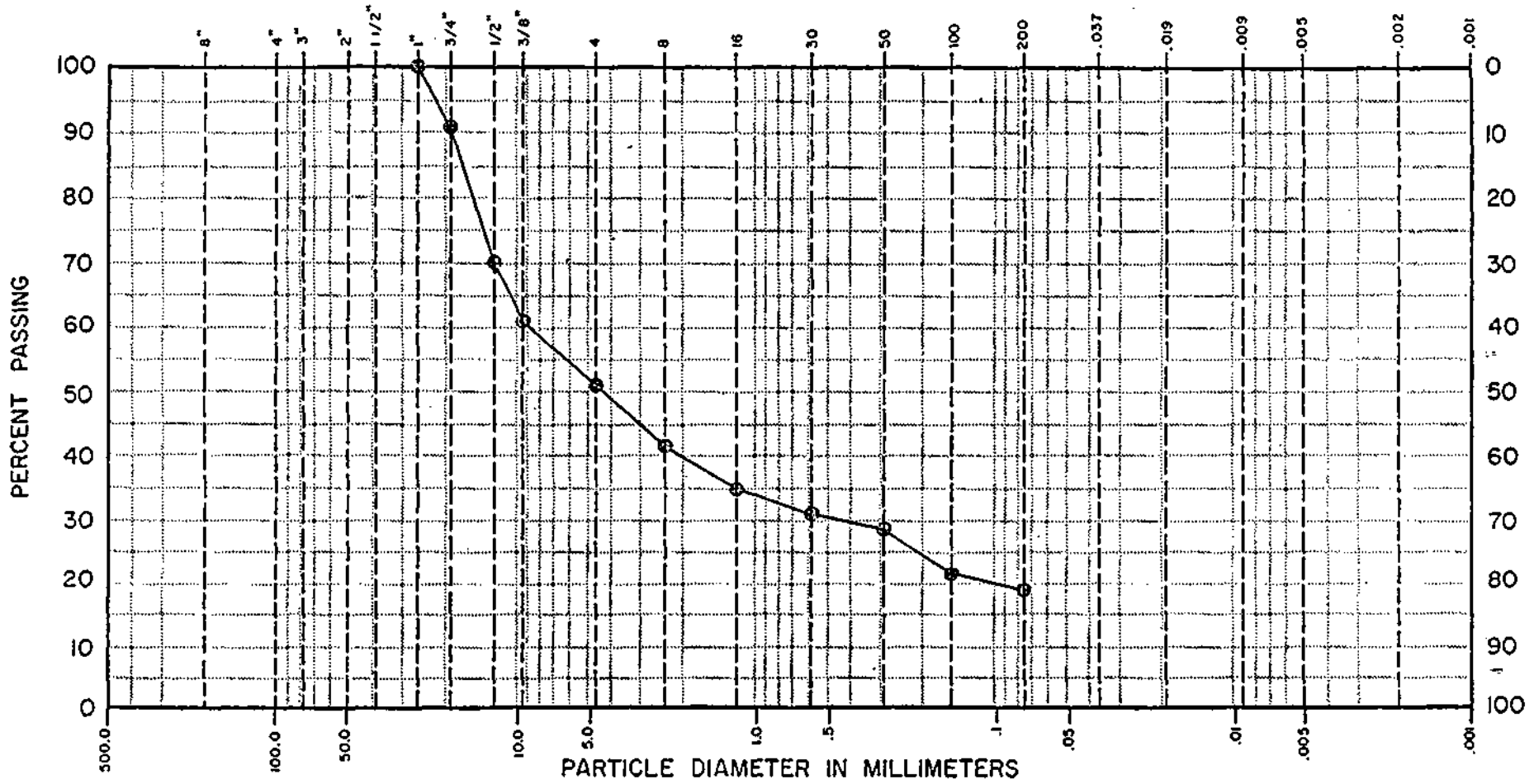
DRAWN BY:

JOB NO. 16991

DATE: 8/17/79

PAGE 42

L-7, 1/76




| COBBLES TO BOULDERS | GRAVEL | | SAND | | | CLAY (Plastic) TO SILT (Non-Plastic) |
|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | |

| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 5 | | 65 | | | | | MIXTURE OF ALLUVIUM AND COLLUVIUM |

GEOTEK, Inc.

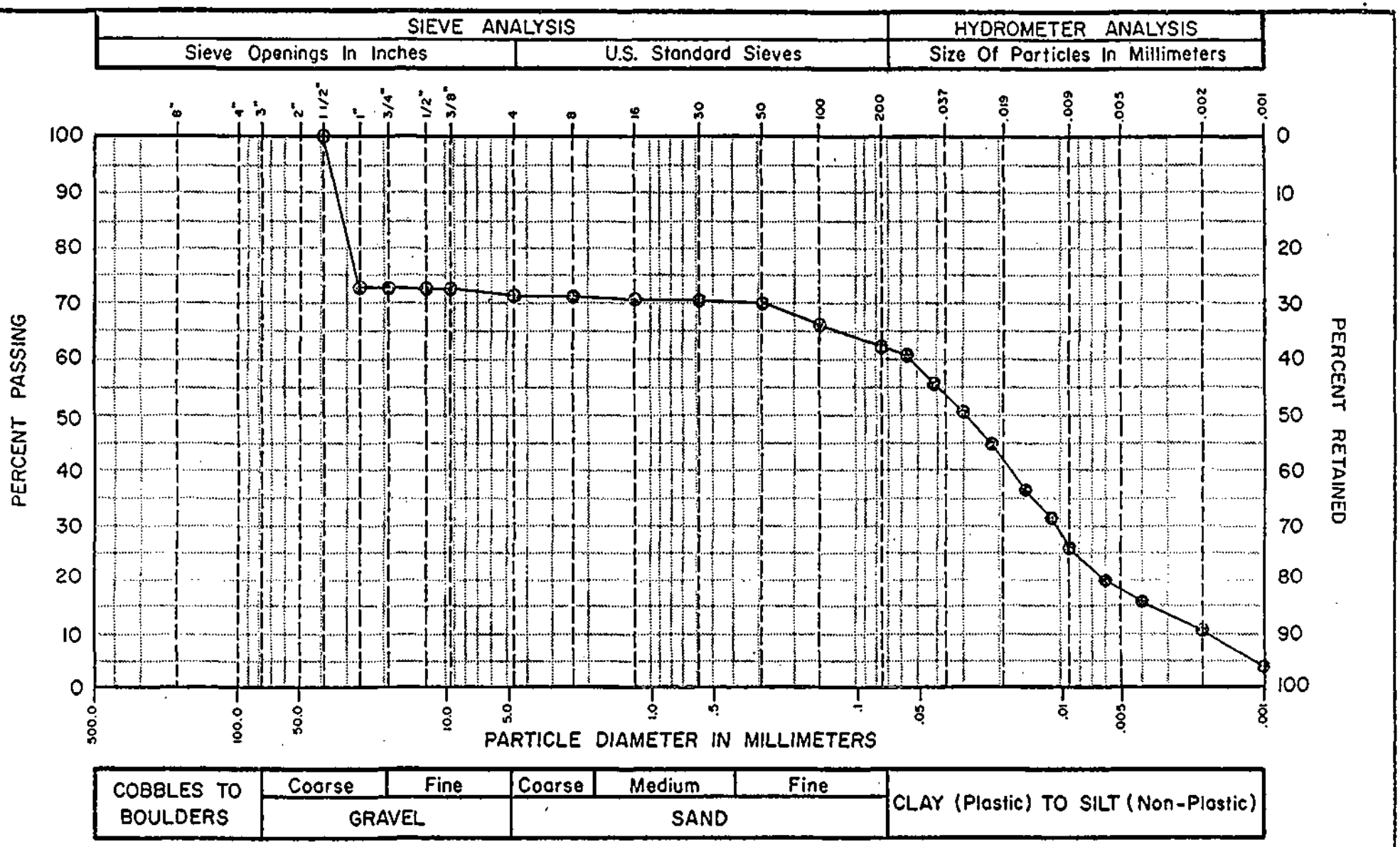
GRADATION ANALYSIS

DRAWN BY: SS

JOB NO. 16991

DATE: 8/17/79

PLATE 43




| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 6 | | 4 | | | | | DIKE MATERIAL |

GEOTEK, Inc.

GRADATION ANALYSIS

DRAWN BY: [illegible]

JOB NO. 16991

DATE: 8/17/79

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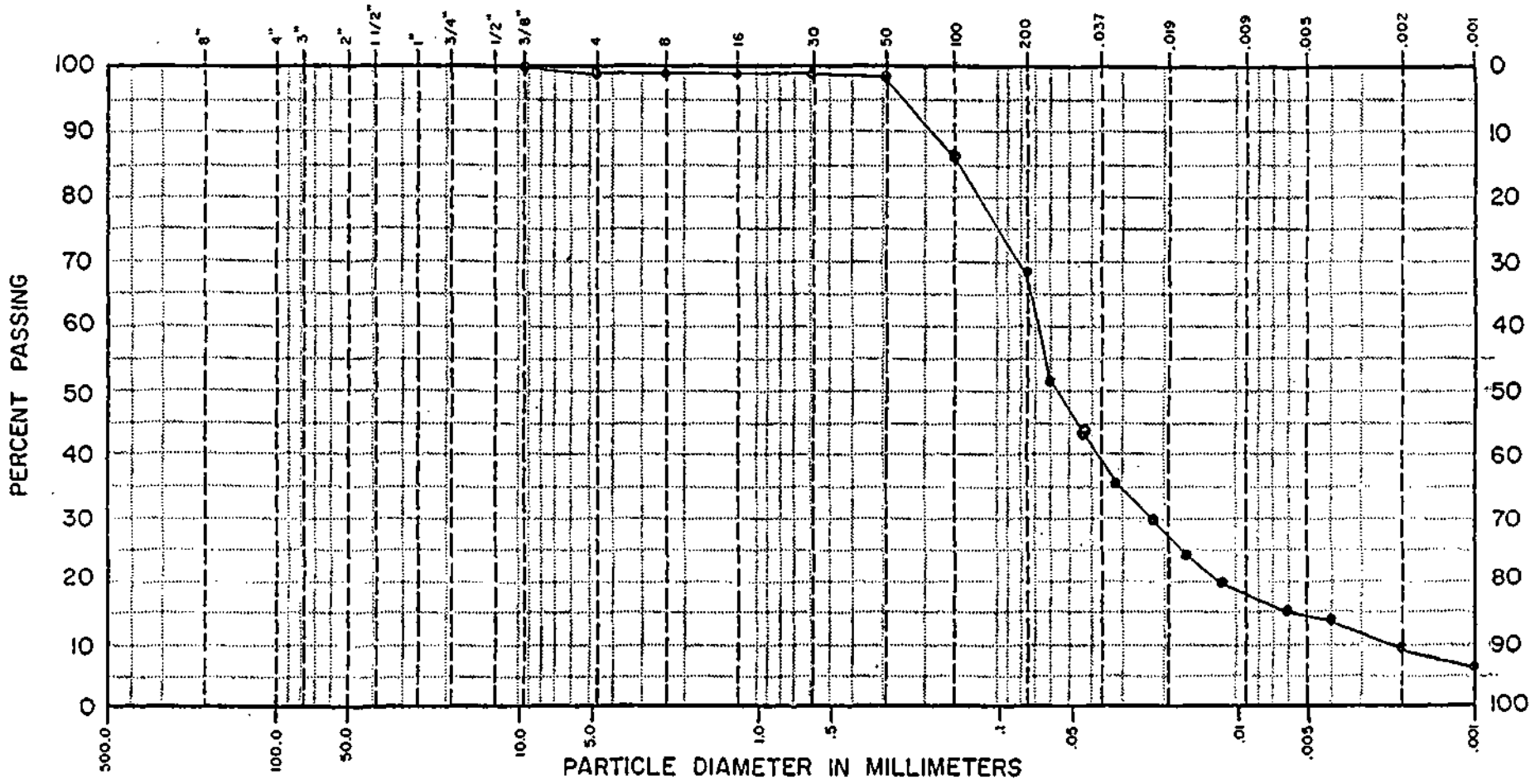



| COBBLES TO BOULDERS | Coarse | Fine | Coarse | Medium | Fine | CLAY (Plastic) TO SILT (Non-Plastic) |
|---|---|---|---|---|---|---|
| | GRAVEL | | SAND | | | |

| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 6 | | 29 | | | | | MILL TAILINGS |

GEOTEK, Inc.

GRADATION ANALYSIS

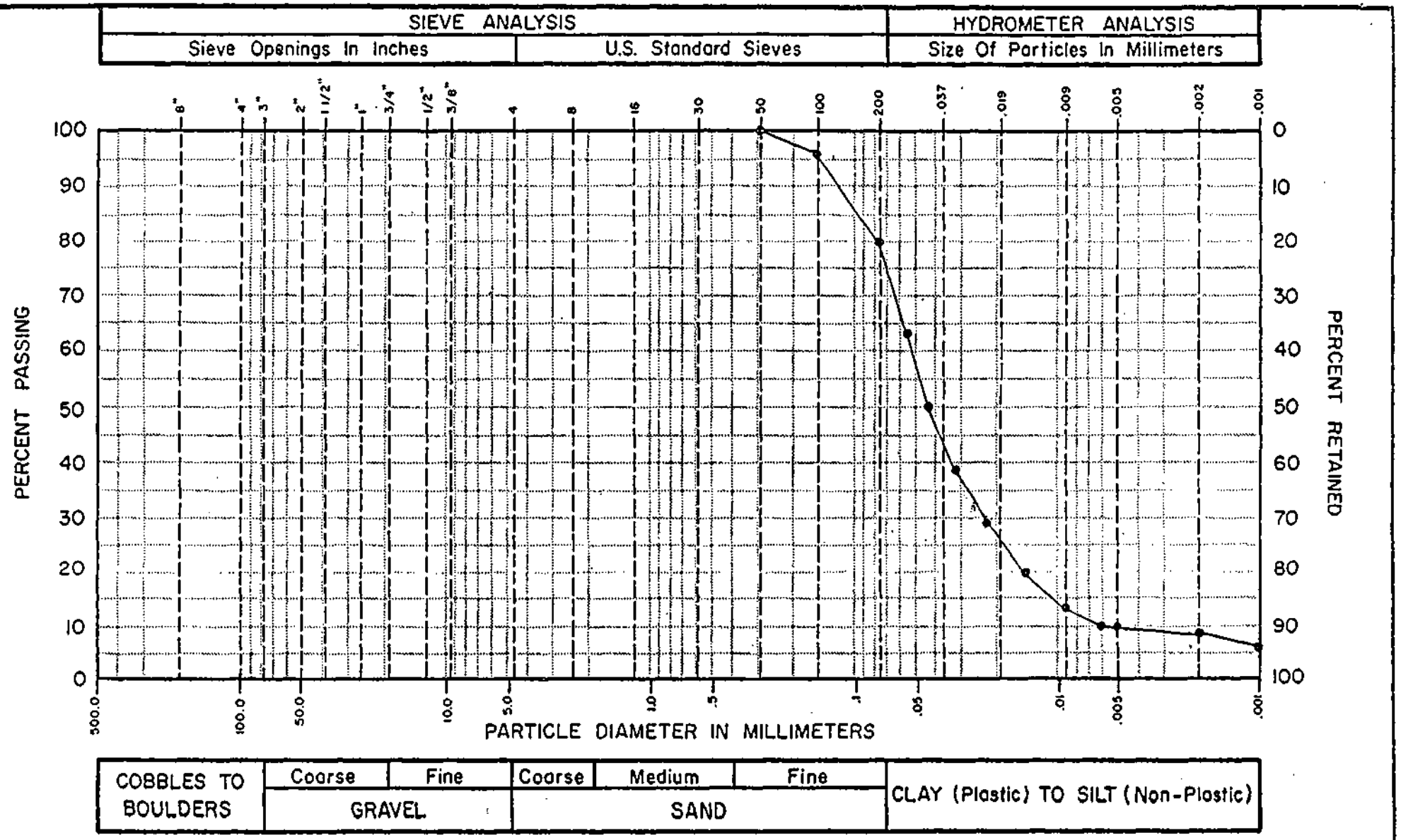
DRAWN BY: KM

JOB NO. 16991

DATE: 8/17/79

PLATE 45

L-7, 1/76




| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 6 | | 39 | | | | | MILL TAILINGS |

GEOTEK, Inc.

GRADATION ANALYSIS

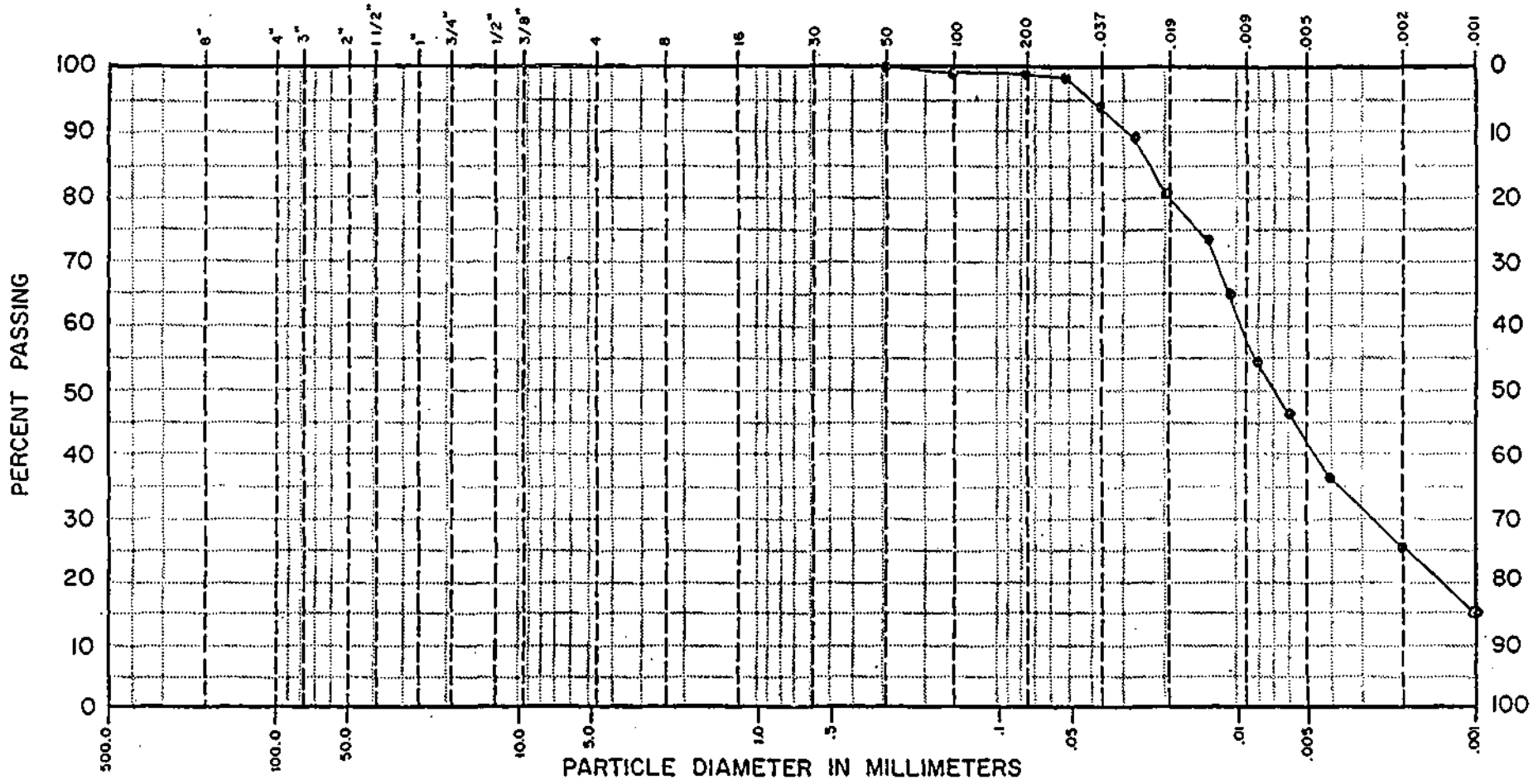
DRAWN BY: KN

JOB NO. 16991

DATE: 8/17/79

PLATE 46

L-7, 1/76




| COBBLES TO BOULDERS | GRAVEL | | SAND | | | CLAY (Plastic) TO SILT (Non-Plastic) |
|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | |

| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 6 | | 59 | | | | | MILL TAILINGS |

GEOTEK, Inc.

GRADATION ANALYSIS

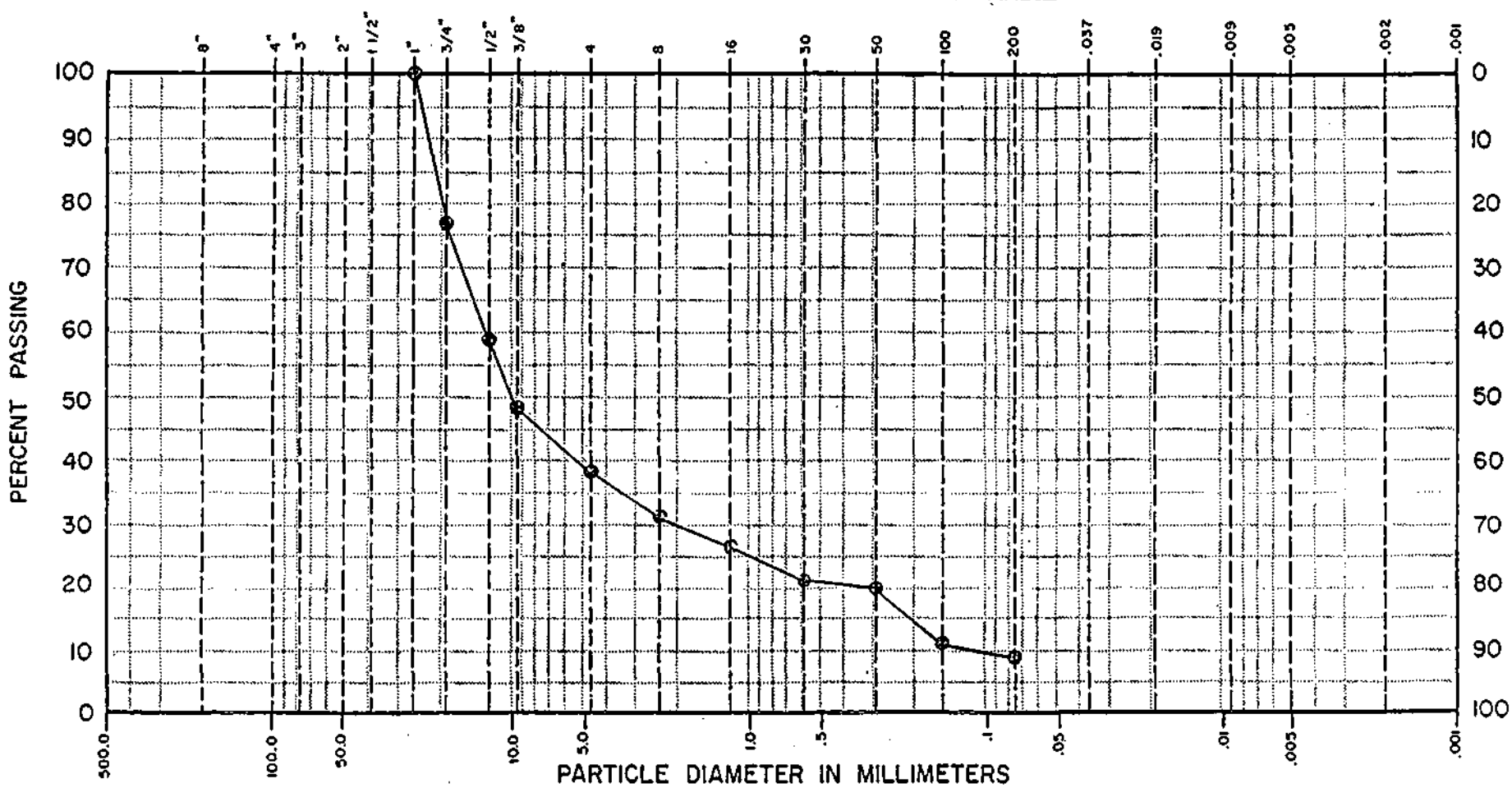
DRAWN BY: KM

JOB NO. 16991

DATE: 8/17/79

PLATE 47

L-7, 1/76




| COBBLES TO BOULDERS | GRAVEL | | SAND | | | CLAY (Plastic) TO SILT (Non-Plastic) |
|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | |

| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 6 | | 74 | | | | | MIXTURE OF ALLUVIUM AND COLLUVIUM |

GEOTEK, Inc.

GRADATION ANALYSIS

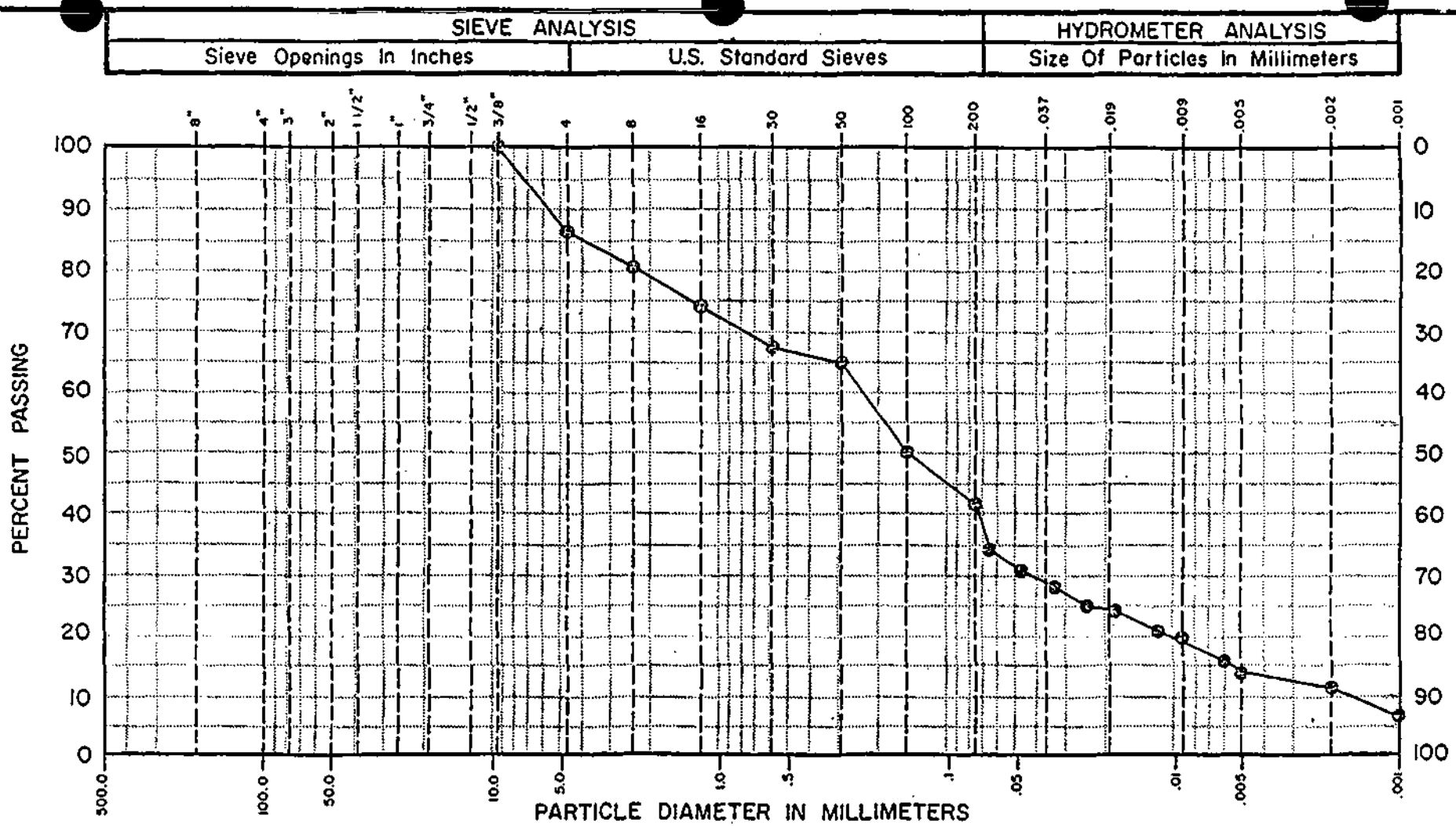
DRAWN BY: [illegible]

JOB NO. 16991

DATE: 8/17/79

[illegible]TE 48

L-7, 1/76




| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 7 | | 10 | | | | | MILL TAILINGS |

GEOTEK, Inc.

GRADATION ANALYSIS

DRAWN BY: SS

JOB NO. 16991

DATE: 8/17/79

PLATE 49

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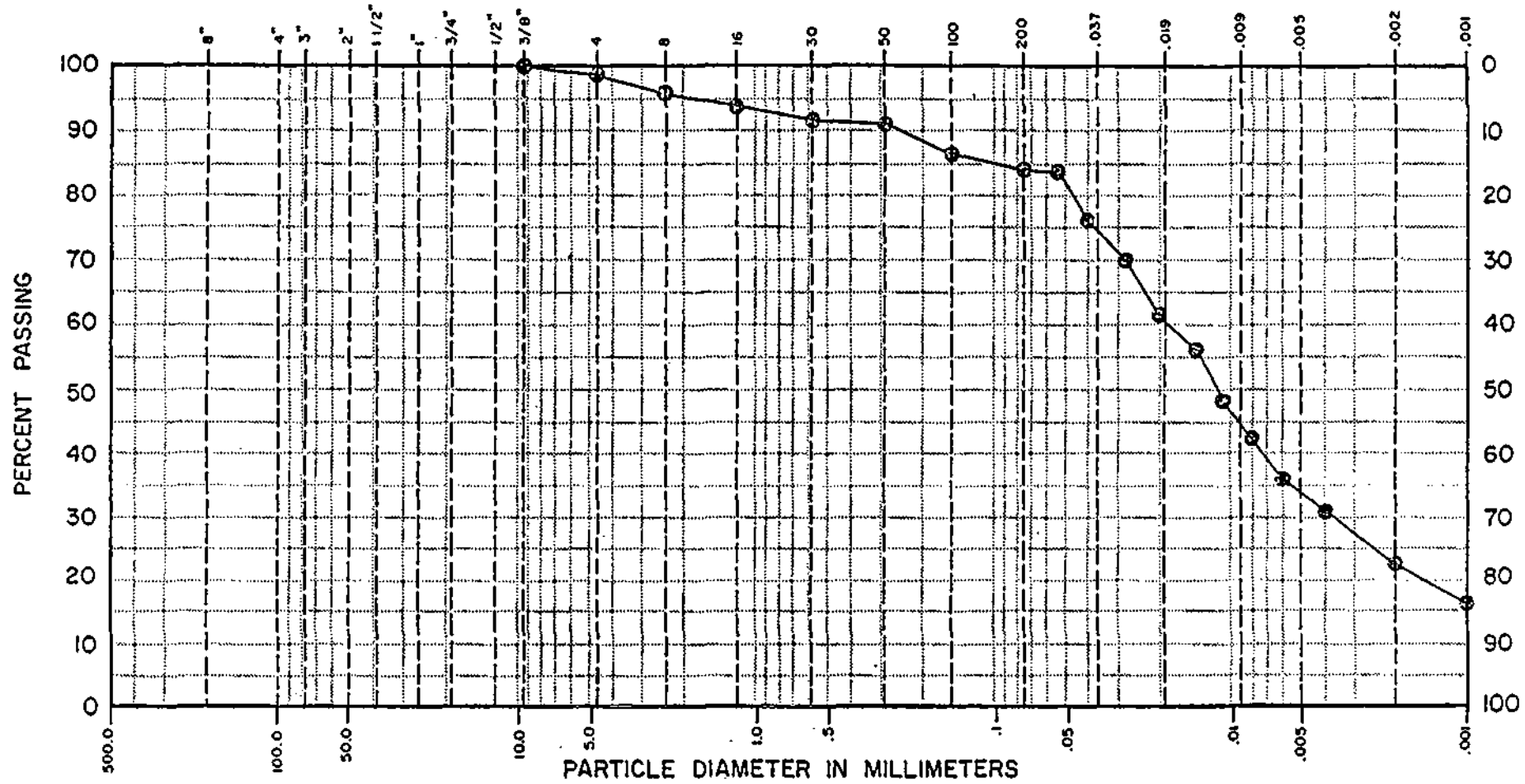


| COBBLES TO BOULDERS | GRAVEL | | SAND | | | CLAY (Plastic) TO SILT (Non-Plastic) |
|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | |

| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 7 | | 20 | | | | | MILL TAILINGS |

GEOTEK, Inc.

GRADATION ANALYSIS

DRAWN BY: SS

DATE: 8/17/79

JOB NO. 16991

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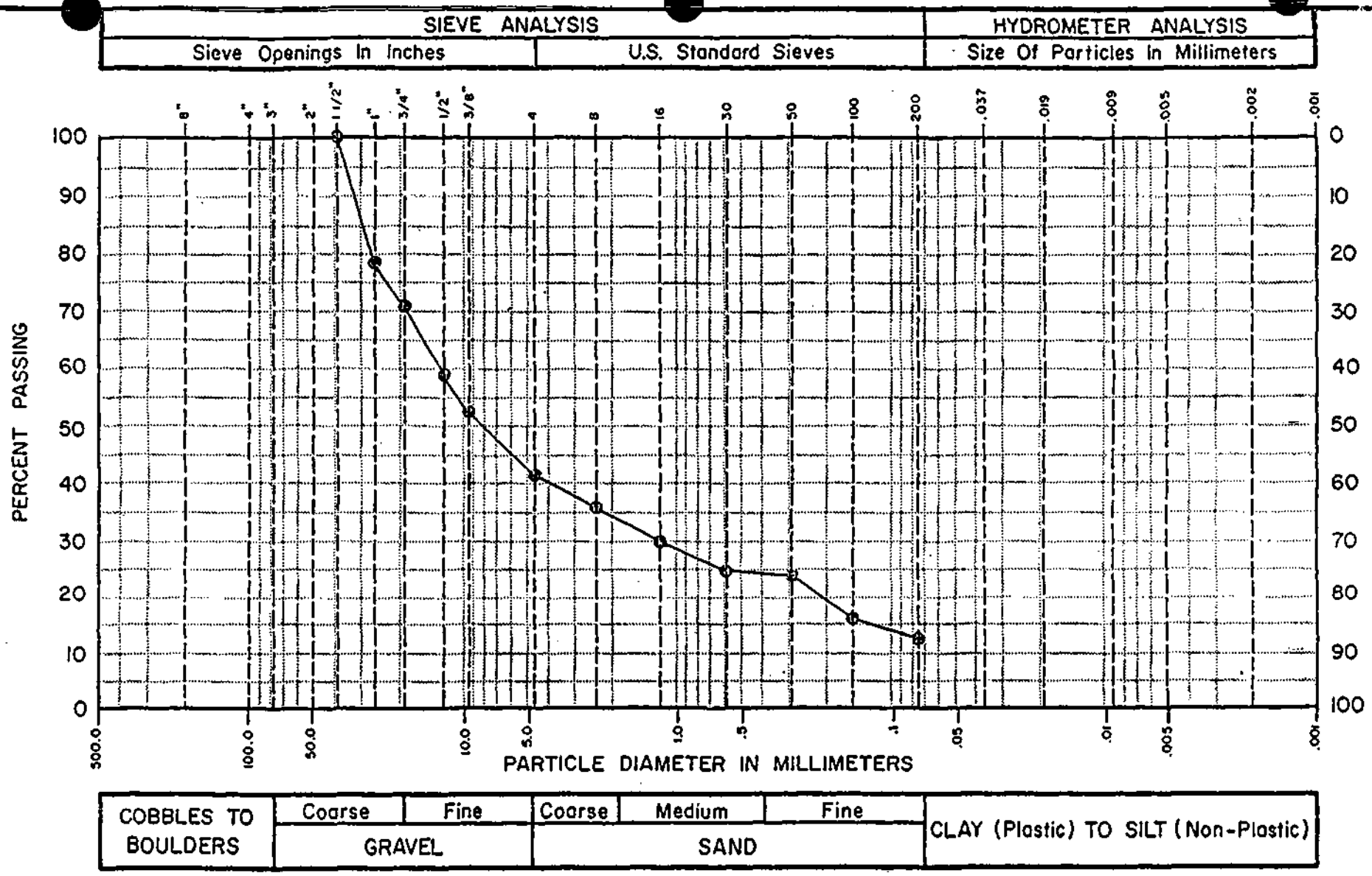



| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 7 | | 25 | | | | | MIXTURE OF ALLUVIUM AND COLLUVIUM |

GEOTEK, Inc.

GRADATION ANALYSIS

DRAWN BY: SS

JOB NO. 16991

DATE: 8/17/79

PLATE 51

L-7, 1/76

**Pond 2-3**

## TABLE A-1

## PIEZOMETER INSTALLATION DATA

| Boring | Total Standpipe Length (Feet) | Stickup Above Existing Ground Surface (Feet) | Slotted Interval Below Ground Surface (Feet) |
|---|---|---|---|
| B-9 | 72.7 | 0.5 | 67.2 - 72.2 |
| B-10 | 13.8 | 0.5 | 11.3 - 13.3 |
| B-11 | 37.3 | 0.5 | 32.8 - 36.8 |
| B-12 | 9.0 | 4.5 | 3.5 - 4.5 |
| B-13 | 7.3 | 0.5 | 5.8 - 6.8 |

## TABLE A-2

## SUMMARY OF PIEZOMETER READINGS

| | Water Level Below Ground Surface (Feet) | | | |
|---|---|---|---|---|
| Boring | 6-11-81 | 6-30-82 | 7-7-82 | 7-29-81 |
| B-9 | 69.0 | 71.0 | 71.0 | Dry |
| B-10 | - | 12.1 | 12.2 | 12.9 |
| B-11 | 34.9 | 36.0 | 36.0 | 36.3 |
| B-12 | 0.4 | 0.8* | 0.6* | 0.4* |
| B-13 | 3.8 | 1.8 | 2.0 | 1.8 |

*Water level above ground surface

## BORING B-10

SURFACE ELEVATION 9225

COORDINATES

| OTHER TESTS | STRENGTH TEST RESULTS: TYPE OF TEST | CONFINING PRESSURE (psf) | PEAK SHEAR STRENGTH (psf) | % PASSING NO. 200 SIEVE | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LL (%) | PL (%) | PI (%) | SAMPLING: BLOW COUNT | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 10 | SPT |
| | | | | | | | | | | 58/9" | SPT |
| | | | | | | | | | | 12 | SPT |

DEPTH IN FEET: 0, 5, 10, 15, 20

SAMPLING

SYMBOLS

DESCRIPTION

BROWN CLAYEY GRAVEL WITH SOME SAND

GC

BROWN SILTY FINE COARSE SAND WITH GRAVEL MEDIUM DENSE

SM

BORING COMPLETED AT 15 FEET ON 6/9/81

WATER ENCOUNTERED AT 13.5 FEET ON 6/9/81

PIEZOMETER INSTALLED

## BORING B-11

SURFACE ELEVATION 9221

COORDINATES

| OTHER TESTS | STRENGTH TEST RESULTS: TYPE OF TEST | CONFINING PRESSURE (psf) | PEAK SHEAR STRENGTH (psf) | % PASSING NO. 200 SIEVE | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LL (%) | PL (%) | PI (%) | SAMPLING: BLOW COUNT | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 11 | SPT |
| | | | | | | | | | | 14/3" | C |
| | | | | | | | | | | 8 | SPT |
| $G_s$=3.5 GRADATION | DIRECT SHEAR | 1500 | 1200 | 58 | 115 | 11 | | | | P | D |
| | | | | | | | | | | 11 | SPT |
| | | | | 46 | 136 | 14 | | | | P | D |
| | | | | | | | | | | 22 | SPT |

DEPTH IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

SAMPLING

SYMBOLS

DESCRIPTION

BROWN AND YELLOW BROWN SILTY FINE SAND LOOSE

SM

BROWN AND GREY SILTY SAND WITH SOME CLAY MEDIUM DENSE

SM

GREY FINE SANDY SILT WITH SOME CLAY LOOSE

ML

GREY FINE SANDY SILT LOOSE TO MEDIUM DENSE

ML

GRADES WITH LENSES AND LAYERS OF CLAYEY SILT

GRADES WITH GRAVEL

AUGER REFUSAL AT 37 FEET

BORING COMPLETED AT 37 FEET ON 6/10/81

WATER LEVEL ENCOUNTERED AT 34.9 FEET ON 6/10/81

PIEZOMETER INSTALLED

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- SPT - STANDARD SPLIT-SPOON
- D - DAMES & MOORE "D" SAMPLER

NOTE:

SEE PLATE A - 1A

# LOG OF BORING

DAMES & MOORE

## BORING B-12

SURFACE ELEVATION 9176

COORDINATES

| OTHER TESTS | STRENGTH TEST RESULTS: TYPE OF TEST | CONFINING PRESSURE (psf) | PEAK SHEAR STRENGTH (psf) | % PASSING NO 200 SIEVE | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LL (%) | PL (%) | PI (%) | SAMPLING: BLOW COUNT | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | REFUSAL ON COBBLE | SPT |

DEPTH IN FEET: 0, 5, 10, 15, 20, 25, 30

SAMPLING

SYMBOLS DESCRIPTION

BROWN SANDY SILTY GRAVEL WITH COBBLES

BORING COMPLETED AT 5.0 FEET ON 6/10/81

WATER ENCOUNTERED AT 0.4 FEET ON 6/11/81

PIEZOMETER INSTALLED

## BORING B-13

SURFACE ELEVATION 9144

COORDINATES

| OTHER TESTS | STRENGTH TEST RESULTS: TYPE OF TEST | CONFINING PRESSURE (psf) | PEAK SHEAR STRENGTH (psf) | % PASSING NO. 200 SIEVE | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LL (%) | PL (%) | PI (%) | SAMPLING: BLOW COUNT | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 20 | SPT |

DEPTH IN FEET: 0, 5, 10, 15, 20, 25, 30

SAMPLING

SYMBOLS DESCRIPTION

BROWN SILTY SANDY GRAVEL WITH CLAY LOOSE TO MEDIUM DENSE

BORING COMPLETED AT 7.5 FEET ON 6/10/81

WATER ENCOUNTERED AT 3.8 FEET ON 6/11/81

PIEZOMETER INSTALLED

KEY

- INDICATES UNDISTURBED SAMPLE
- INDICATES DISTURBED SAMPLE
- INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- SPT - STANDARD SPLIT-SPOON
- D - DAMES & MOORE "D" SAMPLER

NOTE:

SEE PLATE A - 1A.

# LOG OF BORING

DAMES & MOORE

# BORING B-20

SURFACE ELEVATION 9223

COORDINATES

| OTHER TESTS | STRENGTH TEST RESULTS: TYPE OF TEST | CONFINING PRESSURE (psf) | PEAK SHEAR STRENGTH (psf) | % PASSING NO. 200 SIEVE | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LL (%) | PL (%) | PI (%) | SAMPLING: BLOW COUNT | SAMPLE TYPE | DEPTH IN FEET | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | 0 | GREY AND BROWN FINE SANDY SILT LOOSE TO MEDIUM DENSE |
| | | | | | | | | | | | | | GRADES WITH SOME GRAVEL |
| | | | | | | | | | | 31/4" | U | 5 | BROWN SANDY GRAVEL WITH SILT |
| | | | | | | | | | | 36 | U | | GRADES WITH LESS SILT |
| | | | | | | | | | | 13 | SPT | 10 | GRADES WITH MORE SILT |
| SPECIFIC GRAVITY Gs = 2.9 | SEE PLATE A-5B | | | | 122 | 7 | | | | P | T | | BROWN & GREY SILTY FINE SAND LOOSE TO MEDIUM DENSE |
| PERMEABILITY k = 7 x 10⁻⁴ cm/sec | | | | | | | | | | 46 | SPT | 15 | BROWN SANDY GRAVEL WITH SILT MEDIUM DENSE |
| | | | | | | | | | | 46 | U | 20 | BROWN SANDY GRAVEL WITH CLAY AND SILT MEDIUM DENSE TO DENSE |
| | | | | | | 7 | 25 | 20 | 5 | 50/3" | U | 25 | |
| | | | | | | | | | | 75 | U | | |
| | | | | | | | | | | 20/6" | SPT | 30 | AUGER REFUSAL |
| | | | | | | | | | | | | | BORING COMPLETED AT 29.5 FEET ON 7/3/81 |
| | | | | | | | | | | | | 35 | |
| | | | | | | | | | | | | 40 | |
| | | | | | | | | | | | | 45 | |
| | | | | | | | | | | | | 50 | |
| | | | | | | | | | | | | 55 | |
| | | | | | | | | | | | | 60 | |
| | | | | | | | | | | | | 65 | |
| | | | | | | | | | | | | 70 | |

SYMBOLS

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- SPT - STANDARD SPLIT-SPOON

NOTE:
SEE PLATE A-1A

# LOG OF BORING

DAMES & MOORE

# BORING B-21

SURFACE ELEVATION 9224

COORDINATES

| OTHER TESTS | STRENGTH TEST RESULTS: TYPE OF TEST | CONFINING PRESSURE (psf) | PEAK SHEAR STRENGTH (psf) | % PASSING NO 200 SIEVE | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LL (%) | PL (%) | PI (%) | SAMPLING: BLOW COUNT | SAMPLE TYPE | DEPTH IN FEET | SAMPLING | SYMBOLS | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 49 | | 30 | 32 | NON-PLASTIC | | 6 | SPT | 0 | ■ | | BROWN AND YELLOW BROWN SANDY SILT AND SILTY SAND LOOSE<br>GRADES WITH MORE SAND COLORS GREY AND YELLOW BROWN |
| SPECIFIC GRAVITY Gs = 2.1 | SEE PLATE A-6B | | | | 92 | 20 | | | | P | T | 5 | ■ ■ | ML-SM | |
| | | | | | 109 | 8 | | | | 15 | U | 10 | ⊠ | | COLORS GREY-BROWN |
| CONSOLIDATION PERMEABILITY k=4 x $10^{-5}$ cm/sec | | | | 40 | 102 | 10 | | | | P<br>3 | T<br>SPT | 15 | ■<br>◪ | | GRADES WITH LESS SAND<br>GREY CLAYEY SILT SOFT |
| CONSOLIDATION | SEE PLATE A-6A | | | | 91<br>83 | 38<br>44 | 37 | 26 | 11 | P<br>3-1/2 | T<br>SPT | 20 | ⊠<br>◪ | ML | |
| | SEE PLATE A-6A | | | | 93 | 37 | | | | P<br>4 | T<br>SPT | 25 | ■<br>◪ | | |
| | | | | | | | | | | 50/1" | U | 30 | | | |
| | | | | | | | | | | 50/1" | U | 35 | ⊠<br>□ | GM | REDDISH BROWN SANDY GRAVEL WITH SILT MEDIUM DENSE TO DENSE<br>AUGER REFUSAL<br>BORING COMPLETED AT 36.5 FEET ON 7/4/81 |
| | | | | | | | | | | | | 40 | | | |
| | | | | | | | | | | | | 45 | | | |
| | | | | | | | | | | | | 50 | | | |
| | | | | | | | | | | | | 55 | | | |
| | | | | | | | | | | | | 60 | | | |
| | | | | | | | | | | | | 65 | | | |
| | | | | | | | | | | | | 70 | | | |

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- SPT - STANDARD SPLIT-SPOON

NOTE:
SEE PLATE A-1A

# LOG OF BORING

DAMES & MOORE

# BORING B-22

SURFACE ELEVATION 9239

COORDINATES

| OTHER TESTS | STRENGTH TEST RESULTS: TYPE OF TEST | CONFINING PRESSURE (psf) | PEAK SHEAR STRENGTH (psf) | % PASSING NO. 200 SIEVE | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LL (%) | PL (%) | PI (%) | SAMPLING: BLOW COUNT | SAMPLE TYPE | DEPTH IN FEET | SAMPLING SYMBOLS | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | 0 | | REDDISH BROWN SILTY AND CLAYEY GRAVEL WITH SAND, LOOSE |
| | | | | | 111 | 13 | | | | 12 | U | 5 | | |
| | | | | | | | | | | 24 | SPT | 10 | | GRADES WITH MORE GRAVEL AND LESS CLAY |
| | | | | | | | | | | 65 | U | 15 | | GREY FINE SANDY SILT LOOSE |
| | | | | | | | | | | 7 | U | 20 | | |
| CONSOLIDATION SPECIFIC GRAVITY Gs = 3.3 | SEE PLATE A-1A | | | | 95<br>107 | 35<br>29 | | | | P | T | 25 | | GREY CLAYEY SILT SOFT |
| | | | | | | | | | | 10 | SPT | 30 | | |
| | | | | | 120 | 18 | | | | P | T | 35 | | GRADES WITH MORE SAND |
| | | | | | | | | | | 22/6" | SPT | 40 | | BROWN SANDY GRAVEL WITH SILT MEDIUM DENSE TO DENSE<br>AUGER REFUSAL<br>BORING COMPLETED AT 40 FEET ON 7/4/81 |
| | | | | | | | | | | | | 45 | | |
| | | | | | | | | | | | | 50 | | |
| | | | | | | | | | | | | 55 | | |
| | | | | | | | | | | | | 60 | | |
| | | | | | | | | | | | | 65 | | |
| | | | | | | | | | | | | 70 | | |

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

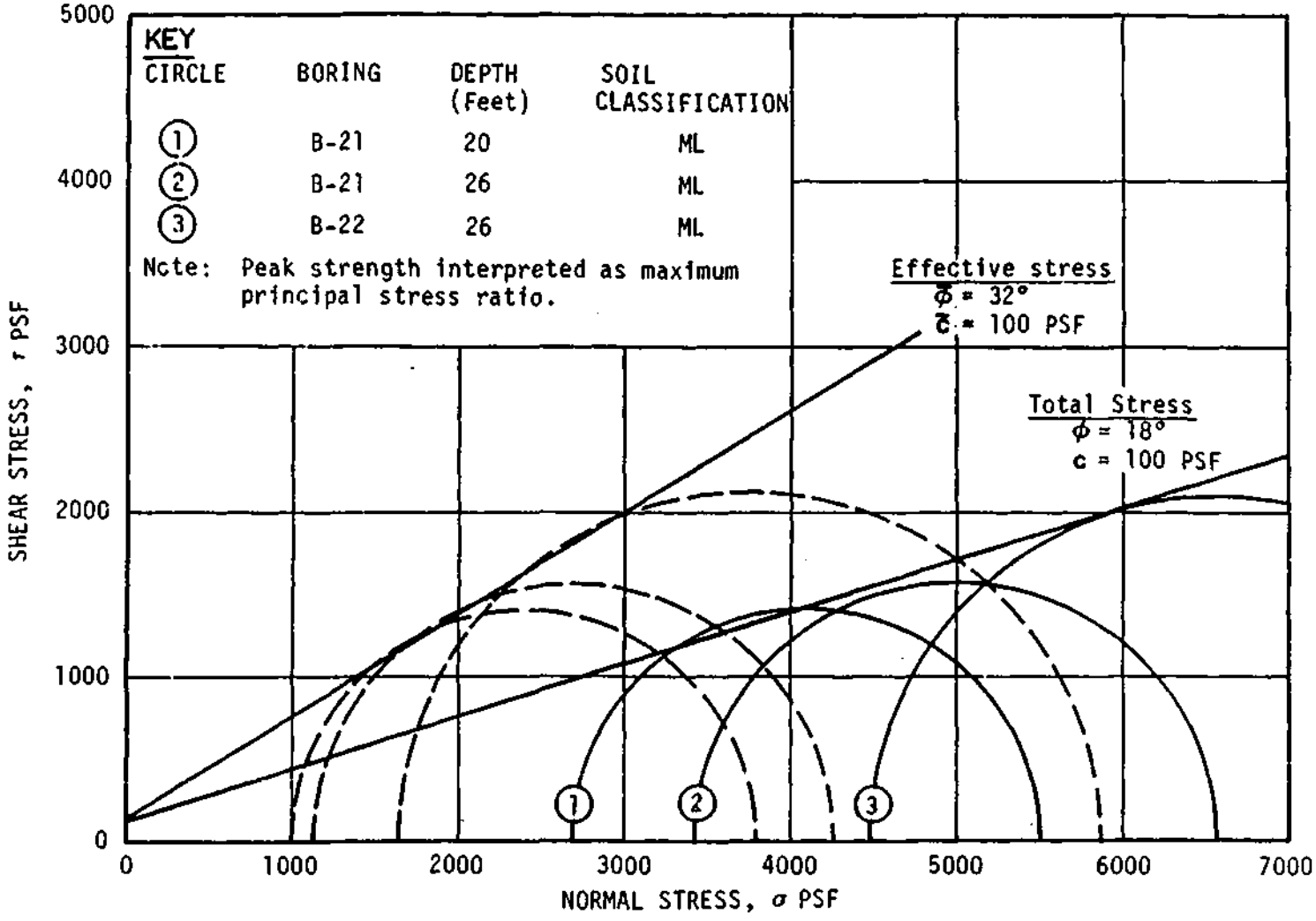
SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- SPT - STANDARD SPLIT-SPOON

NOTE:
SEE PLATE A-1A

# LOG OF BORING

DAMES & MOORE

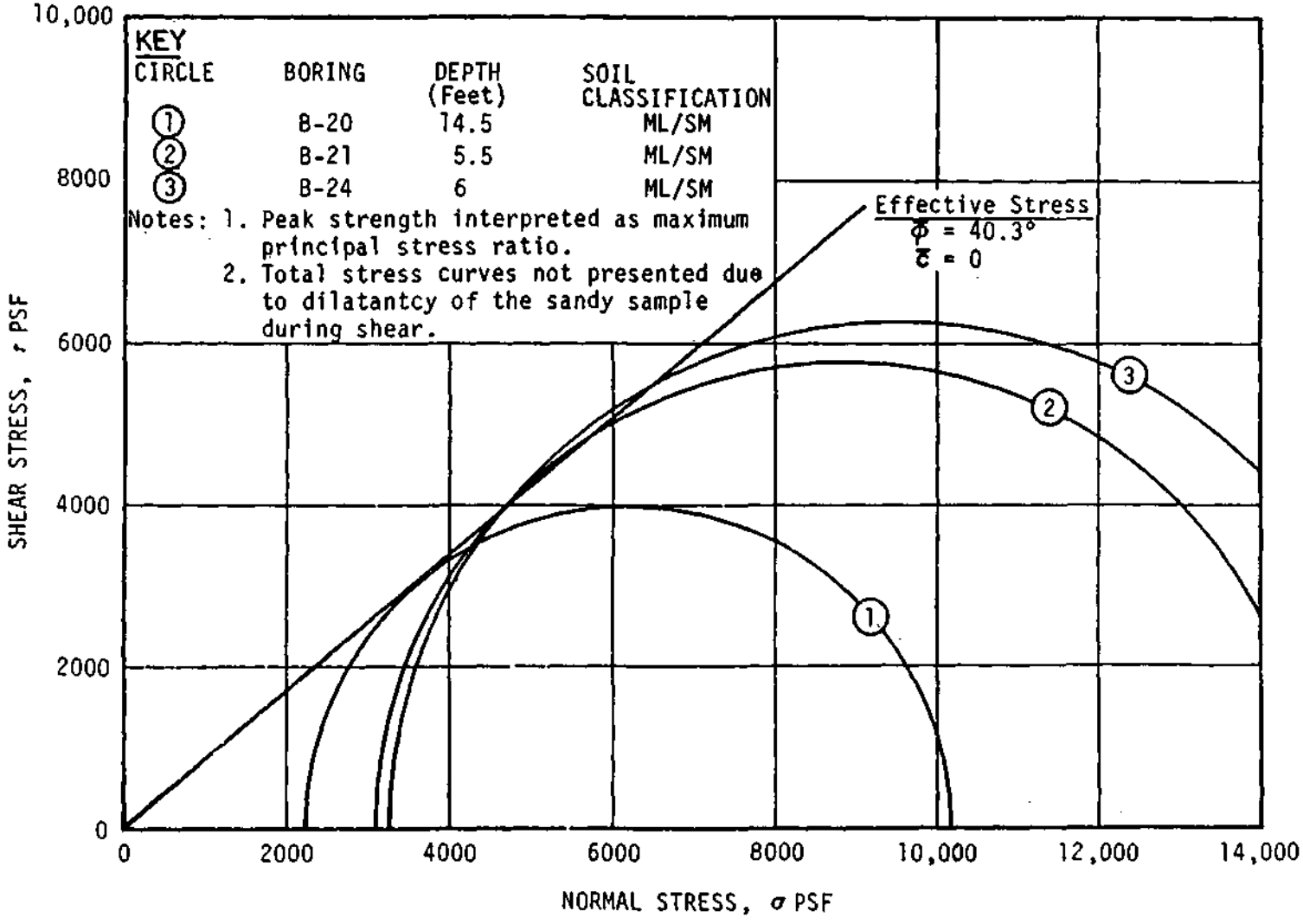



# TRIAXIAL COMPRESSION TEST RESULTS

## CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENT

Dames & Moore

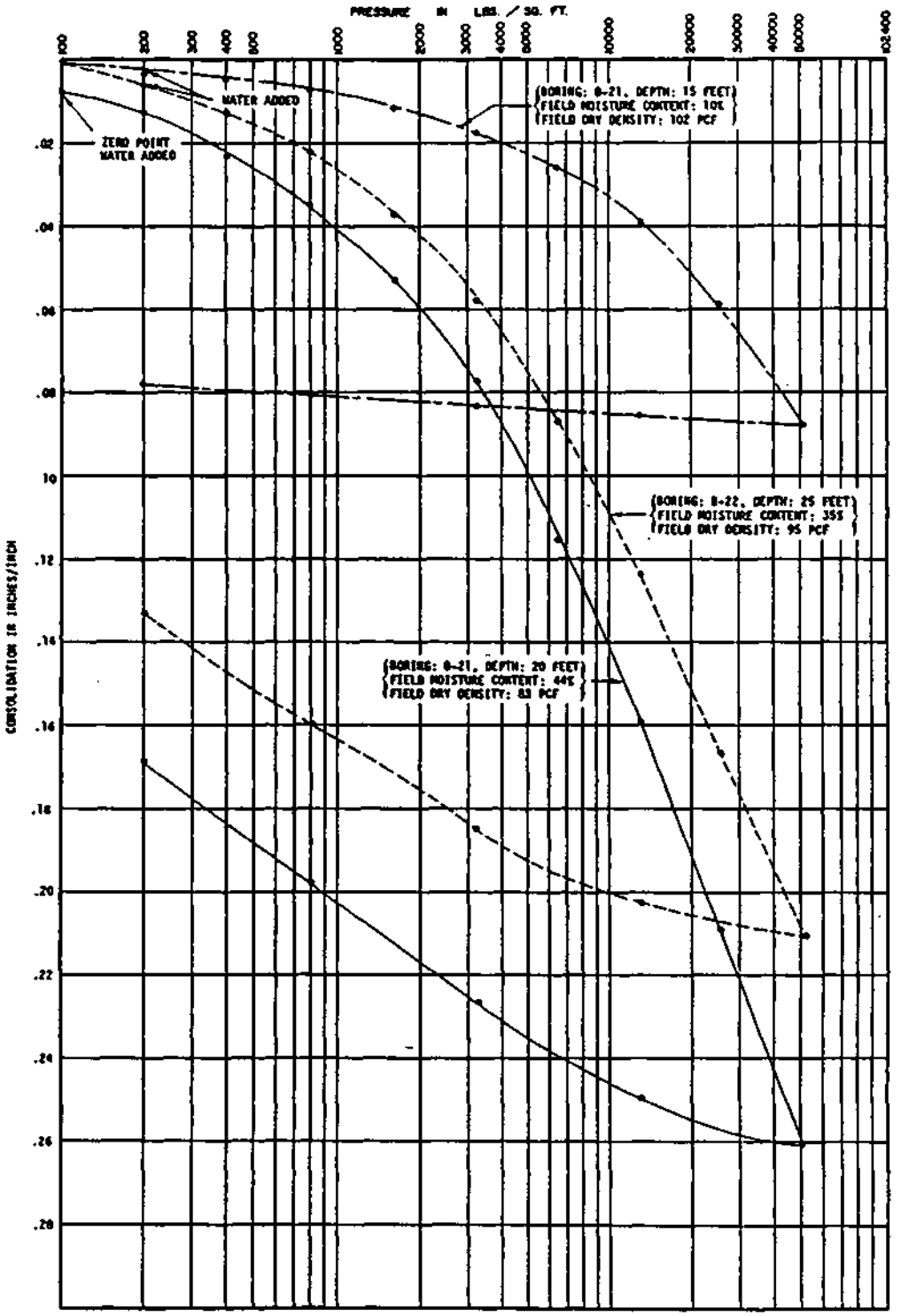
PLATE A-5A




# TRIAXIAL COMPRESSION TEST RESULTS

## CONSOLIDATED UNDRAINED WITH PORE PRESSURE MEASUREMENT

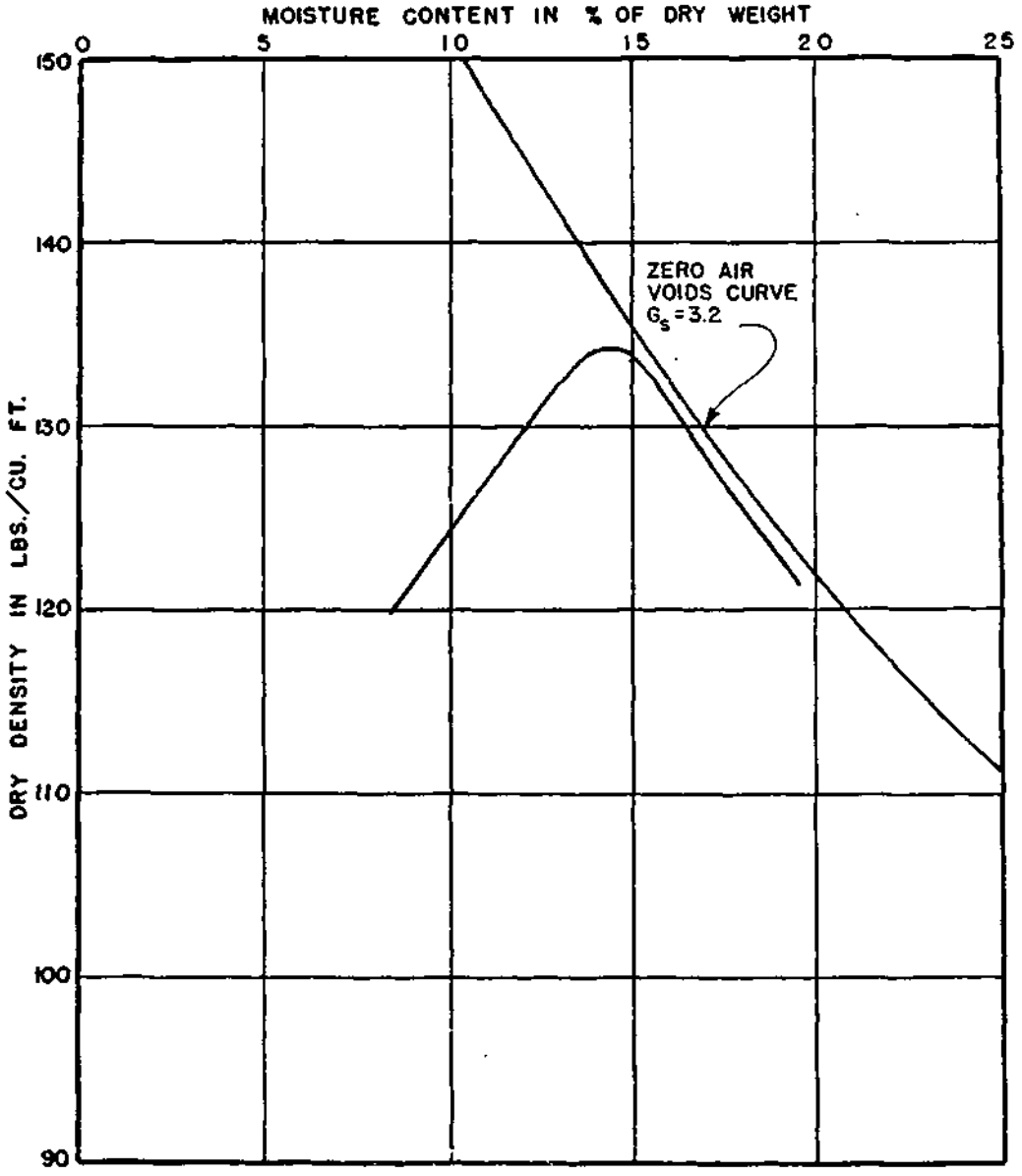
Dames & Moore




## CONSOLIDATION TEST DATA

DAMES & MOORE

SAMPLE NO. BULK No. 3 DEPTH — ELEVATION —
SOIL GREY SANDY SILT (ML)
LOCATION DAM FILL MATERIAL ON POND-2
OPTIMUM MOISTURE CONTENT 14.3 PERCENT
MAXIMUM DRY DENSITY 134 POUNDS PER CUBIC FOOT
METHOD OF COMPACTION ASTM-1557 (METHOD-A)



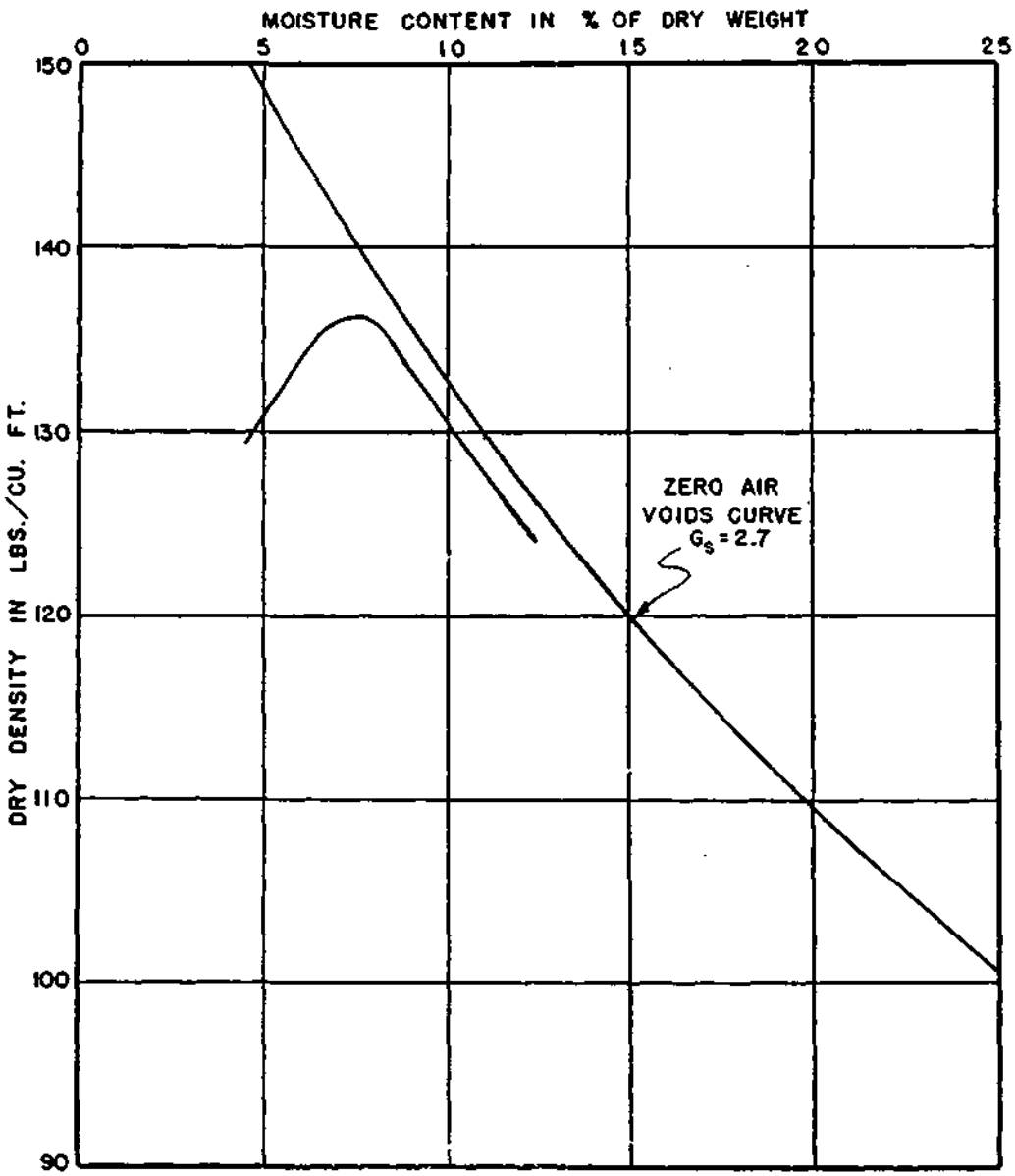

# COMPACTION TEST DATA

DAMES & MOORE

PLATE A-7A

CHECKED BY ____ DATE ____
BY ____ DATE ____
BY ____ DATE ____

SAMPLE NO. BULK No.2 DEPTH — ELEVATION —
SOIL BROWN SILTY SAND AND SANDY GRAVEL (SP-SM/GW-GC)
LOCATION DAM FILL MATERIAL BETWEEN PONDS 2 & 3
OPTIMUM MOISTURE CONTENT 7.5 PERCENT
MAXIMUM DRY DENSITY 136 POUNDS PER CUBIC FOOT
METHOD OF COMPACTION ASTM D-1557 (METHOD-C)




# COMPACTION TEST DATA

DAMES & MOORE

PLATE A-78

DRAWN BY ____ DATE ____
CHECKED BY ____ DATE ____
REVISION 2 BY ____ DATE ____
REVISION 1 BY ____ DATE ____
FILE ____

56.1 (REV. 4-57)

# BORING 8

SURFACE ELEVATION _____

| DEPTH IN FEET | BLOW COUNT | SAMPLES | SYMBOLS | DESCRIPTIONS |
|---|---|---|---|---|
| 0 | | | | FILL CONSISTING OF GRAVEL, COBBLES, BOULDERS, SAND AND SILT, MOIST (DIKE MATERIAL) |
| | 45 | ■ | | |
| 10 | | | | GRADING WITH SOME WOOD AT 7 FEET |
| | 25 | ■ | | |
| | 85 | ■ | | GRAVEL, COBBLES, BOULDERS, SAND, LITTLE SILT, VERY MOIST (MIXTURE OF ALLUVIUM AND COLLUVIUM) |
| 20 | | | | AUGER REFUSAL AT 18 FEET |

BORING COMPLETED ON 7-21-79

NO GROUNDWATER ENCOUNTERED AT TIME OF DRILLING

GEOTEK Consultants, Inc.

# BORING 9

SURFACE ELEVATION _____

| DEPTH IN FEET | BLOW COUNT | SAMPLES | SYMBOLS | DESCRIPTIONS |
|---|---|---|---|---|
| 0 | | | | |
| | 42 | | | FILL CONSISTING OF GRAVEL, BOULDERS, COBBLES, SAND, LITTLE SILT, MOIST (DIKE MATERIAL) |
| 10 | 36 | | | |
| | 48 | | | |
| 20 | 2 | | | FILL CONSISTING OF SILT, LITTLE TO SOME CLAY, OCCASIONAL FINE, SANDY LENSES, VERY MOIST, SOFT (MILL TAILINGS) |
| | P | | | GRADING TO WET AND MEDIUM STIFF AT 26 FEET |
| 30 | 6 | | | |
| | 6 | | | |
| 40 | 34 | | | GRAVEL, COBBLES, BOULDERS, SAND, LITTLE SILT, WET (MIXTURE OF ALLUVIUM AND COLLUVIUM) |
| | 31 | | | |
| 50 | | | | AUGER REFUSAL AT 49 FEET |

BORING COMPLETED ON 7-22-79

GROUNDWATER OBSERVED AT A DEPTH OF 27 FEET ON 7-22-79

GEOTEK Consultants, Inc.

# BORING 10

SURFACE ELEVATION _____

| DEPTH IN FEET | BLOW COUNT | SAMPLES | SYMBOLS | DESCRIPTIONS |
|---|---|---|---|---|
| 0 | | | | |
| | 15 | | | FILL CONSISTING OF SILT, SOME SAND, TRACE TO LITTLE CLAY, MOIST (DIKE MATERIAL) |
| 10 | 12 | | | GRADING TO GRAVEL, COBBLES, SAND AND LITTLE SILT BELOW 12 FEET |
| | 34 | | | |
| 20 | | | | FILL CONSISTING OF SILT, WITH LENSES OF FINE, SILTY SAND, VERY MOIST, SOFT TO MEDIUM STIFF (MILL TAILINGS) |
| | P | | | |
| 30 | | | | |
| | 94 | | | GRAVEL, COBBLES, BOULDERS, SAND WITH LITTLE SILT, WET (MIXTURE OF ALLUVIUM AND COLLUVIUM) |
| 40 | 82 | | | AUGER REFUSAL AT 42-1/2 FEET |
| 50 | | | | |

BORING COMPLETED ON 7-22-79

GROUNDWATER OBSERVED AT A DEPTH OF 39-1/2 FEET ON 7-22-79

GEOTEK Consultants, Inc.

# BORING 11

SURFACE ELEVATION _____

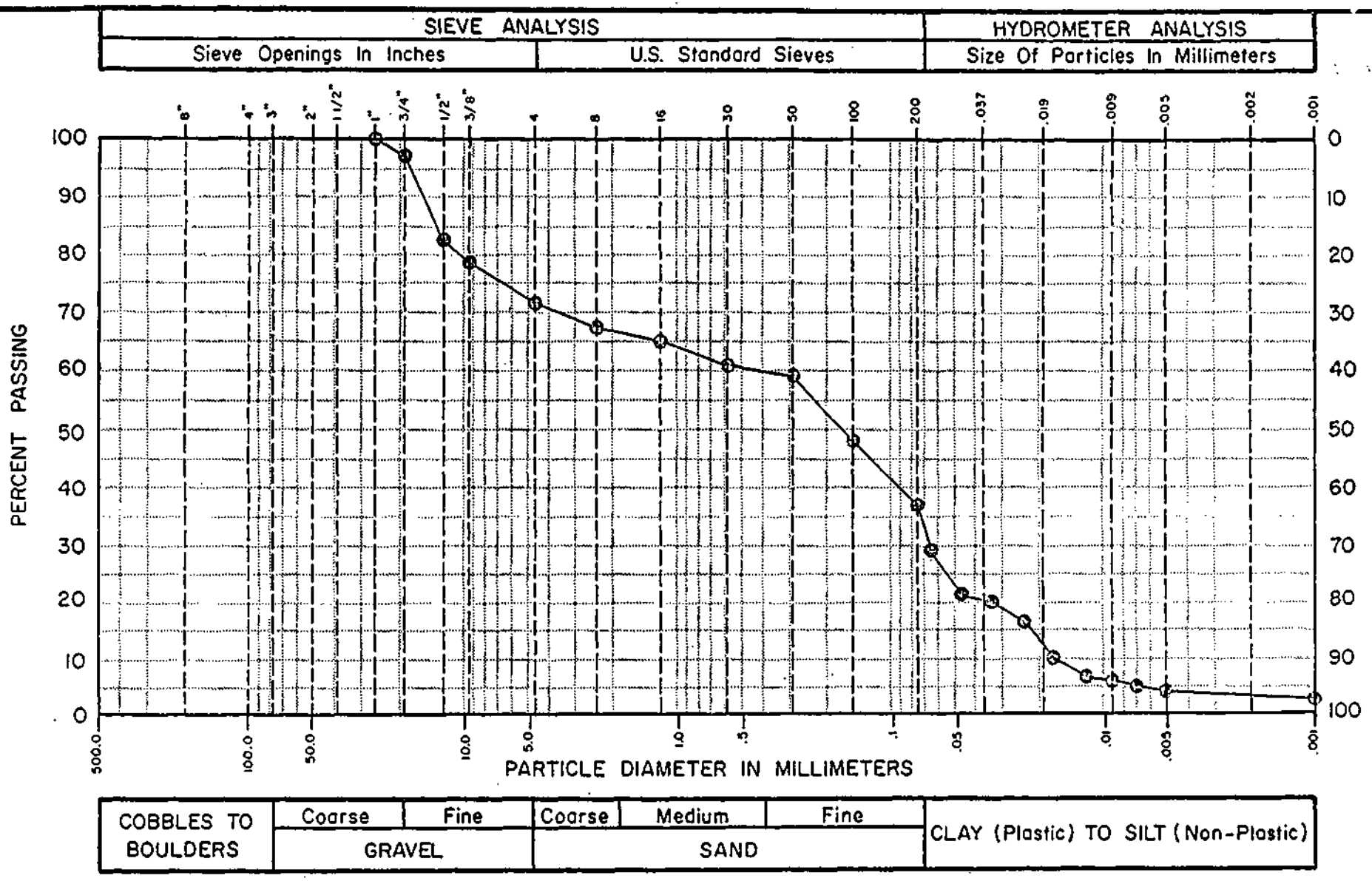
| DEPTH IN FEET | BLOW COUNT | SAMPLES | SYMBOLS | DESCRIPTIONS |
|---|---|---|---|---|
| 0 | | | | FILL CONSISTING OF FINE SAND, SILT, CLAY AND GRAVEL, MOIST |
| | 21 | ■ | | GRADING WITH MORE GRAVEL AND COBBLES BELOW 4 FEET |
| 10 | 17 | ■ | | FILL CONSISTING OF FINE SAND, SOME SILT, TRACE CLAY, MOIST, MEDIUM STIFF (MILL TAILINGS) |
| | P | ■ | | |
| 20 | 8 | ■ | | GRADING TO VERY MOIST BELOW 21 FEET |
| | 20 | ■ | | TOPSOIL CONSISTING OF CLAY, SILT, SAND, WOOD, VERY MOIST |
| 30 | 29 | ■ | | SAND AND GRAVEL WITH COBBLES, LITTLE SILT, VERY MOIST (MIXTURE OF ALLUVIUM AND COLLUVIUM) |
| | 161 | ■ | | GRADING TO WET WITH BOULDERS BELOW 32 FEET |
| 40 | | | | AUGER REFUSAL AT 36 FEET |

BORING COMPLETED ON 7-22-79

NO GROUNDWATER ENCOUNTERED AT TIME OF DRILLING

GEOTEK Consultants, Inc.

PLATE




| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 8 | | 5 | | | | | DIKE MATERIAL |

GEOTEK, Inc.

GRADATION ANALYSIS

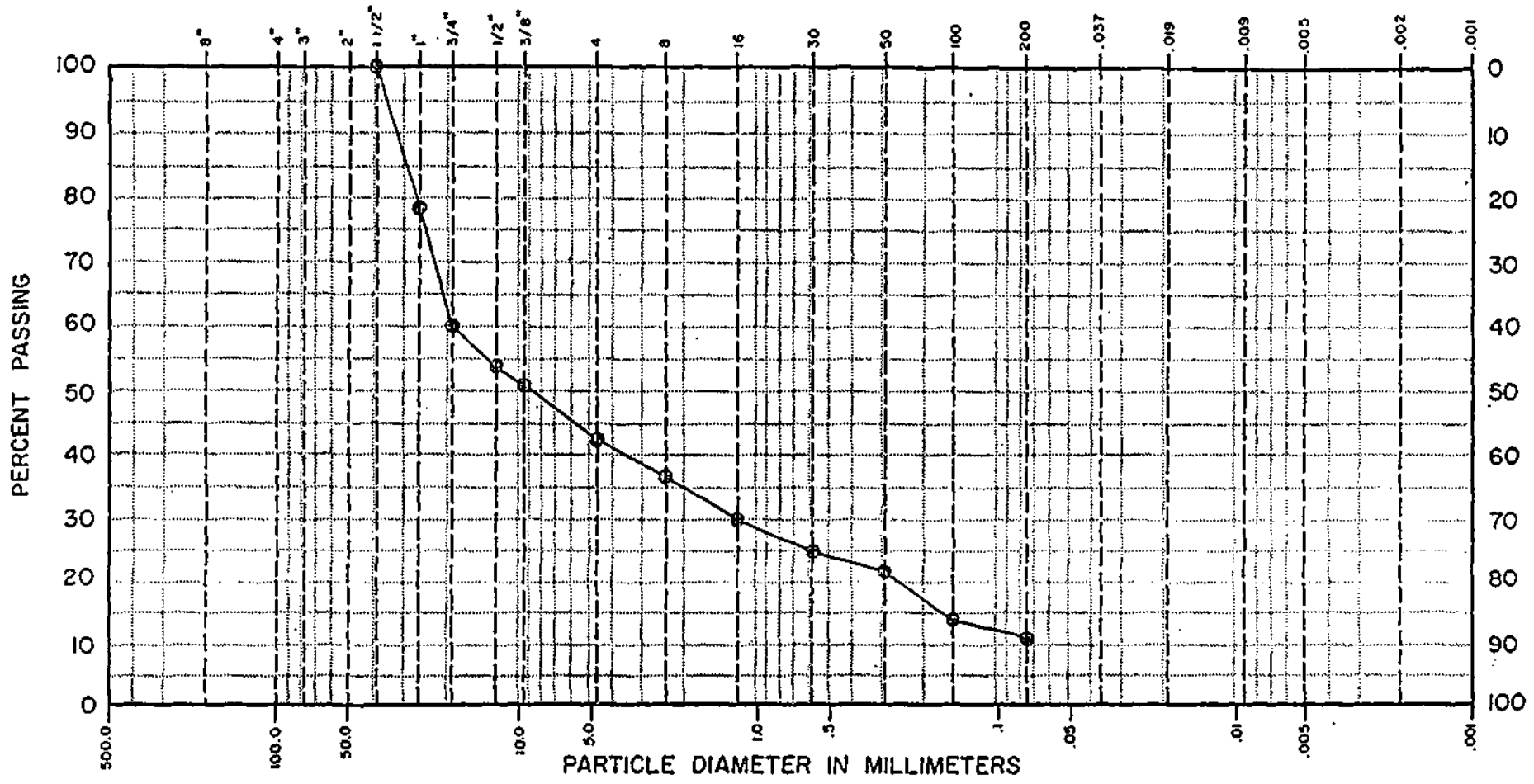
DRAWN BY: SS

JOB NO. 16991

DATE: 8/17/79

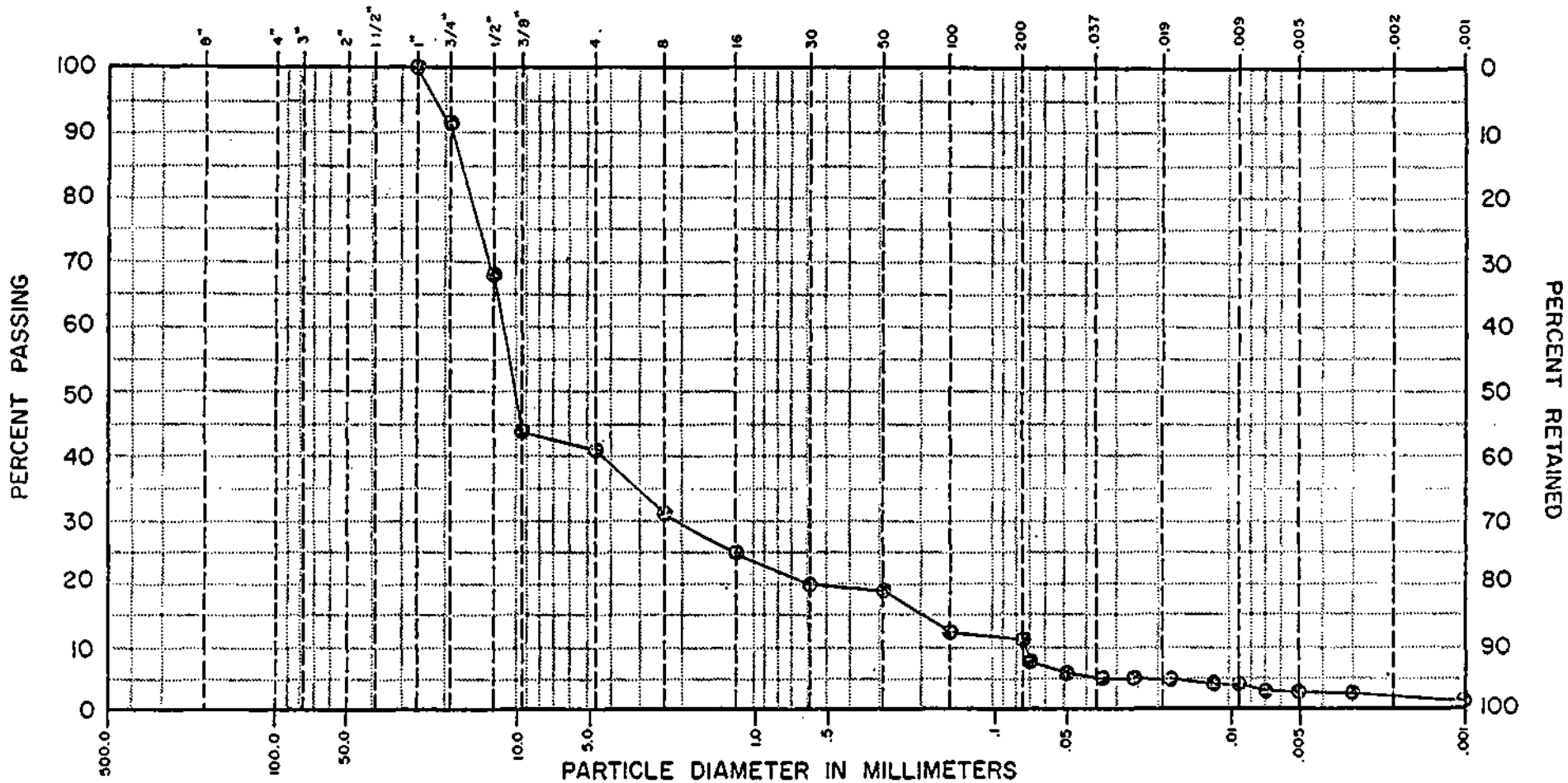
PLATE 52

L-7. 1/76




| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION | GEOTEK, Inc. | |
|---|---|---|---|---|---|---|---|---|---|
| 8 | | 15 | | | | | MIXTURE OF ALLUVIUM AND COLLUVIUM | GRADATION ANALYSIS | |
| | | | | | | | | DRAWN BY: SS | JOB NO. 16991 |
| | | | | | | | | DATE: 8/17/79 | PLATE 53 |

L-7, 1/76




| COBBLES TO BOULDERS | GRAVEL: Coarse | GRAVEL: Fine | SAND: Coarse | SAND: Medium | SAND: Fine | CLAY (Plastic) TO SILT (Non-Plastic) |
|---|---|---|---|---|---|---|

| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 9 | | 10 | | | | | DIKE MATERIAL |

GEOTEK, Inc.

GRADATION ANALYSIS

DRAWN BY: [illegible]

DATE: 8/17/79

JOB NO. 16991

PAGE 54

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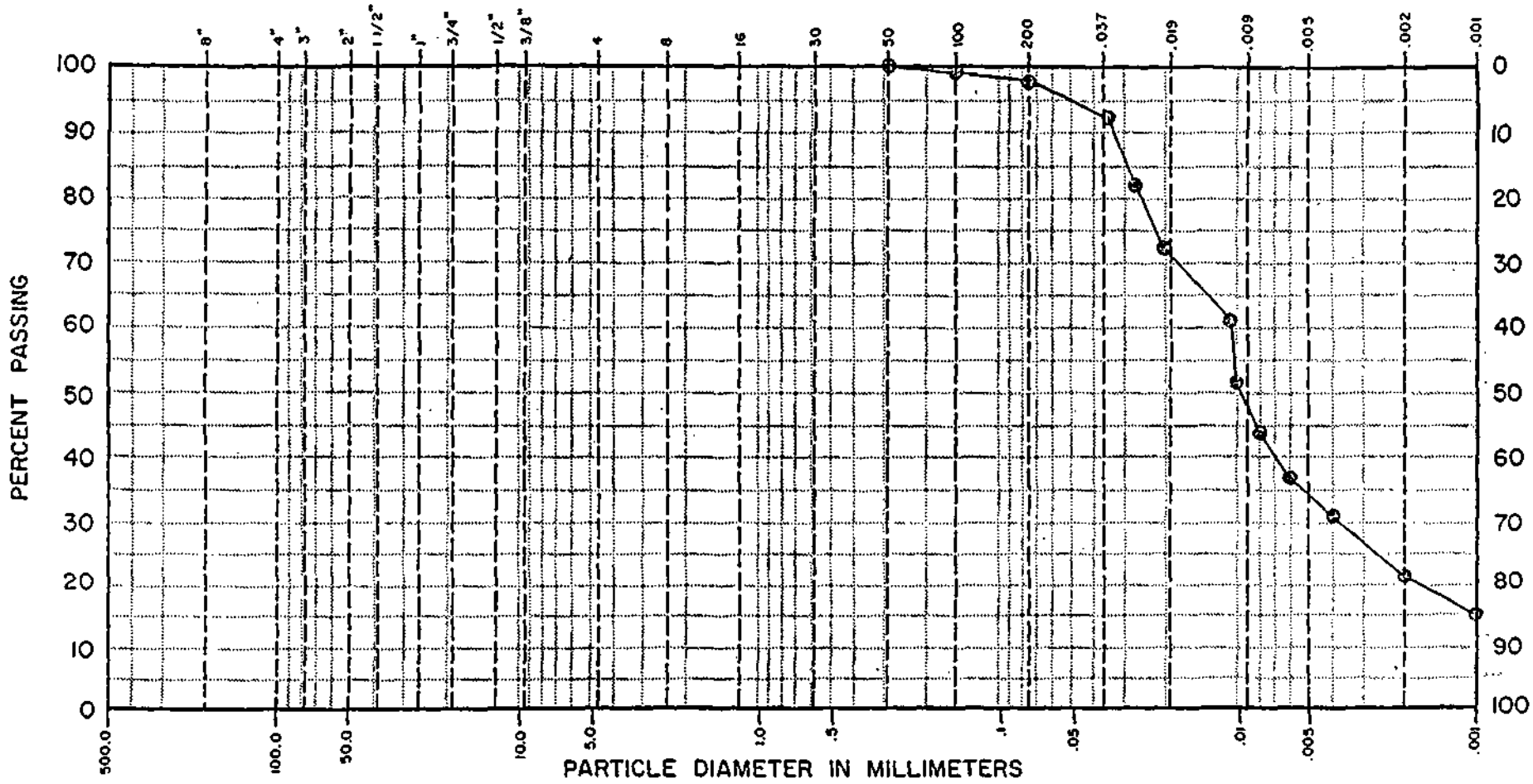



| COBBLES TO BOULDERS | Coarse | Fine | Coarse | Medium | Fine | CLAY (Plastic) TO SILT (Non-Plastic) |
|---|---|---|---|---|---|---|
| | GRAVEL | | SAND | | | |

| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 9 | | 20 | | | | | MILL TAILINGS |

GEOTEK, Inc.

GRADATION ANALYSIS

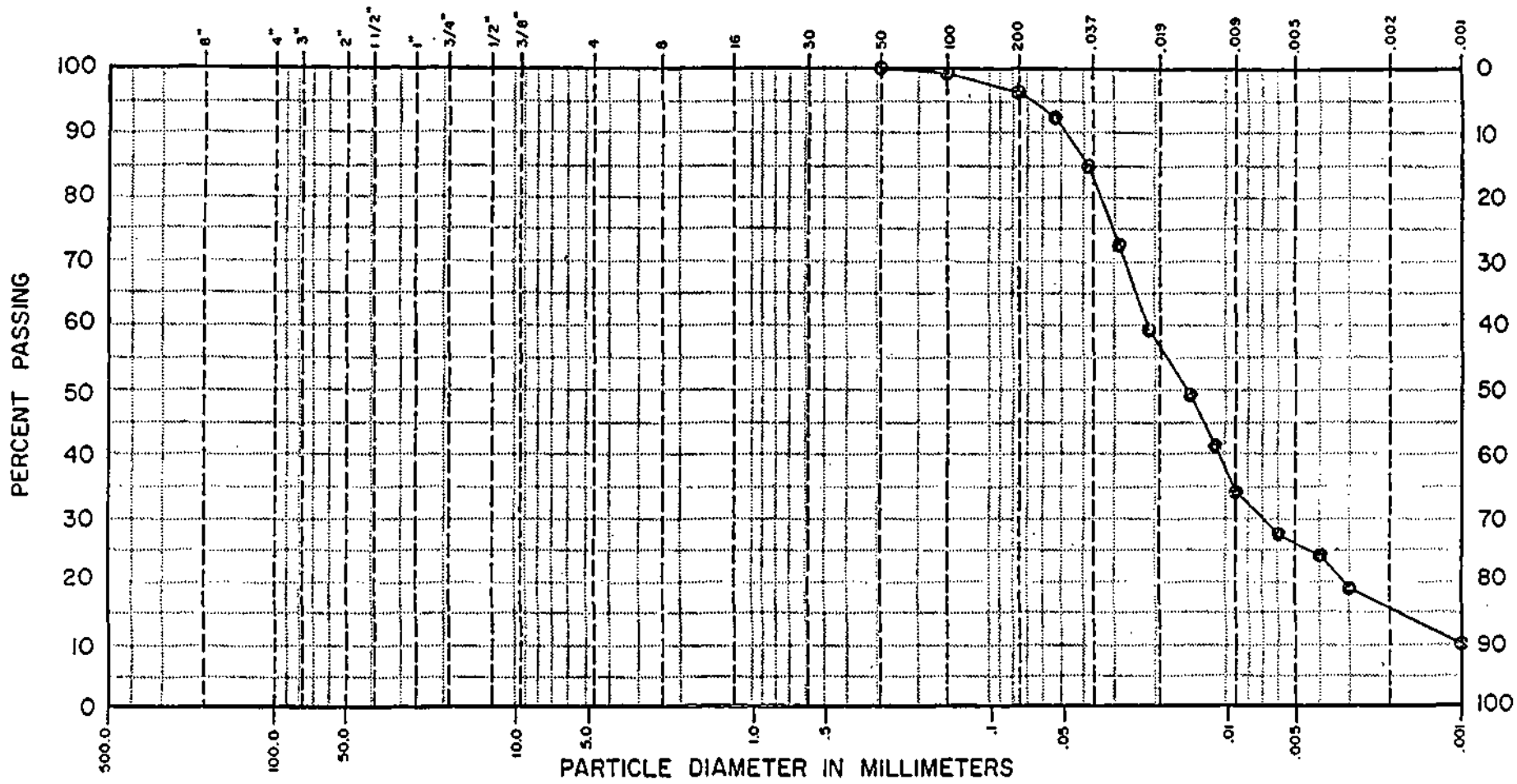
DRAWN BY: SS

JOB NO. 16991

DATE: 8/17/79

PLATE 55

L-7. 1/76




| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 9 | | 30 | | | | | MILL TAILINGS |

GEOTEK, Inc.

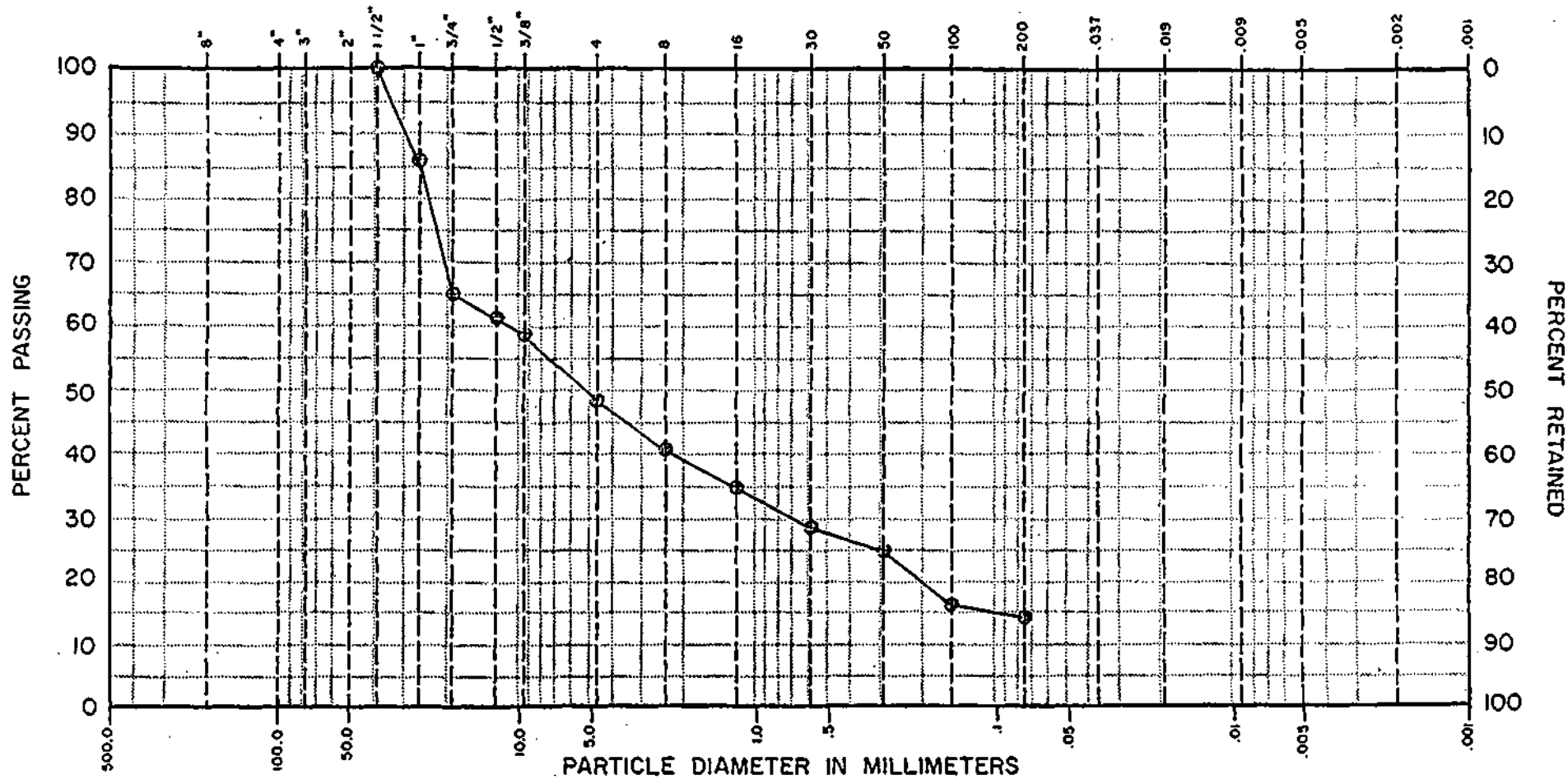
GRADATION ANALYSIS

DRAWN BY:

JOB NO. 16991

DATE: 8/17/79

P[redacted] 56




| COBBLES TO BOULDERS | Coarse | Fine | Coarse | Medium | Fine | CLAY (Plastic) TO SILT (Non-Plastic) |
|---|---|---|---|---|---|---|
| | GRAVEL | | SAND | | | |

| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 9 | | 40 | | | | | MIXTURE OF ALLUVIUM AND COLLUVIUM |

GEOTEK, Inc.

GRADATION ANALYSIS

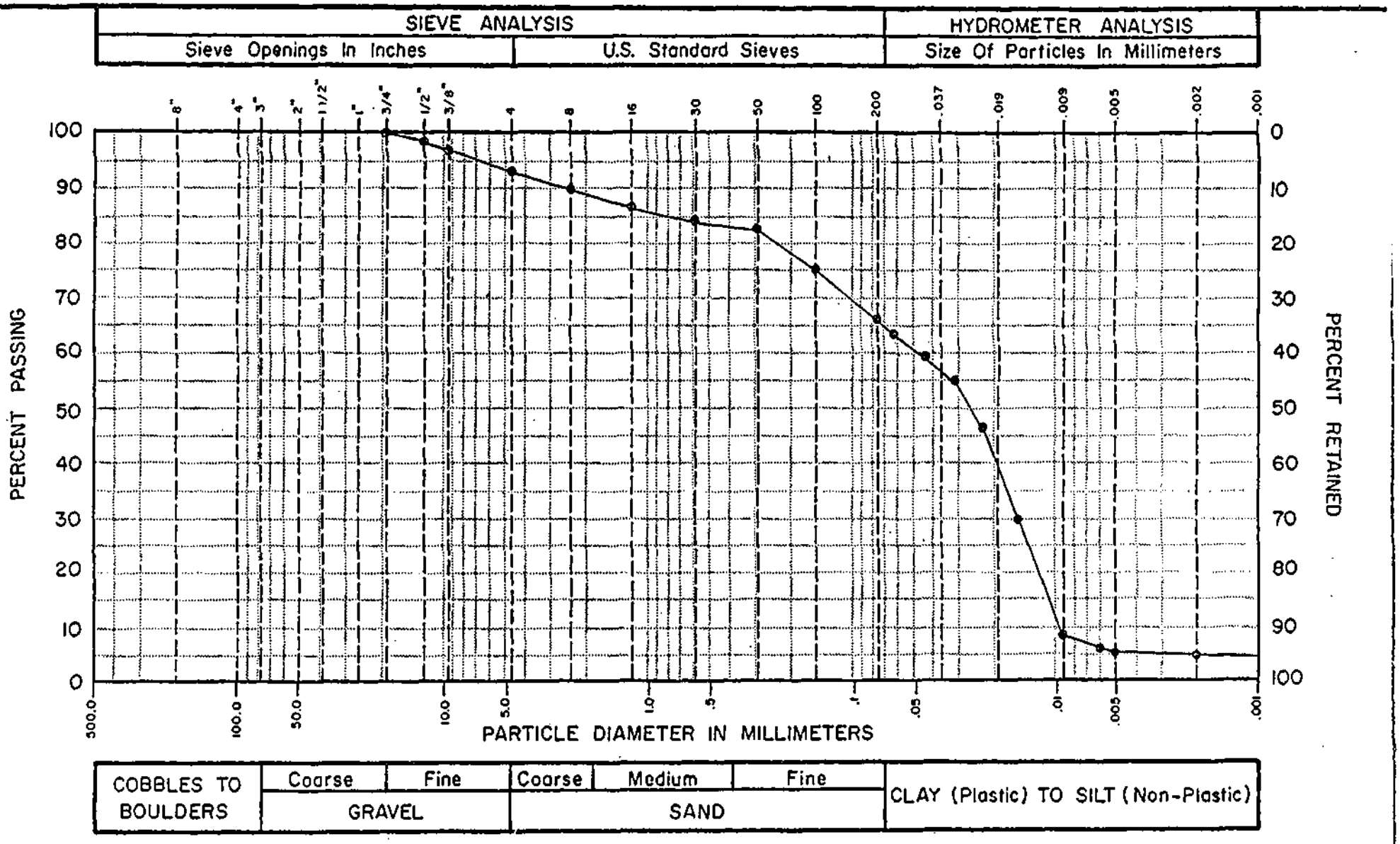
DRAWN BY: SS

JOB NO. 16991

DATE: 8/17/79

PLATE 57

L-7. 1/76




| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 10 | | 5 | | | | | DIKE MATERIAL |

GEOTEK, Inc.

GRADATION ANALYSIS

DRAWN BY: KM

JOB NO. 16991

DATE: 8/17/79

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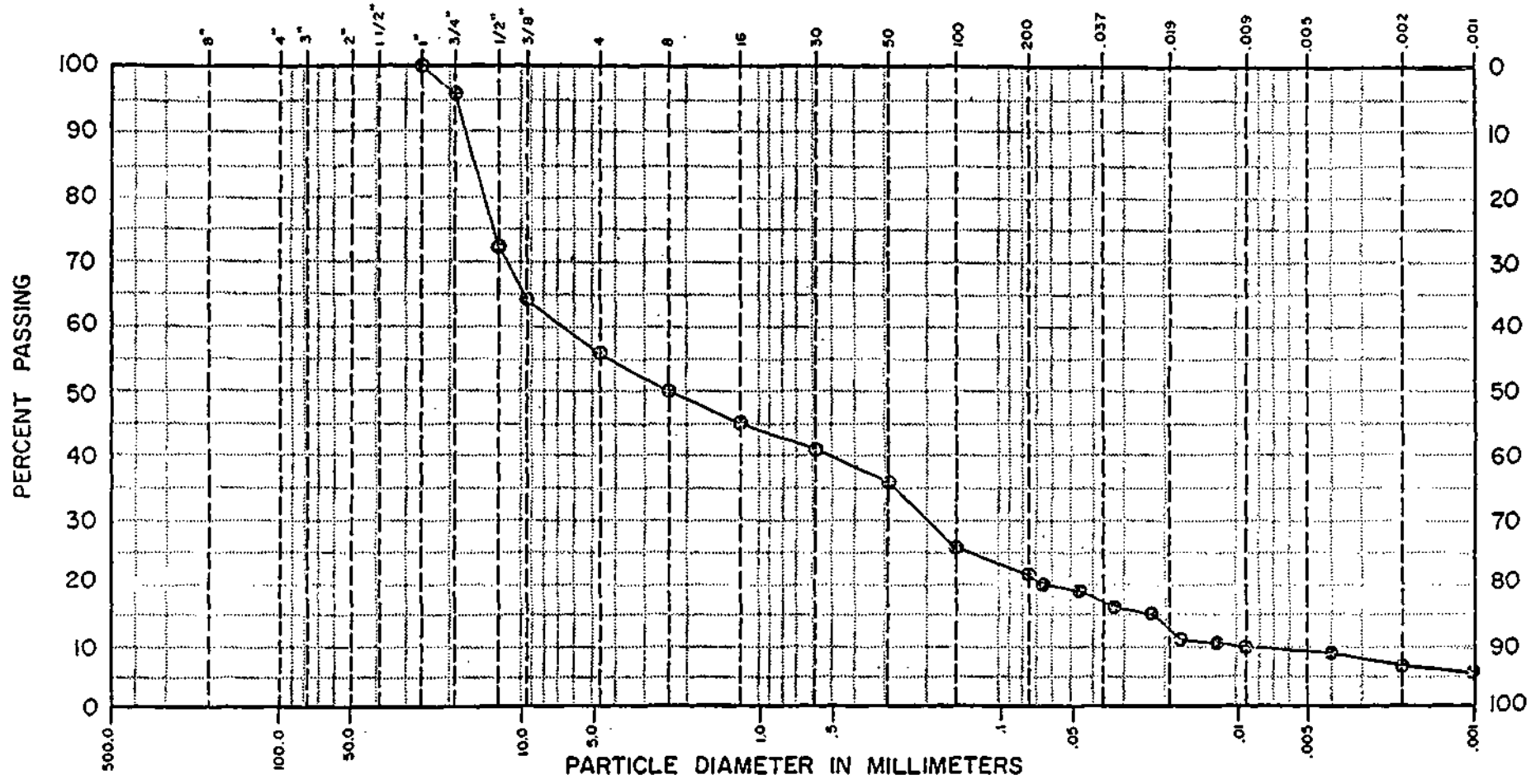



| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 10 | | 15 | | | | | DIKE MATERIAL |

GEOTEK, Inc.

GRADATION ANALYSIS

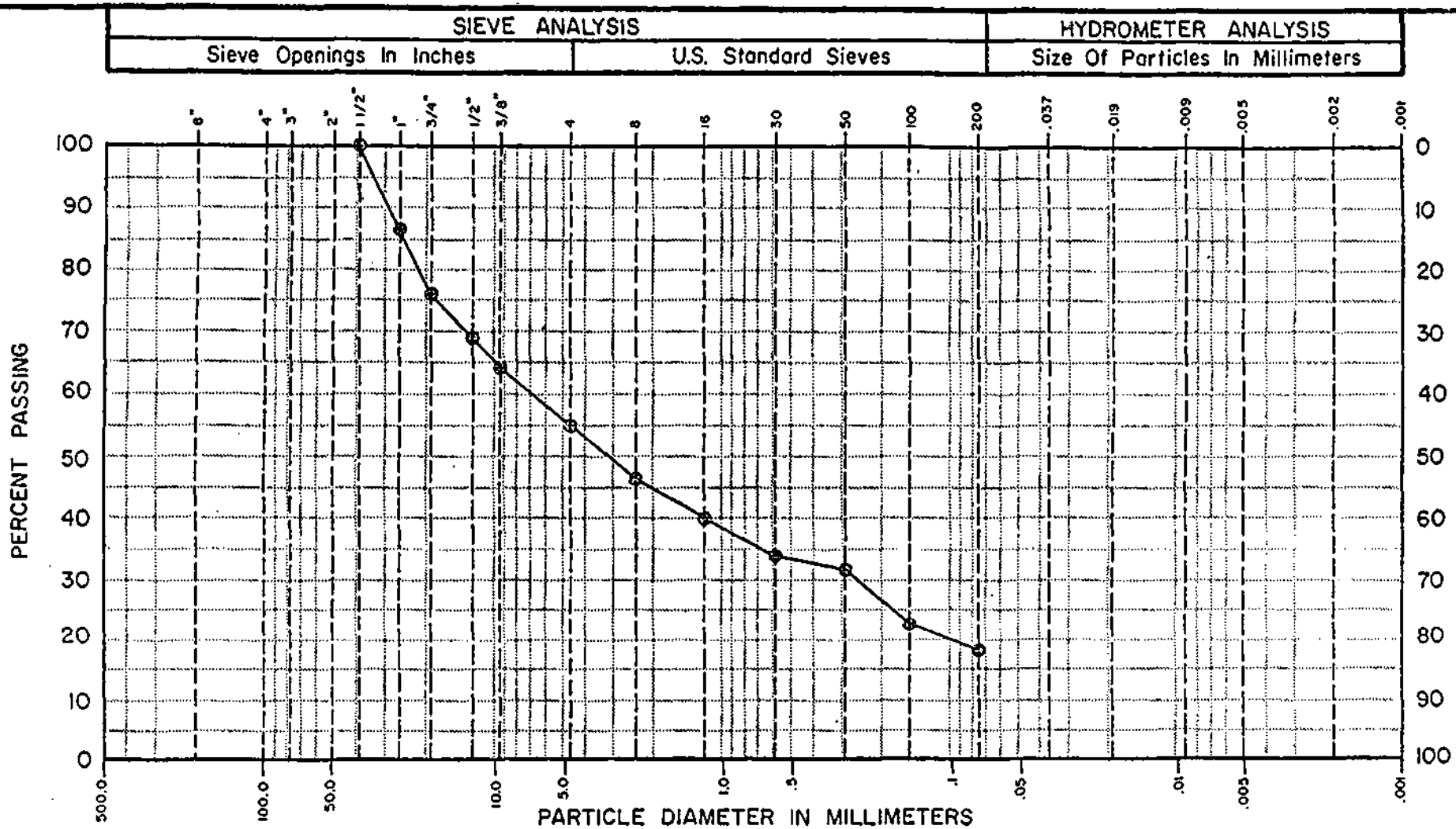
DRAWN BY: SS

JOB NO. 16991

DATE: 8/17/79

PLATE 59

L-7 1/76




| COBBLES TO BOULDERS | GRAVEL | | SAND | | | CLAY (Plastic) TO SILT (Non-Plastic) |
|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | |

| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 10 | | 35 | | | | | MIXTURE OF ALLUVIUM AND COLLUVIUM |

GEOTEK, Inc.

GRADATION ANALYSIS

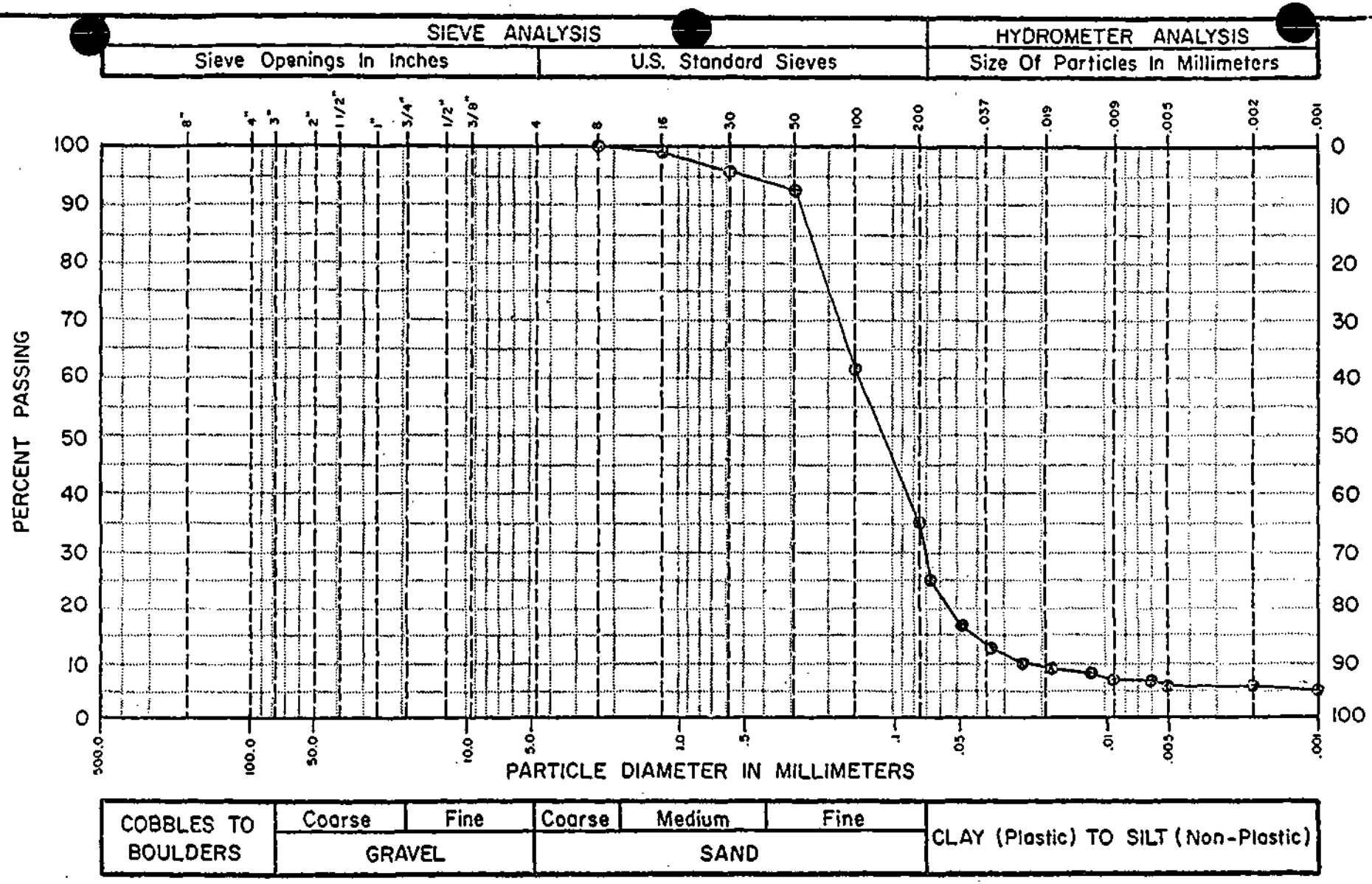
DRAWN BY: SS

JOB NO. 16991

DATE: 8/17/79

PAGE 60

L-7, 1/76




| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 11 | | 10 | | | | | MILL TAILINGS |

GEOTEX, Inc.

GRADATION ANALYSIS

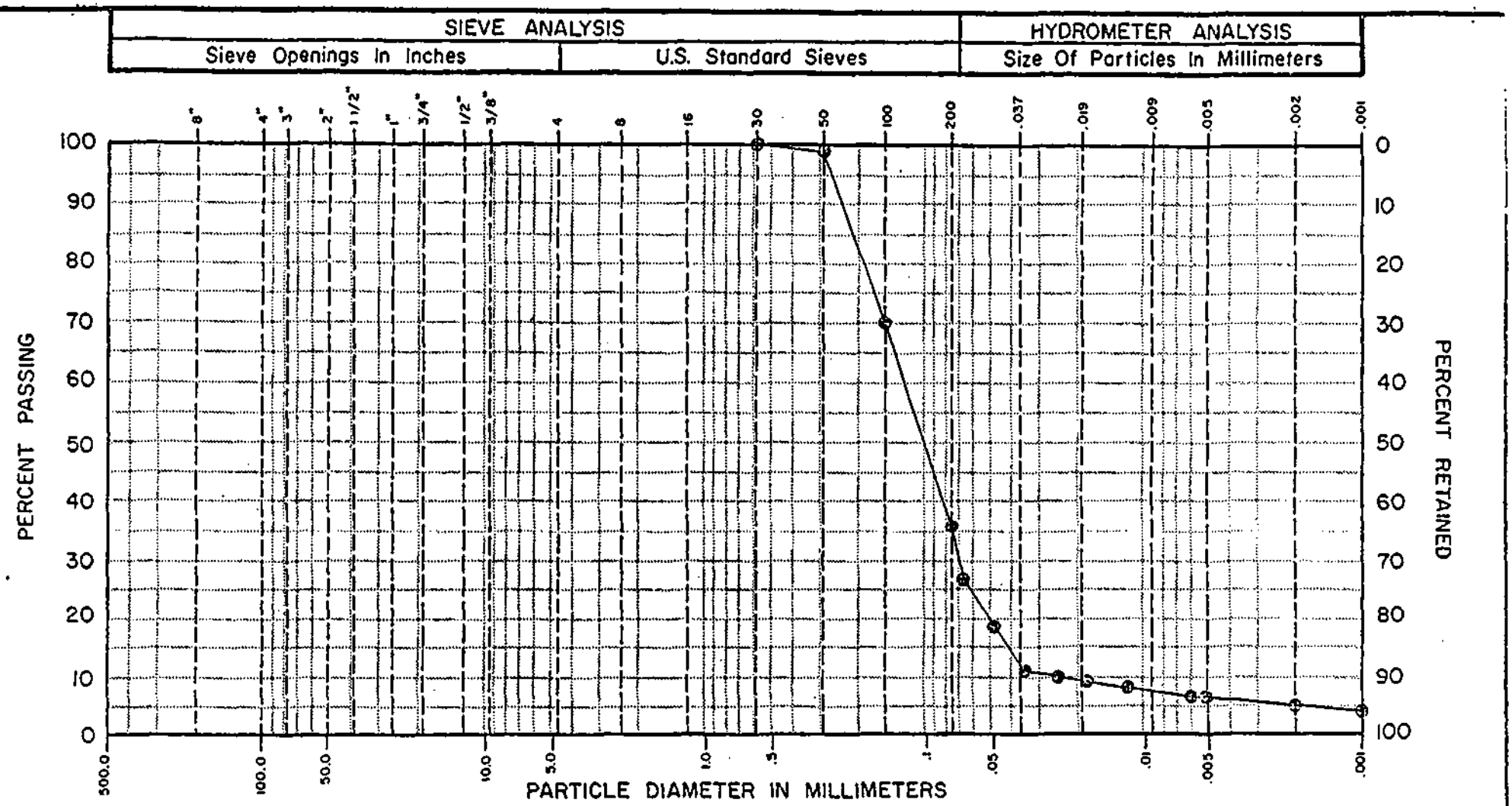
DRAWN BY: SS

JOB NO. 16991

DATE: 8/17/79

PLATE 61

L-7, 1/76




| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 11 | | 20 | | | | | MILL TAILINGS |

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GRADATION ANALYSIS

DRAWN BY: SS

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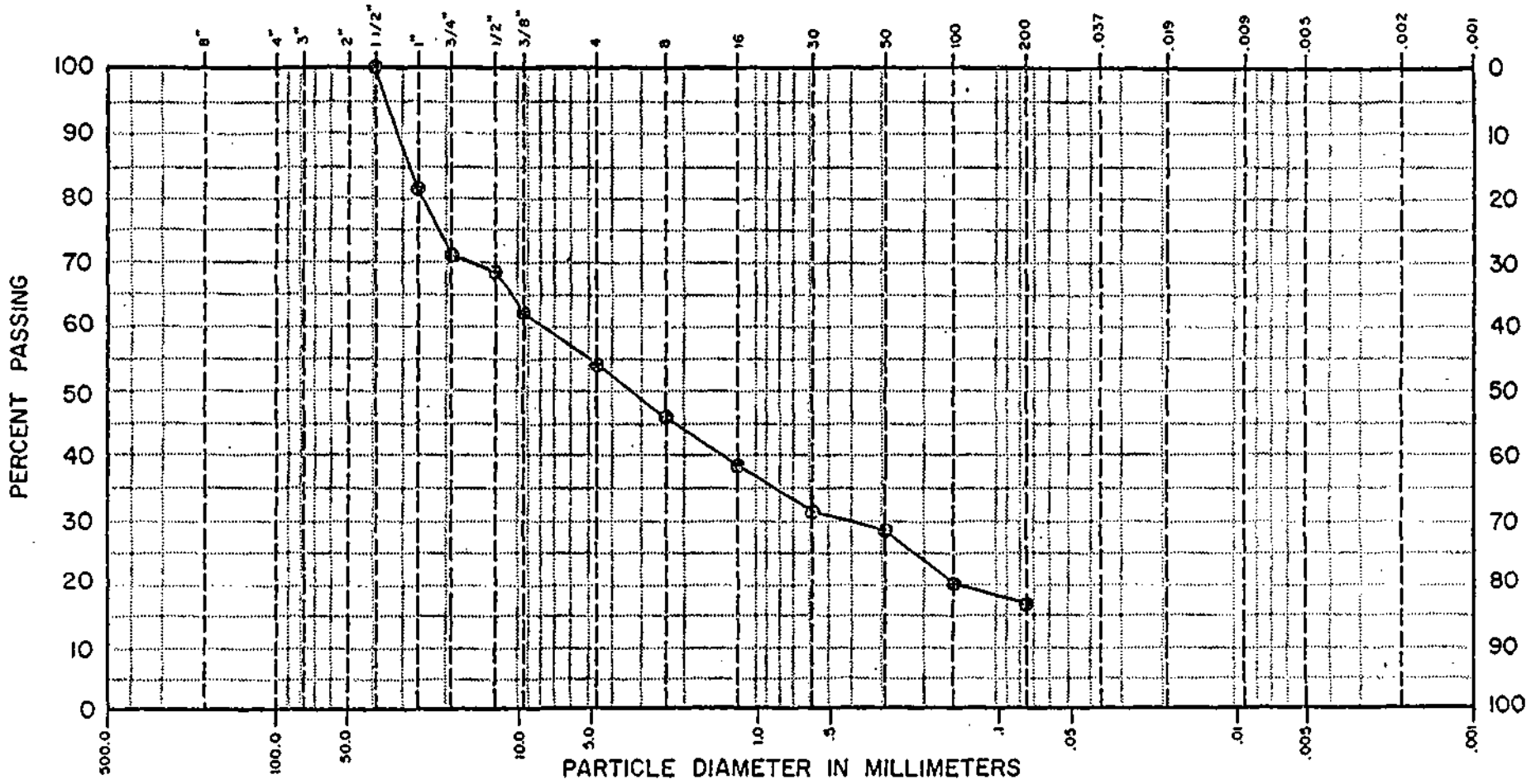


| COBBLES TO BOULDERS | Coarse | Fine | Coarse | Medium | Fine | CLAY (Plastic) TO SILT (Non-Plastic) |
|---|---|---|---|---|---|---|
| | GRAVEL | | SAND | | | |

| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 11 | | 30 | | | | | MIXTURE OF ALLUVIUM AND COLLUVIUM |

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PLATE 63

**Pond 4**

## BORING B-16

SURFACE ELEVATION 9197

COORDINATES

| OTHER TESTS | STRENGTH TEST RESULTS: TYPE OF TEST | CONFINING PRESSURE (psf) | PEAK SHEAR STRENGTH (psf) | % PASSING NO. 200 SIEVE | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LL (%) | PL (%) | PI (%) | SAMPLING: BLOW COUNT | SAMPLE TYPE | DEPTH IN FEET |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | 0 |
| | | | | | | | | | | | | 5 |
| | | | | | 116 | 16 | | | | 25 | U | |
| | | | | | | | | | | 33/3" 32 | SPT U | 10 |
| | | | | | | | | | | | | 15 |
| | | | | | | | | | | 22 | SPT | |
| | | | | | | | | | | | | 20 |
| | | | | | | | | | | 16/1" | SPT | |
| | | | | | | | | | | | | 25 |
| | | | | | | | | | | 20/3" | SPT | |
| | | | | | 115 | 14 | | | | 35/6" | U | 30 |

SYMBOLS

DESCRIPTION

BROWN SILTY AND CLAYEY GRAVEL LOOSE TO MEDIUM DENSE

GRADES WITH LENSES & THIN LAYERS OF SILTY SAND FROM 2.5 FEET TO 7.5 FEET

BROWN SANDY SILT WITH GRAVEL AND CLAY

BROWN SILTY AND CLAYEY GRAVEL MEDIUM DENSE

GRADES WITH MORE GRAVEL

LARGE COBBLES BETWEEN 21 AND 22 FEET

COLORS GREY AND GREY BROWN

COLORS BROWN

BORING COMPLETED AT 30 FEET ON 7/2/81

## BORING B-17

SURFACE ELEVATION 9166

COORDINATES

| OTHER TESTS | STRENGTH TEST RESULTS: TYPE OF TEST | CONFINING PRESSURE (psf) | PEAK SHEAR STRENGTH (psf) | % PASSING NO. 200 SIEVE | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LL (%) | PL (%) | PI (%) | SAMPLING: BLOW COUNT | SAMPLE TYPE | DEPTH IN FEET |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | 0 |
| GRADATION | | | | 8 | | 15 | | | | 19 | U | 5 |
| | | | | | | | | | | 63/ 9 1/2" | U | 10 |
| | | | | | | | | | | 51/6" | U | |
| | | | | | | | | | | | | 15 |
| | | | | | | | | | | | | 20 |
| | | | | | | | | | | | | 25 |
| | | | | | | | | | | | | 30 |

SYMBOLS

DESCRIPTION

BROWN SANDY GRAVEL WITH SILT AND COBBLES LOOSE TO MEDIUM DENSE — FILL

REDDISH BROWN SANDY GRAVEL WITH SOME SILT AND ROOTS LOOSE TO MEDIUM DENSE

GRADES WITHOUT ROOTS

COLORS BROWN

CASING REFUSAL

BORING COMPLETED AT 13 FEET ON 7/2/81

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊗ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- SPT - STANDARD SPLIT-SPOON

NOTE:

SEE PLATE A-1A

# LOG OF BORING

DAMES & MOORE

## BORING B-18

SURFACE ELEVATION 9193

COORDINATES

| OTHER TESTS | STRENGTH TEST RESULTS: TYPE OF TEST | CONFINING PRESSURE (psf) | PEAK SHEAR STRENGTH (psf) | % PASSING NO. 200 SIEVE | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LL (%) | PL (%) | PI (%) | SAMPLING: BLOW COUNT | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | 115 | 22 | | | | P | T |
| | | | | | | | | | | 5 | SPT |
| GRADATION SPECIFIC GRAVITY Gs = 2.7 | DIRECT SHEAR | 1000 | 1340 | 7 | 118 | 12 | | | | 50/5" | U |
| | | | | | | | | | | 15/11" | U |
| | | | | | | | | | | 50/4" | U |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

DEPTH IN FEET: 0, 5, 10, 15, 20, 25, 30

SAMPLING

SYMBOLS

DESCRIPTION

BROWN SILTY SAND WITH GRAVEL, LOOSE

BROWN SANDY SILT WITH LENSES AND LAYERS OF GREY SILT, LOOSE

REDDISH BROWN SANDY GRAVEL WITH SILT MEDIUM DENSE TO DENSE

GRADES WITH MORE GRAVEL

AUGER REFUSAL

BORING COMPLETED AT 16.5 FEET ON 7/3/81

## BORING B-19

SURFACE ELEVATION 9198

COORDINATES

| OTHER TESTS | STRENGTH TEST RESULTS: TYPE OF TEST | CONFINING PRESSURE (psf) | PEAK SHEAR STRENGTH (psf) | % PASSING NO. 200 SIEVE | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LL (%) | PL (%) | PI (%) | SAMPLING: BLOW COUNT | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| | | | | | | | | | | 31 | U |
| | | | | | | | | | | 9 | SPT |
| | | | | | 117 | 15 | | | | 24 | U |
| | | | | | | | | | | 57 | U |
| | | | | | | | | | | 40 | SPT |
| | | | | | | | | | | 30/3" | SPT |

DEPTH IN FEET: 0, 5, 10, 15, 20, 25, 30

SAMPLING

SYMBOLS

DESCRIPTION

REDDISH BROWN SANDY GRAVEL WITH SILT AND CLAY LOOSE TO MEDIUM DENSE

GRADES WITH MORE GRAVEL

BROWN VERY SANDY SILT

BROWN SILTY GRAVEL WITH SAND LOOSE TO MEDIUM DENSE

DARK BROWN TO BLACK ORGANIC SANDY SILT WITH ROOTS

REDDISH BROWN SANDY GRAVEL WITH SILT

AUGER REFUSAL

BORING COMPLETED AT 25.5 FEET ON 7/3/81

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- SPT - STANDARD SPLIT-SPOON

NOTE:
SEE PLATE A-1A

# LOG OF BORING

DAMES & MOORE

# BORING 12

SURFACE ELEVATION _____

| DEPTH IN FEET | BLOW COUNT | SAMPLES | SYMBOLS | DESCRIPTIONS |
|---|---|---|---|---|
| 0 | | | | |
| | 11 | | | FILL CONSISTING OF GRAVEL, COBBLES, BOULDERS, SAND, SILT AND CLAY, MOIST (DIKE MATERIAL) |
| | | | | GRADING WITH LESS COBBLES AND BOULDERS BELOW 3 FEET |
| 10 | 17 | | | POCKET OF COBBLES AND BOULDERS FROM 6-1/2 TO 7-1/2 FEET |
| | 14 | | | GRADING TO WET BELOW 14 FEET |
| 20 | 88/6 | | | GRAVEL, COBBLES, BOULDERS, SOME SAND, LITTLE SILT, WET (MIXTURE OF ALLUVIUM AND COLLUVIUM) |
| | | | | AUGER REFUSAL AT 21 FEET |
| 30 | | | | |

BORING COMPLETED ON 7-22-79

GROUNDWATER OBSERVED AT A DEPTH OF 19-1/2 FEET ON 7-22-79 AND AT 14 FEET ON 7-24-79

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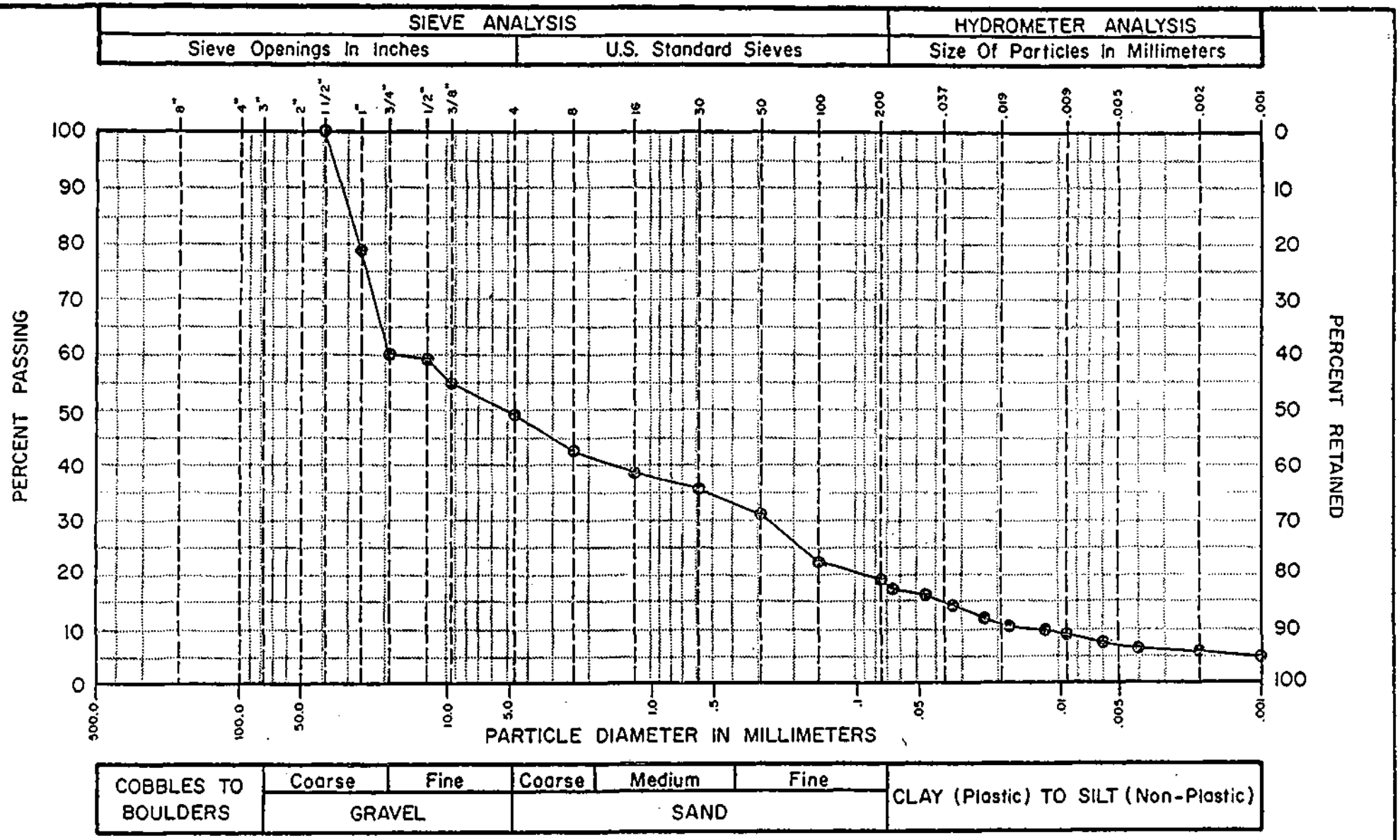



| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 12 | | 5 | | | | | DIKE MATERIAL |

GEOTEK, Inc.

GRADATION ANALYSIS

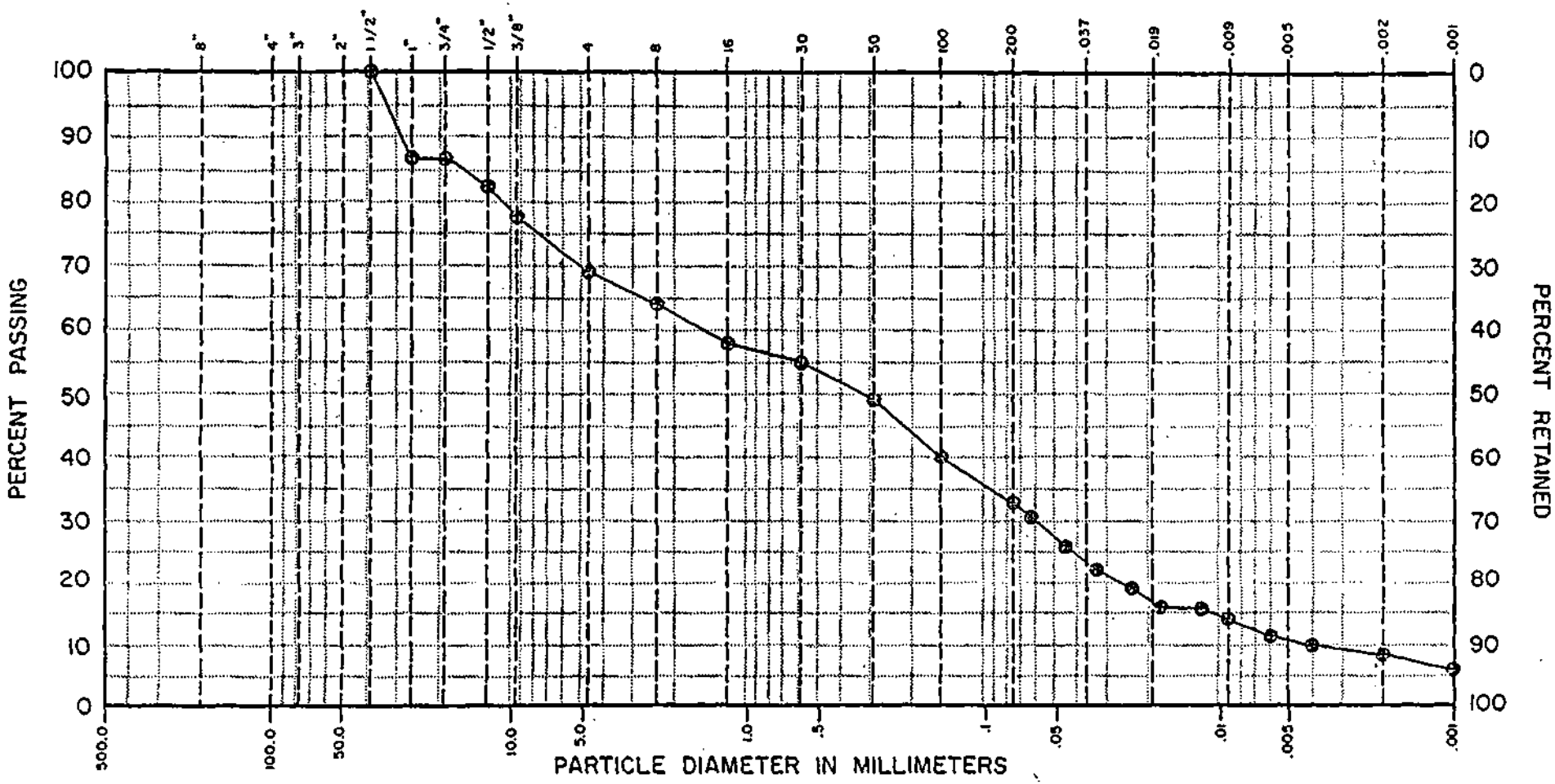
DRAWN BY: SS

JOB NO. 16991

DATE: 8/17/79

PLATE 64

-7, 1/76




| COBBLES TO BOULDERS | GRAVEL | | SAND | | | CLAY (Plastic) TO SILT (Non-Plastic) |
|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | |

| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 12 | | 15 | | | | | DIKE MATERIAL |

GEOTEK, Inc.

GRADATION ANALYSIS

DRAWN BY: SS

JOB NO. 16991

DATE: 8/17/79

PLATE 65

-7, 1/76

# Miscellaneous

TABLE A-1

PIEZOMETER INSTALLATION DATA

| Boring | Total Standpipe Length (Feet) | Stickup Above Existing Ground Surface (Feet) | Slotted Interval Below Ground Surface (Feet) |
|---|---|---|---|
| B-9 | 72.7 | 0.5 | 67.2 - 72.2 |
| B-10 | 13.8 | 0.5 | 11.3 - 13.3 |
| B-11 | 37.3 | 0.5 | 32.8 - 36.8 |
| B-12 | 9.0 | 4.5 | 3.5 - 4.5 |
| B-13 | 7.3 | 0.5 | 5.8 - 6.8 |

TABLE A-2

SUMMARY OF PIEZOMETER READINGS

| | Water Level Below Ground Surface (Feet) | | | |
|---|---|---|---|---|
| Boring | 6-11-81 | 6-30-82 | 7-7-82 | 7-29-81 |
| B-9 | 69.0 | 71.0 | 71.0 | Dry |
| B-10 | - | 12.1 | 12.2 | 12.9 |
| B-11 | 34.9 | 36.0 | 36.0 | 36.3 |
| B-12 | 0.4 | 0.8* | 0.6* | 0.4* |
| B-13 | 3.8 | 1.8 | 2.0 | 1.8 |

*Water level above ground surface

## BORING B-12

SURFACE ELEVATION 9176

COORDINATES

| OTHER TESTS | STRENGTH TEST RESULTS | | | % PASSING NO. 200 SIEVE | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS | | | SAMPLING | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | TYPE OF TEST | CONFINING PRESSURE (psf) | PEAK SHEAR STRENGTH (psf) | | | | LL (%) | PL (%) | PI (%) | BLOW COUNT | SAMPLE TYPE |
| | | | | | | | | | | REFUSAL ON COBBLE | SPT |

DEPTH IN FEET: 0, 5, 10, 15, 20, 25, 30

SAMPLING

SYMBOLS DESCRIPTION

BROWN SANDY SILTY GRAVEL WITH COBBLES

BORING COMPLETED AT 5.0 FEET ON 6/10/81

WATER ENCOUNTERED AT 0.4 FEET ON 6/11/81

PIEZOMETER INSTALLED

## BORING B-13

SURFACE ELEVATION 9144

COORDINATES

| OTHER TESTS | STRENGTH TEST RESULTS | | | % PASSING NO. 200 SIEVE | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS | | | SAMPLING | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | TYPE OF TEST | CONFINING PRESSURE (psf) | PEAK SHEAR STRENGTH (psf) | | | | LL (%) | PL (%) | PI (%) | BLOW COUNT | SAMPLE TYPE |
| | | | | | | | | | | 20 | SPT |

DEPTH IN FEET: 0, 5, 10, 15, 20, 25, 30

SAMPLING

SYMBOLS DESCRIPTION

BROWN SILTY SANDY GRAVEL WITH CLAY LOOSE TO MEDIUM DENSE

BORING COMPLETED AT 7.5 FEET ON 6/10/81

WATER ENCOUNTERED AT 3.8 FEET ON 6/11/81

PIEZOMETER INSTALLED

KEY

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- SPT - STANDARD SPLIT-SPOON
- D - DAMES & MOORE "D" SAMPLER

NOTE:

SEE PLATE A - 1A.

# LOG OF BORING

DAMES & MOORE

## BORING B-14

SURFACE ELEVATION 9133

COORDINATES

| OTHER TESTS | STRENGTH TEST RESULTS: TYPE OF TEST | CONFINING PRESSURE (psf) | PEAK SHEAR STRENGTH (psf) | % PASSING NO 200 SIEVE | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LL (%) | PL (%) | PI (%) | SAMPLING: BLOW COUNT | SAMPLE TYPE | DEPTH IN FEET | SAMPLING | SYMBOLS | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | 0 | | | GREYISH BROWN SILTY FINE TO COARSE GRAVEL & COBBLES, LOOSE TO MEDIUM DENSE |
| | | | | | | | | | | | | | | | COLORS REDDISH BROWN |
| | | | | | | | | | | 113 | U | 5 | ⊠ | GM | GRADES MEDIUM DENSE TO DENSE |
| | | | | | | | | | | 17 | SPT | | ◪ | | COBBLES FROM 8.5 TO 9 FEET GRADES MEDIUM DENSE |
| | | | | | | | | | | 59 | U | 10 | □ | | |
| GRADATION | | | | 24 | | 15 | | | | 31 | SPT | 15 | ◪ | SM-GM | REDDISH BROWN SILTY SAND AND SANDY GRAVEL MEDIUM DENSE TO DENSE |
| | | | | | | | | | | | SPT | 20 | ◪ | | BORING COMPLETED AT 19.5 FEET ON 7/1/81 |
| | | | | | | | | | | | | 25 | | | |
| | | | | | | | | | | | | 30 | | | |

## BORING B-15

SURFACE ELEVATION 9185

COORDINATES

| OTHER TESTS | STRENGTH TEST RESULTS: TYPE OF TEST | CONFINING PRESSURE (psf) | PEAK SHEAR STRENGTH (psf) | % PASSING NO 200 SIEVE | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LL (%) | PL (%) | PI (%) | SAMPLING: BLOW COUNT | SAMPLE TYPE | DEPTH IN FEET | SAMPLING | SYMBOLS | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | 0 | | GM/GC | BROWN SILTY AND CLAYEY GRAVEL WITH LARGE COBBLES, MEDIUM DENSE |
| | | | | | | 25 | 26 | 21 | 5 | 60 | SPT | 5 | ◪ | | |
| | | | | | | | | | | | | | | | REDDISH BROWN SANDY GRAVEL WITH SILT, GRADES MEDIUM DENSE TO DENSE |
| | | | | | | | | | | 38 | SPT | 10 | ◪ | GM | |
| | | | | | | | | | | | | 15 | | | BORING COMPLETED AT 17 FEET ON 7/1/81 |
| | | | | | | | | | | | | 20 | | | |
| | | | | | | | | | | | | 25 | | | |
| | | | | | | | | | | | | 30 | | | |

KEY

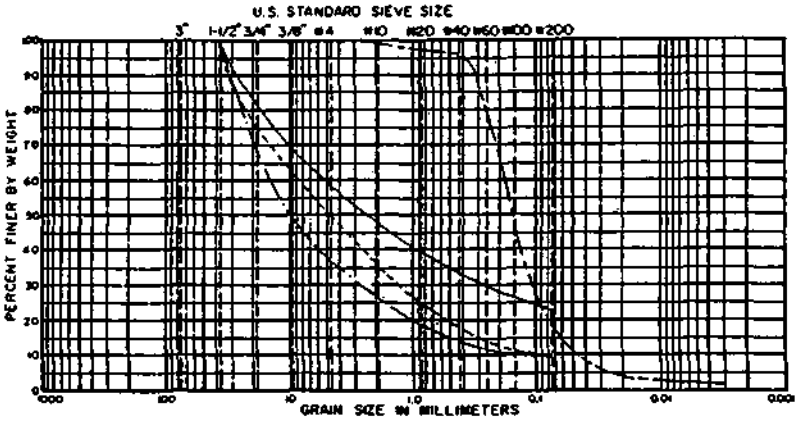
- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- ◪ INDICATES STANDARD PENETRATION TEST SAMPLE
- P - IN BLOW COUNT COLUMN INDICATES SAMPLER HYDRAULICALLY PUSHED

SAMPLE TYPE

- U - DAMES & MOORE "U" BIT
- T - DAMES & MOORE THIN-WALL
- P - DAMES & MOORE PISTON
- SPT - STANDARD SPLIT-SPOON

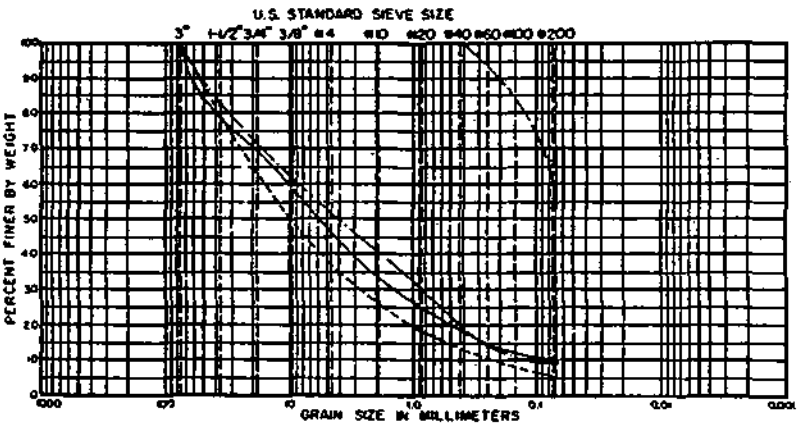
# LOG OF BORING

DAMES & MOORE




| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | COARSE | FINE | COARSE | MEDIUM | FINE | |

| LOCATION | DEPTH | CLASSIFICATION | KEY |
|---|---|---|---|
| B-14 | 14.5 Feet | Reddish Brown Silty Sand and Sandy Gravel (SM-GM) | ——— |
| B-17 | 5 Feet | Reddish Brown Sandy Gravel With Some Silt and Rocks (GP-GM) | - - - - - - |
| B-18 | 10 Feet | Reddish Brown Sandy Gravel With Silt (GW-GM) | —·—·— |
| B-20 | 13 Feet | Brown Silty Fine Sand (SM) | —··—··— |




| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | COARSE | FINE | COARSE | MEDIUM | FINE | |

| LOCATION | DEPTH | CLASSIFICATION | KEY |
|---|---|---|---|
| B-25 | 15 Feet | Brown Silty Gravel With Sand (GW-GM) | ——— |
| Dam Fill Material, Pond-1 | Bulk Sample No. 1 | Brown Silty Gravel With Sand (GW-GM) | - - - - - - |
| Dam Fill Material Between Ponds 2 & 3 | Bulk Sample No. 2 | Brown Silty Sand and Sandy Gravel (SW-SM/GW-GC) | —·—·— |
| B-[illegible] | 20 Feet | Fine Sandy Silt (ML) | —··—··— |

# GRADATION CURVES

DAMES & MOORE

# BORING 13

SURFACE ELEVATION _____

| DEPTH IN FEET | BLOW COUNT | SAMPLES | SYMBOLS | DESCRIPTIONS |
|---|---|---|---|---|
| 0 | | | | 6 INCHES OF GRAVEL, COBBLES, SAND, SILT AND CLAY FILL |
| | 23 | ■ | | GRAVEL AND SAND WITH SILTY AND CLAYEY POCKETS, MOIST (MIXTURE OF ALLUVIUM AND COLLUVIUM) |
| 10 | 45 | ■ | | GRADING TO VERY MOIST BELOW 8 FEET |
| | | | | GRADING WITH COBBLES AND BOULDERS BELOW 10 FEET |
| | 101 | ■ | | |
| 20 | | | | AUGER REFUSAL AT 18-1/2 FEET |

BORING COMPLETED ON 7-23-79

NO GROUNDWATER ENCOUNTERED AT TIME OF DRILLING

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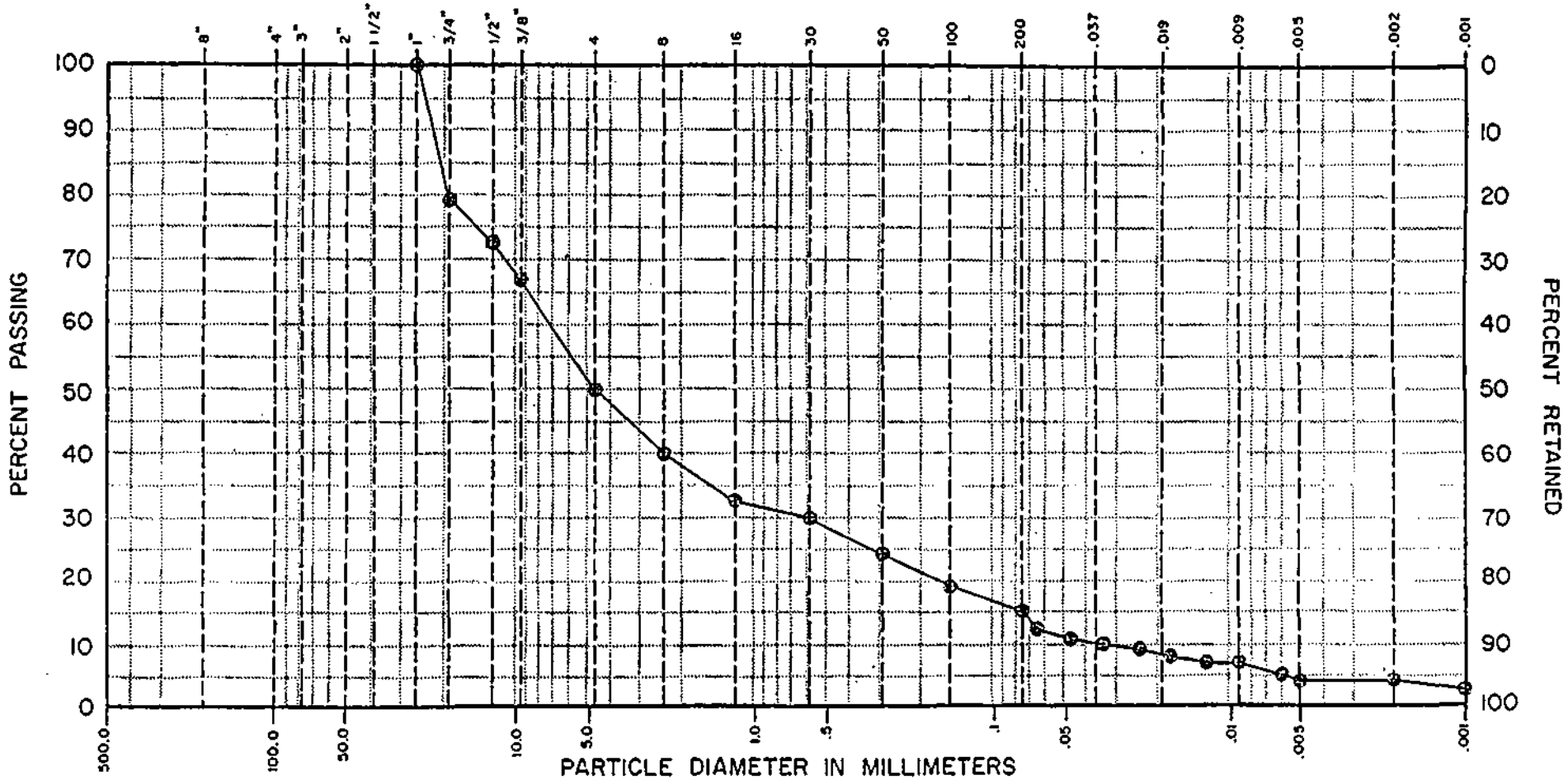


| BORING NO. | SAMPLE NO. | DEPTH IN FEET | PL | LL | PI | NAT. WC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 13 | | 10 | | | | | MIXTURE OF ALLUVIUM AND COLLUVIUM |

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GRADATION ANALYSIS

DRAWN BY: [illegible]

JOB NO. 16991

DATE: 8/17/79

P[illegible] 66

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GEOTEK Consultants, Inc.
CONSULTING GEOTECHNICAL
AND MATERIALS ENGINEERS

# SUMMARY OF LABORATORY TEST RESULTS

PROJECT NO. 16991

| BORING NO. | SAMPLE NO. | DEPTH IN FEET | SAMPLE TYPE (NOTE 1) | NATURAL DRY DENSITY (PCF) | NATURAL MOISTURE (%) | ATTERBERG LIMITS LL | ATTERBERG LIMITS PI | ATTERBERG LIMITS PL | % FINES | WATER SOLUBLE SULFATES (%) | SHEAR STRENGTH (PSF) (NOTE 2) | ADDITIONAL TEST RESULTS ATTACHED (NOTE 3) | | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 40 | ST | 131 | 15.5 | | | | | | $C_1$ 260* | | | MILL TAILINGS |
| 1 | | 40 | ST | 131 | 15.5 | | | | | | $C_2$ 645<br>$C_2$ 874 | | | MILL TAILINGS |
| 3 | | 30 | ST | 113 | 12.8 | | | | | | $C_1$ 362* | | | MILL TAILINGS |
| 3 | | 46 | ST | 98 | 26.7 | | | | | | $C_2$ 926<br>$C_2$ 1051 | | | MILL TAILINGS |
| 3 | | 46 | ST | 98 | 26.7 | | | | | | 820 | TT-UU | | MILL TAILINGS |
| 3 | | 65 | ST | 123 | 18.4 | | | | | | 1804 | TT-UU | | MILL TAILINGS |
| 4 | | 55 | ST | 122 | 36.4 | | | | | | $C_1$ 547* | | | MILL TAILINGS |
| 4 | | 55 | ST | 122 | 36.4 | | | | | | $C_2$ 800<br>$C_2$ 909 | | | MILL TAILINGS |
| 6 | | 29 | ST | 129 | 13.3 | | | | | | $C_1$ 377* | | | MILL TAILINGS |

RF-1, 1/76

NOTE 1 - SAMPLE TYPE

- BS - Bag Sample
- AS - Auger Sample
- ST - Shelby Tube Sample
- CA - California Sample
- RM - Remolded Sample
- HD - Hand Drive
- AD - Air Dried

NOTE 2 - SHEAR STRENGTH TESTS

- $C_1$ - Unconfined Compression
- $C_2$ - Miniature Vane Shear
- $C_3$ - Pocket Penetrometer
- $C_4$ - Pocket Vane

NOTE 3 - ADDITIONAL TEST RESULTS ATTACHED

- SW - Swell-Consolidation Test
- TT - Triaxial Test
- PT - Proctor
- GA - Gradation Analysis
- CT - Consolidation Test

**GEOTEK Consultants, Inc.**
CONSULTING GEOTECHNICAL
AND MATERIALS ENGINEERS

# SUMMARY OF LABORATORY TEST RESULTS

PROJECT NO. 16991

| BORING NO. | SAMPLE NO. | DEPTH IN FEET | SAMPLE TYPE (NOTE 1) | NATURAL DRY DENSITY (PCF) | NATURAL MOISTURE (%) | ATTERBERG LIMITS LL | ATTERBERG LIMITS PI | ATTERBERG LIMITS PL | % FINES | WATER SOLUBLE SULFATES (%) | SHEAR STRENGTH (PSF) (NOTE 2) | ADDITIONAL TEST RESULTS ATTACHED (NOTE 3) | | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | | 29 | ST | 129 | 13.3 | | | | | | $C_2$ 777<br>$C_2$ 904 | | | MILL TAILINGS |
| 6 | | 59 | ST | 93 | 35.0 | | | | | | $C_1$ 215* | | | MILL TAILINGS |
| 6 | | 59 | ST | 93 | 35.0 | | | | | | $C_2$ 909<br>$C_2$ 1024 | | | MILL TAILINGS |

* BECAUSE OF THE SILT AND SAND CONTENT OF THE SAMPLES, WE BELIEVE THE MINIATURESHEAR VANE GIVES A MORE REPRESENTATIVE VALUE FOR THE SHEAR STRENGTH THAN THE UNCONFINED COMPRESSION TEST.

RF-1, 1/76

NOTE 1 - SAMPLE TYPE

- BS - Bag Sample
- AS - Auger Sample
- ST - Shelby Tube Sample
- CA - California Sample
- RM - Remolded Sample
- HD - Hand Drive
- AD - Air Dried

NOTE 2 - SHEAR STRENGTH TESTS

- $C_1$ - Unconfined Compression
- $C_2$ - Miniature Vane Shear
- $C_3$ - Pocket Penetrometer
- $C_4$ - Pocket Vane

NOTE 3 - ADDITIONAL TEST RESULTS ATTACHED

- SW - Swell-Consolidation Test
- TT - Triaxial Test
- PT - Proctor
- GA - Gradation Analysis
- CT - Consolidation Test

# B4 SLOPE STABILITY/EARTHQUAKE ANALYSES

## SEISMIC ANALYSIS

The Rico area is located within the Colorado Plateau seismotectonic province, which is regarded as fairly stable tectonically (Kirkham and Rodgers, 1981). The site is southwest (outside) of the Uncompahgre uplift portion of the province, within which evidence of recurrent and locally active tectonism has been documented. A custom search of historic seismicity within 150 km of the site was made (National Geophysical Data Center, 1995). In the available 103 year record of felt and instrumentally recorded events, the largest earthquake within 50 km of the site was a magnitude 4.6 event in 1994. The largest event within a 100 km radius was a magnitude 5.5 earthquake in 1960 located approximately 76 km northeast of Rico. Another 5.5 magnitude event was recorded in 1966 119 km southeast of the site, and is the largest event out to a radius of 150 km. Given the low to moderate magnitudes and large distances of these earthquakes from the site, peak horizontal ground accelerations less than 0.02g in the vicinity of Rico would have occurred based on any of a variety of attenuation relationships (e.g., Schnabel and Seed, 1972; Campbell, 1981; Joyner and Boore, 1988). Such low accelerations acting for the short duration characteristic of these size earthquakes would have had no discernible effects on the Rico site structures or their foundations.

The nearest mapped potentially active faults to Rico are approximately 50-55 km (30-35 miles) away to the northwest, north and northeast (Kirkham and Rodgers, 1981). Of these, the Ridgeway fault to the north (within the Uncompahgre uplift) has been examined in greatest detail as part of seismotectonic studies for Ridgeway Dam (Sullivan, et al., 1980). This fault is assigned a maximum credible earthquake (MCE) of magnitude 6.5, which would result in estimated horizontal ground accelerations at Rico on the order of 0.05 to 0.1g using the attenuation relationships cited in the previous paragraph. Comparable site accelerations would be expected from MCEs on the other potentially active faults based on their mapped lengths. Earthquakes of lesser magnitude than the MCE (and correspondingly, of greater probability of occurrence) would result in lower expected accelerations in the Rico area.

The seismic risk in the vicinity of Rico is characterized by a number of regional studies widely utilized as a basis for analysis and design of non-critical civil works (in this context critical facilities are considered those whose failure could result in potentially catastrophic consequences, such as major water impounding dams and nuclear power plants). The work of Algermissen, et al. (1990) indicates that there is a 90 percent probability that a peak horizontal ground acceleration of 0.03g will not be exceeded in 50 years at this site. This equates to a recurrence interval of about 470 years, a level of risk comparable to that adopted for flooding, which is the other significant potential natural hazard at the site. The acceleration for a 250 year exposure period (or 2370 year recurrence interval) is still only about 0.1g. The U.S. Army Corps of Engineers' (1983) seismic zonation map shows Rico in Zone 1 on a scale of increasing seismic risk from Zone 0 to Zone 4. Zone 1 is characterized as of low damage potential, with a recommended seismic coefficient of 0.05 (which is not directly equivalent to horizontal ground acceleration), and not necessarily requiring a site-specific seismological evaluation for further assessing seismic hazard. The 1994 Uniform Building Code classifies the region including Rico as Zone 1 in a zonation comparable to that adopted by the Corps of Engineers, while the Colorado Geological Survey (Krikham and Rodgers, 1981) recommends that all but the extreme northeast corner of the state be considered Zone 2.

This summary characterization of the historic seismicity, potentially active faulting, and seismic risk zonation for the Rico area forms the basis of the seismic design events adopted for use in analysis of pertinent aspects of the conceptual remedial plan (specifically the Argentine Mill Tailings Ponds site) as described in Section 4.3.6. Given the generally low to moderate seismicity of the region and the nature of the proposed remediation, earthquakes and active faulting are not regarded as major hazards.

**Seismicity References**


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Campbell, Kenneth W. 1981. Near-Source Attenuation of Peak Horizontal Acceleration: in Bulletin of the Seismological Society of America, Vol. 71, No. 6, pp 2039-2070. December.

Joyner, William B. and David M. Boore. 1988. Measurement, characterization and prediction of strong ground motion: in Earthquake Engineering and Soil Dynamics II, Recent Advances in Ground-motion Evaluation, J. Lawrence Von Thun, ed.; American Society of Civil Engineers, Geotechnical Special Publication no. 20, pp 43-102.

Kirkham, Robert M. and William P. Rogers. 1981. Bulletin No. 43, Earthquake Potential in Colorado, A Preliminary Evaluation. Colorado Geological Survey, Department of Natural Resources.

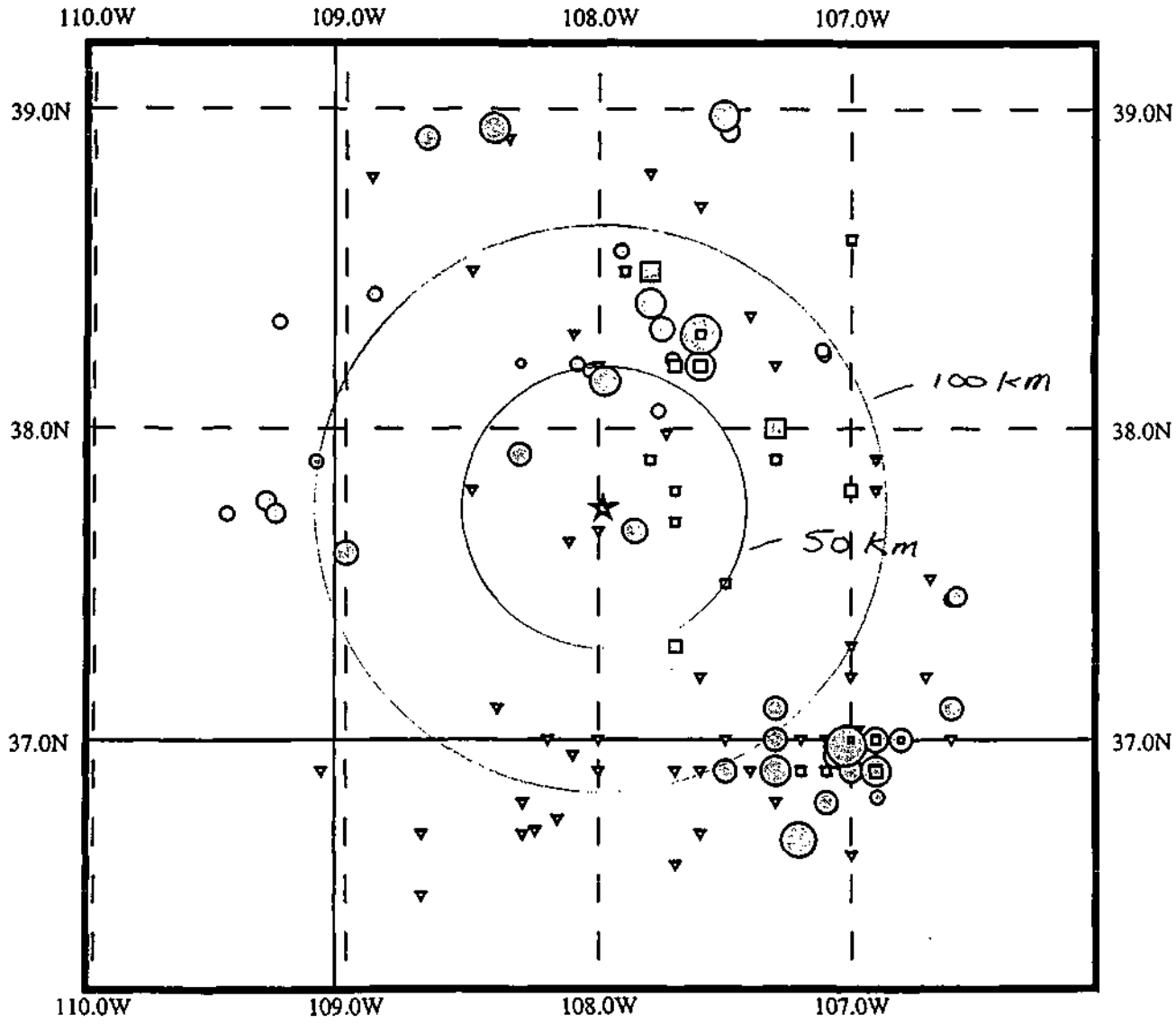
NOAA/National Geophysical Data Center. 1995. Earthquake data - custom request. May 12.

Schnabel, Per B. and H. Bolton Seed. 1972. Accelerations in Rock for Earthquakes in the Western United States. Report No. EERC 72-2, Earthquake Engineering Research Center, College of Engineering, University of California, Berkeley, California. July.

Sullivan, J. Timothy, Charles A. Meeder, Richard A Martin, Jr., and Michael W. West. 1980. Seismic Hazard Evaluation, Ridgeway Dam and Reservoir Site, Dallas Creek Project, Colorado. Report prepared for U.S. Water and Power Resources Service, U.S. Bureau of Reclamation. March.

U.S. Army Corps of Engineers. 1983. Engineering and Design, Earthquake Design and Analysis for Corps of Engineers Project; Report no. ER 1110-2-1806. May 16.

# SEISMICITY WITHIN 150 KM OF RICO CO (37.7N 108W)




101.9502 040

MAGNITUDES

| | | | |
|---|---|---|---|
| 0.1 - 1.9 | ○ | 4.0 - 4.4 | |
| 2.0 - 2.9 | ⊙ | 4.5 - 4.9 | |
| 3.0 - 3.4 | ⊙ | 5.0 - 5.4 | |
| 3.5 - 3.9 | ⊙ | > 5.4 | |

257 Earthquakes Plotted

100 km 61 mi

NO INTENSITY OR MAGNITUDE ▼

INTENSITIES

| | | | |
|---|---|---|---|
| I-III | ▪ | VII | |
| IV | ▫ | VIII | |
| V | □ | IX | |
| VI | □ | X-XII | |

NATIONAL GEOPHYSICAL DATA CENTER / NOAA BOULDER, CO, 80303

Bulletin of the Seismological Society of America, Vol. 71, No. 6, pp. 2039-2070, December 1981

# NEAR-SOURCE ATTENUATION OF PEAK HORIZONTAL ACCELERATION

BY KENNETH W. CAMPBELL


## ABSTRACT

Strong-motion data recorded within 50 km of the rupture zone were used to study near-source attenuation characteristics of horizontal peak ground acceleration for worldwide earthquakes of magnitudes 5.0 to 7.7. The data base consisted of 229 horizontal components of peak acceleration recorded from 27 earthquakes, including the 15 October 1979, Imperial Valley earthquake. These data were found to be adequately represented by the functional relationship

$$\mathrm{PGA} = a \exp(bM)[R + C(M)]^{-d}$$

where PGA represents the mean of the peak values scaled from the two horizontal components of each recording, $M$ is Richter magnitude, and $R$ is distance from the fault rupture zone. Peak acceleration was found to be lognormally distributed with a standard error representing a 45 per cent increase in the median estimate. The regression analysis statistically confirmed the results of earthquake simulation studies that have predicted peak acceleration to become independent of magnitude and distance in the near field. An extensive sensitivity study showed that predictions based on our attenuation relationships are stable with respect to reasonable model and parameter variations. An analysis of residuals was used to investigate the behavior of peak acceleration with respect to various earthquake, site, and recording parameters, the more significant findings being: (1) a similarity in the level of acceleration recorded on soil or rock; (2) larger than average accelerations recorded at sites located on shallow soils or in areas of steep topography; (3) larger than average accelerations associated with earthquakes having reverse fault mechanisms; and (4) lower than average accelerations recorded in large embedded structures.


## INTRODUCTION

The recent expansion of strong-motion networks throughout the world has been responsible for the recording of several significant accelerograms in the near-source region of moderate-to-large earthquakes, an area where data have been severely lacking in the past. Three significant events which have occurred within the past 5 yr are the 1976 Gazli, USSR ($M_S$ 7.0), the 1978 Tabas, Iran, ($M_S$ 7.7), and the 1979 Imperial Valley ($M_S$ 6.9) earthquakes, each producing accelerograms within 10 km of the fault.

These and other recent near-source recordings together with selected near-source data recorded as early as 1933 were used to analyze the behavior of peak horizontal acceleration (PGA) near the causative fault. The goal was to make PGA predictions at these distances as generally reliable as far-field estimates. The study was restricted to the near-source region of earthquakes of magnitude 5.0 or greater to eliminate the small accelerations generally considered to be of little importance in earthquake engineering. This restriction substantially reduced the uncertainty in the analyses and enhanced the statistical significance of the results.

Due to the paucity of near-source data for large earthquakes, the study was not restricted to accelerations recorded in western North America. We acknowledge

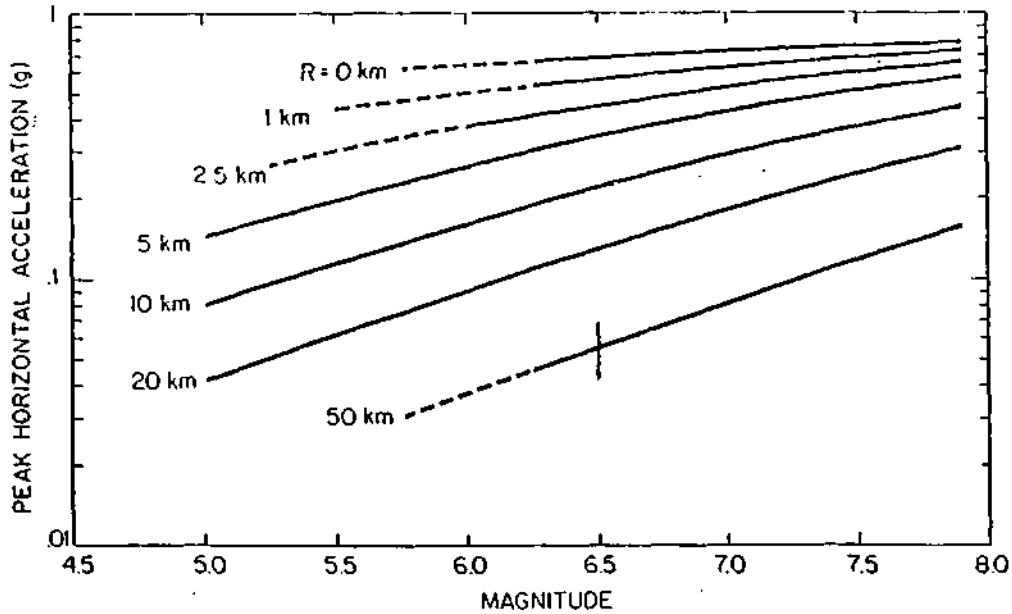



FIG. 3. The unconstrained ground motion model [equation (3)] plotted as a function of magnitude for fault distances of 0 to 50 km. The dashed lines represent extrapolations of limited applicability due to either a lack of data or ambiguity as to the depth of rupture during an event.

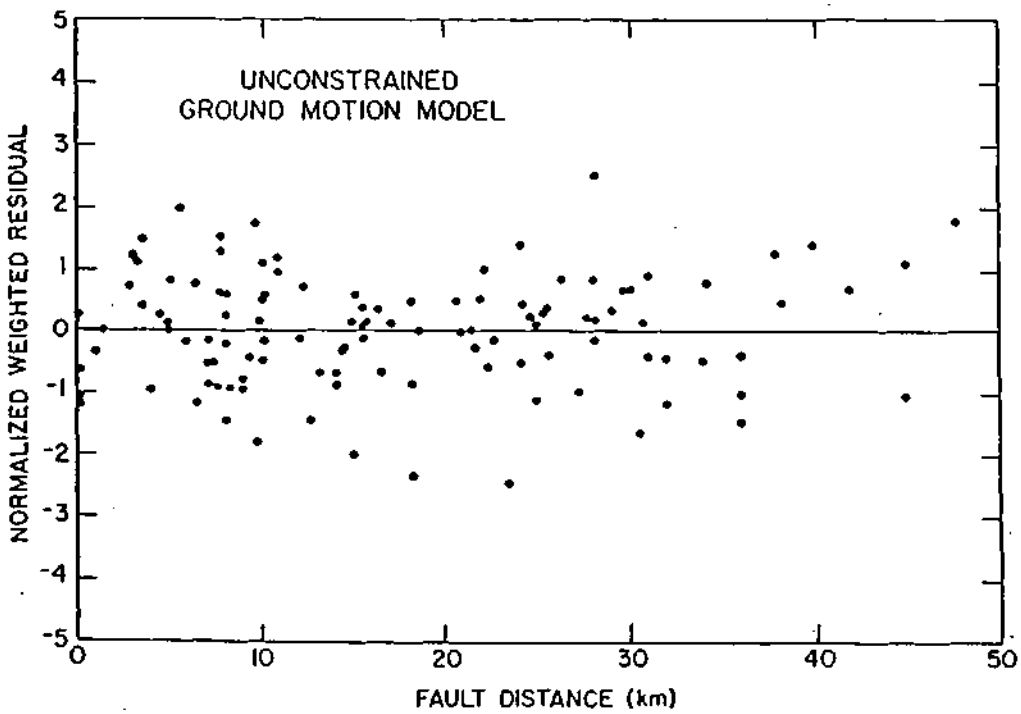



FIG. 4. A plot of residuals as a function of fault distance for the unconstrained regression analysis [equation (3)]. The residuals have been weighted and normalized to have a mean of zero and a variance of unity.

confidence exceeding 99 per cent. The 84 percentile value of PGA is obtained by multiplying the median value by a factor of 1.47, which represents a standard error of 0.384 on the natural logarithm of PGA. The goodness-of-fit is represented by an $r^2$ value of 0.79. The scatter in the data about their predicted values is given in

magnitude unit. Our data, on the other hand, supported reduced magnitude scaling in the near field, the amount of the reduction being dependent on the size of the event. Our relationship gives a 114 per cent increase in peak acceleration from $M$ 6.5 to $M$ 7.5 at 50 km, decreasing to a 48 per cent increase for the same magnitude interval at a distance of 5 km.

A thorough understanding of the differences in magnitude scaling between the two relationships would require a detailed comparison of the data sets and statistical techniques used in each analysis which is beyond the scope of this study. As suggested by Joyner and Boore (1981), part of the difference may be due to their definition of distance. Their use of closest distance to the surface projection of the fault rupture surface would give smaller distances than would our definition for the

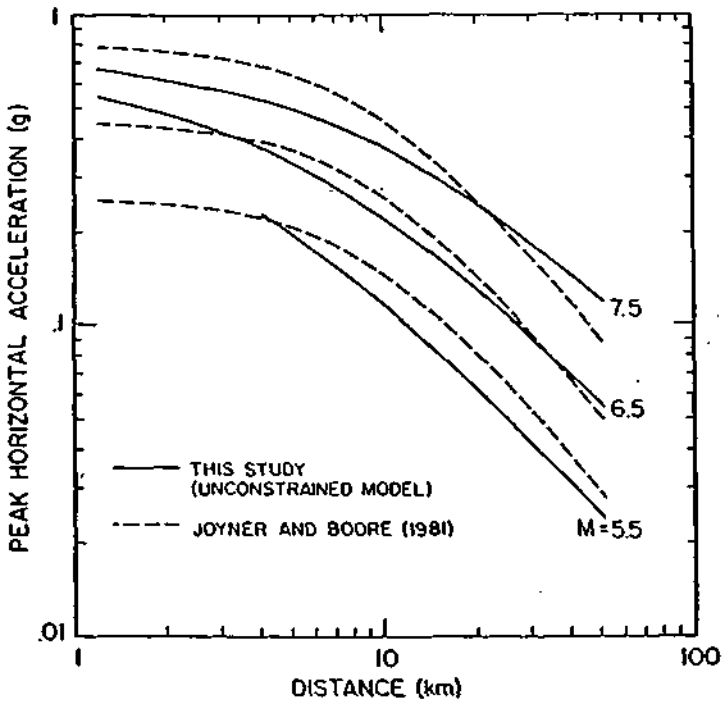



FIG. 11. The unconstrained ground motion model (solid curve) compared with the attenuation relationship (dashed curve) developed by Joyner and Boore (1981). The Joyner and Boore predictions of the maximum horizontal component have been reduced by 12 per cent so they may be compared with the predictions of the mean horizontal peak acceleration given by the unconstrained model.

smaller magnitude events not accompanied by surface rupture. As a result, their data would be expected to support a larger degree of magnitude scaling between moderate and large earthquakes in the near field. For earthquakes exceeding magnitudes 6.0 to 6.3, which generally rupture to the ground surface, their definition of distance becomes consistent with ours and might then be expected to support reduced magnitude scaling in the near field.

To understand the effect of distance definition on the near-source behavior of PGA, we developed a ground motion model from our data, using closest distance to the surface projection of the fault rupture zone, and compared it to the unconstrained relationship given by equation (3). As expected, we found that by using this alternate distance definition the degree of magnitude saturation decreased, whereby magni-

D. M. YADON

REPORT NO.
EERC 72-2
July 1972

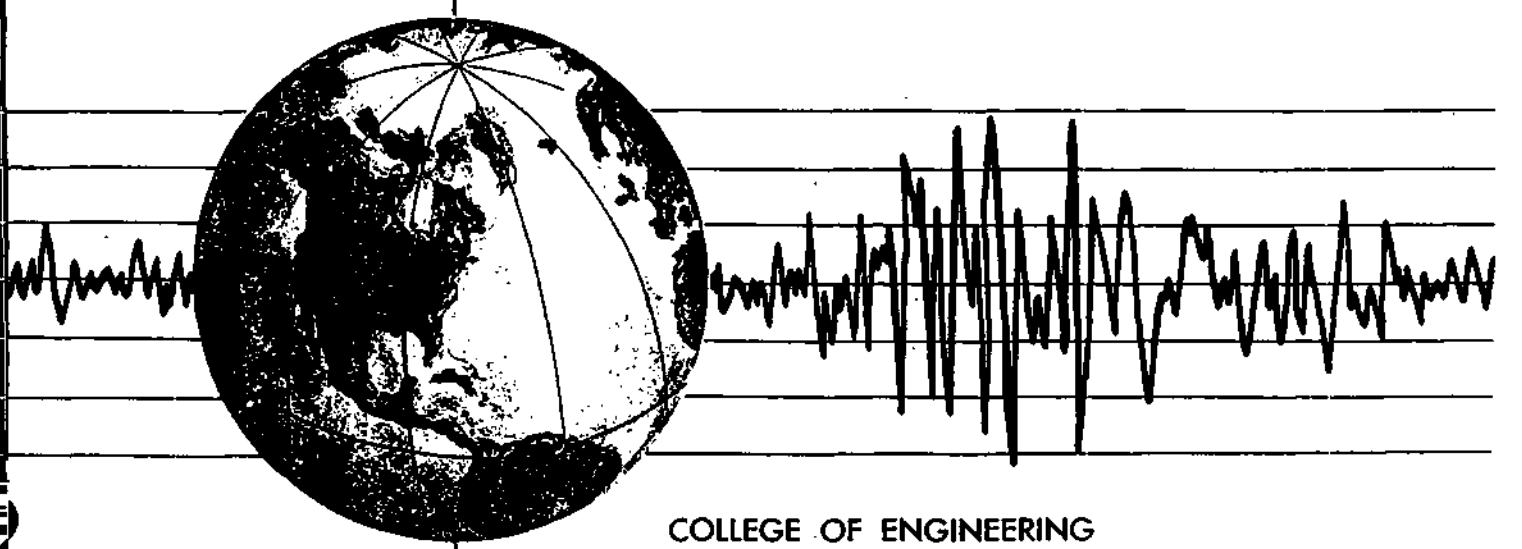
EARTHQUAKE ENGINEERING RESEARCH CENTER

# ACCELERATIONS IN ROCK FOR EARTHQUAKES IN THE WESTERN UNITED STATES

by

PER B. SCHNABEL

H. BOLTON SEED



COLLEGE OF ENGINEERING

UNIVERSITY OF CALIFORNIA · Berkeley, California

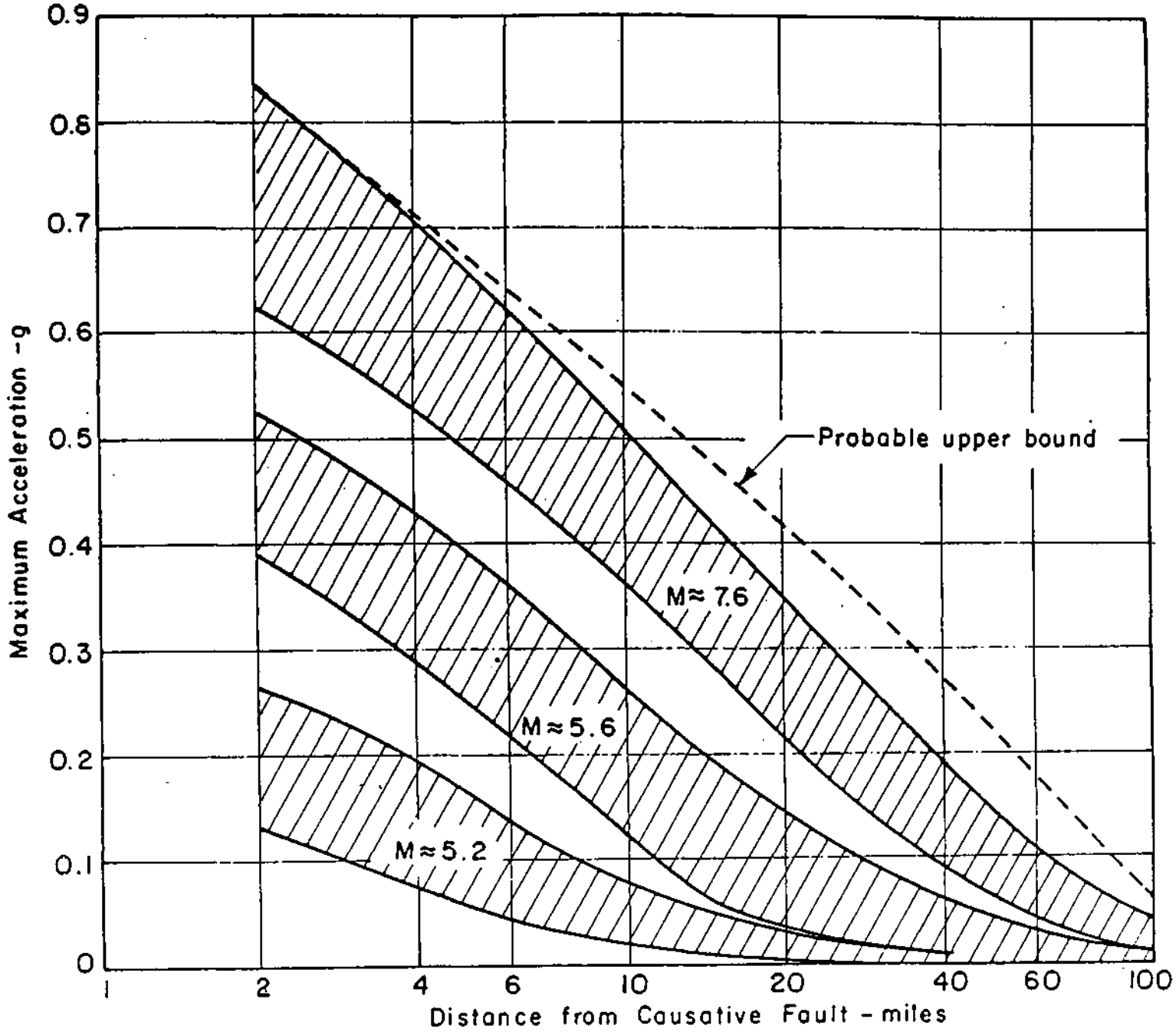



Fig. 6 RANGES OF MAXIMUM ACCELERATIONS IN ROCK

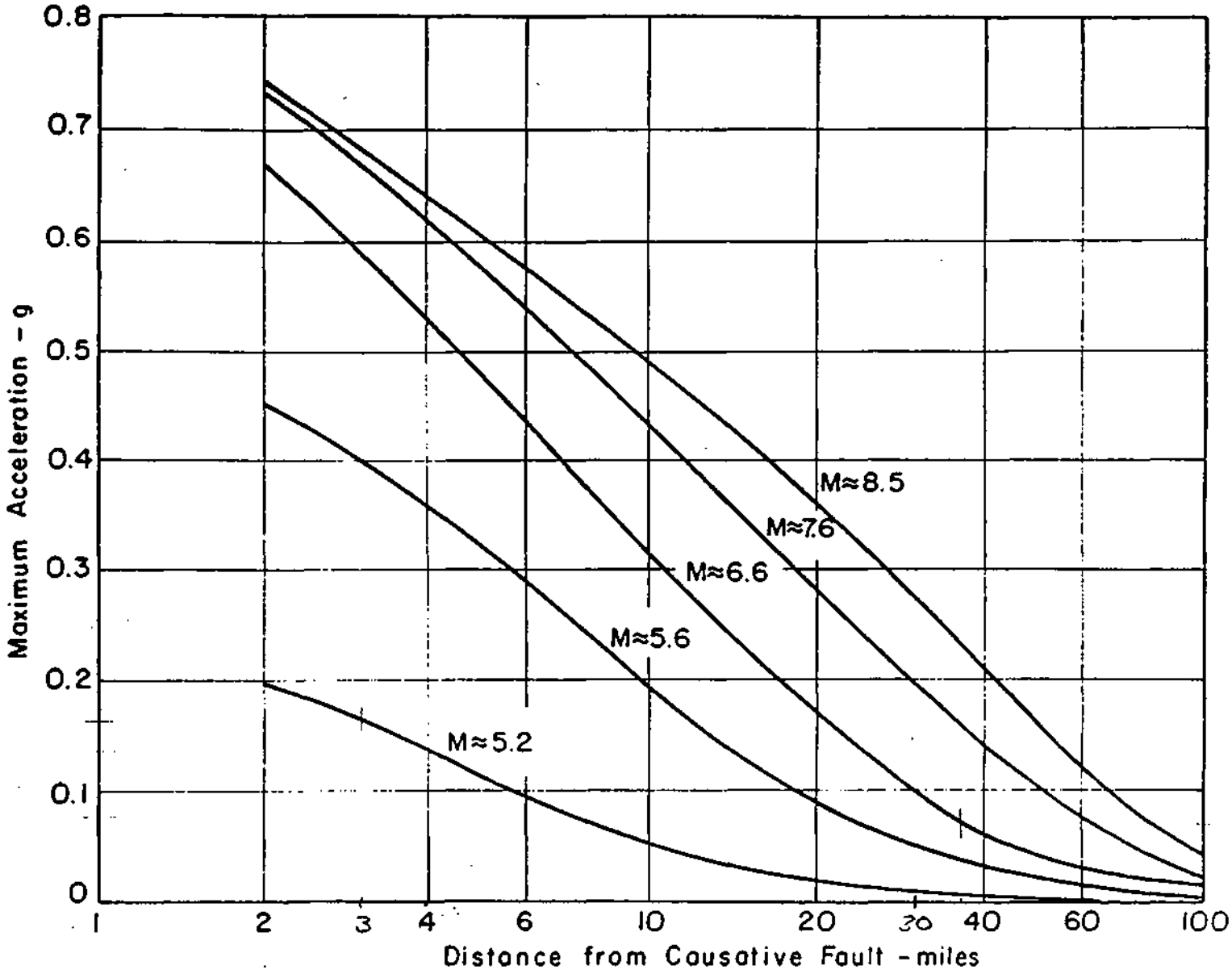
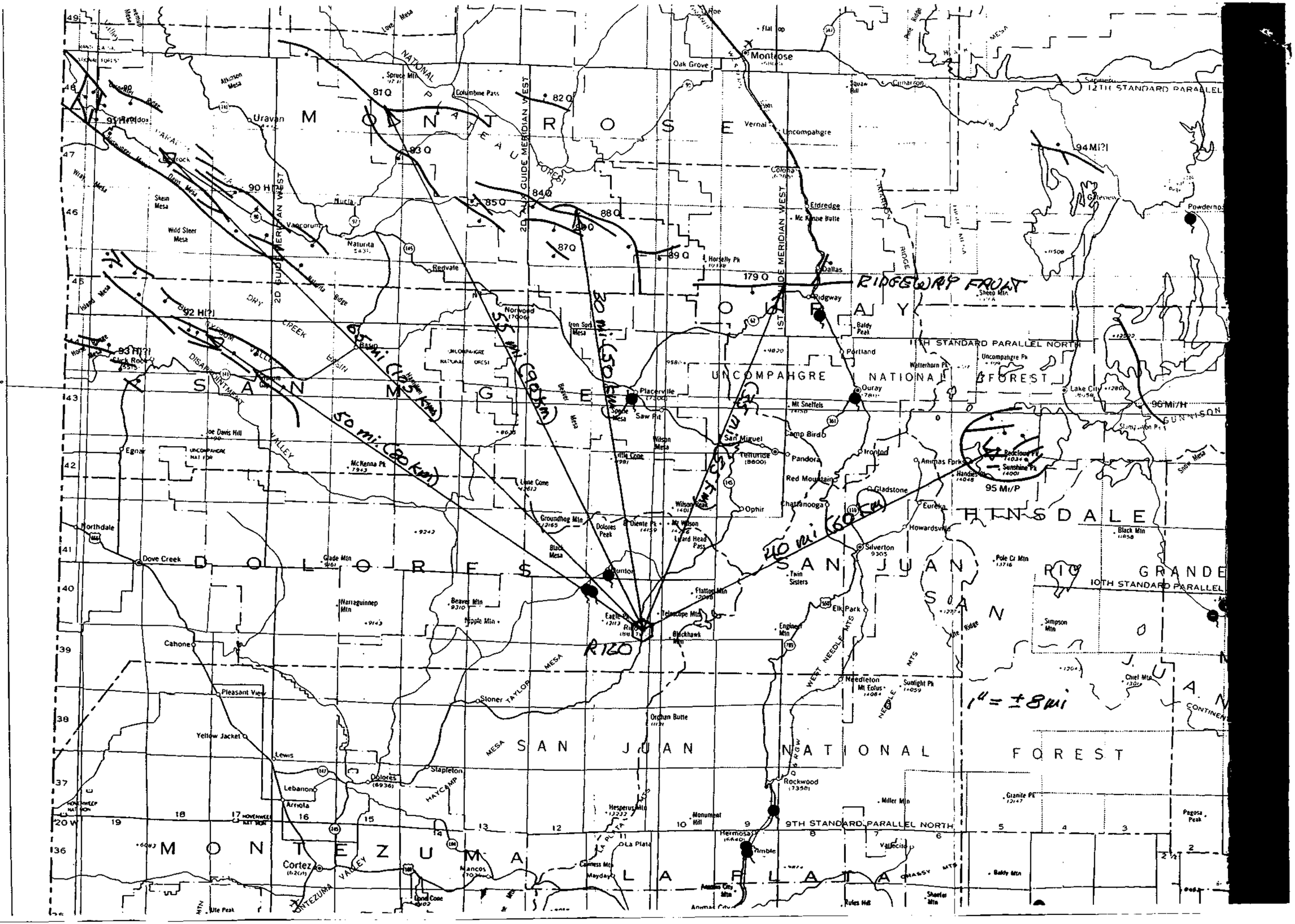



Fig. 5 AVERAGE VALUES OF MAXIMUM ACCELERATIONS IN ROCK


RIDGEWAY FAULT
R160
1" = ±8 mi
65 mi (105 km)
50 mi (80 km)
55 mi (90 km)
210 mi (60 km)
94 Mi?I
96 Mi/H
95 Mi/P
92 H(?)
93 H(?)
90 H
81 Q
82 Q
93 Q
85 Q
84 Q
88 Q
87 Q
89 Q
179 Q
MONTROSE
SAN MIGUEL
OURAY
DOLORES
SAN JUAN
HINSDALE
MONTEZUMA
LA PLATA
RIO GRANDE
UNCOMPAHGRE NATIONAL FOREST
SAN JUAN NATIONAL FOREST
12TH STANDARD PARALLEL
11TH STANDARD PARALLEL NORTH
10TH STANDARD PARALLEL
9TH STANDARD PARALLEL NORTH
2D GUIDE MERIDIAN WEST
1ST GUIDE MERIDIAN WEST
Montrose
Ouray
Ridgway
Telluride
Silverton
Rico
Dolores
Cortez
Hermosa
Durango
Dove Creek
Cahone
Pleasant View
Yellow Jacket
Lewis
Lebanon
Arriola
Stapleton
Egnar
Naturita
Nucla
Redvale
Norwood
Placerville
Saw Pit
Ophir
Pandora
Red Mountain
Ironton
Chattanooga
Gladstone
Eureka
Howardsville
Animas Forks
Lake City
Uravan
Vernal
Uncompahgre
Colona
Dallas
Portland
Camp Bird
San Miguel
Rockwood
Needleton
Mt Eolus
Elk Park
Twin Sisters
Orchard Butte
Stoner
Mancos
Mayday
La Plata
Rules Hill
Powderhorn
Gateway
Cimarron
Oak Grove
Columbine Pass
Spruce Mill
Horsefly Pk
Iron Springs Mesa
Wilson Mesa
Lizard Head Pass
Dolores Peak
Groundhog Mtn
Black Mesa
Lone Cone
McKenna Pk
Joe Davis Hill
Narraguinnep Mtn
Beaver Mtn
Apple Mtn
Glade Mtn
Northdale
Ute Peak
Cortez
Mt Sneffels
Uncompahgre Pk
Wetterhorn Pk
Redcloud Pk
Sunshine Pk
Handies Pk
Sunlight Pk
Chief Mtn
Simpson Mtn
Pole Cr Mtn
Black Mtn
Granite Pk
Miller Mtn
Baldy Mtn
Pagosa Peak
Shearer Mtn
Monument Hill
Hesperus Mtn
Cairness Mtn
Animas City Mtn
Telescope Mtn
Blackhawk Mtn
Engineer Mtn
Flattop Mtn
Baldy Peak
Sheep Mtn
Iron Springs Mesa
Wild Steer Mesa
Skein Mesa
Attwater Mesa
Wright Mesa
Dry Creek Basin
Disappointment Valley
Hartman Ridge
Beaver Mesa
Taylor Mesa
Hay Camp Mesa
La Plata Mts
Grassy Mts
West Needle Mts
Needle Mts
Ute Ridge
Continental Divide
Montezuma Valley
Uncompahgre Nat For
Hovenweep Nat Mon
Navajo Nat Res
Ute Mtn

CGS Bulletin 43 Kirkham & Robbins, 1981

# EXPLANATION

67 Qw/H

POTENTIALLY ACTIVE FAULT; includes faults that are approximately located and/or concealed. Ball on downthrown side. Each fault or fault group is numbered. The number is used in the text and is keyed to Appendix 2. Age of the most recent fault movement is indicated by the letter symbols. The youngest deposit offset by the fault is indicated by the first symbol and the oldest deposit not offset by the fault is indicated by the second symbol. If only one symbol is listed, it is for the youngest deposit displaced by the fault. The symbols used represent the age and, where known, the name of the deposit. The symbols are defined as follows:

| | |
|---|---|
| H | Holocene deposits |
| Qp | Pinedale glacial deposits |
| Qb | Bull Lake glacial deposits |
| Qw | Wisconsinan glacial deposits (undifferentiated) |
| Qpb | pre-Bull Lake glacial deposits |
| Qi | Illinoian glacial or Sangamon interglacial deposits |
| Qk | Kansan glacial or Yarmouth interglacial deposits |
| Qn | Nebraskan glacial or Aftonian interglacial deposits |
| Q | Quaternary deposits (undifferentiated) |
| Mt | Miocene Troublesome Formation |
| Mnp | Miocene North Park Formation |
| Mi | Miocene igneous rocks |
| Td | Miocene-Pliocene Dry Union Formation |
| Tsf | Miocene-Pliocene Santa Fe Formation |
| Tbp | Miocene-Pliocene Browns Park Formation |
| Ts | late Tertiary sedimentary rocks |
| Ti | late Tertiary igneous rocks |
| T | late Tertiary rocks (undifferentiated) |

If a fault has documented historic seismicity associated with it, such as fault numbers 64 and 168, Holocene movement is indicated.

See Appendix 2 and the text for sources of information.

INFERRED POTENTIALLY ACTIVE FAULT; Neogene movement inferred by Tweto (1978). Ball on downthrown side. Inferred faults are not assigned fault numbers nor are they listed in Appendix 2.

DIKE

NEOGENE IGNEOUS ROCKS; includes extrusive and intrusive rocks of Miocene or younger age. "H" indicates rocks are of Holocene age and "Q" indicates rocks are of Quaternary age. All other mapped igneous rocks are Miocene or Pliocene in age.

Source: Tweto, Ogden, 1979, Geologic map of Colorado: U.S. Geol. Survey Special Map.

THERMAL SPRINGS

Source: Pearl, Richard H., 1980, Geothermal Resources of Colorado: Colorado Geological Survey Map Series 14.

SCALE 1:500 000

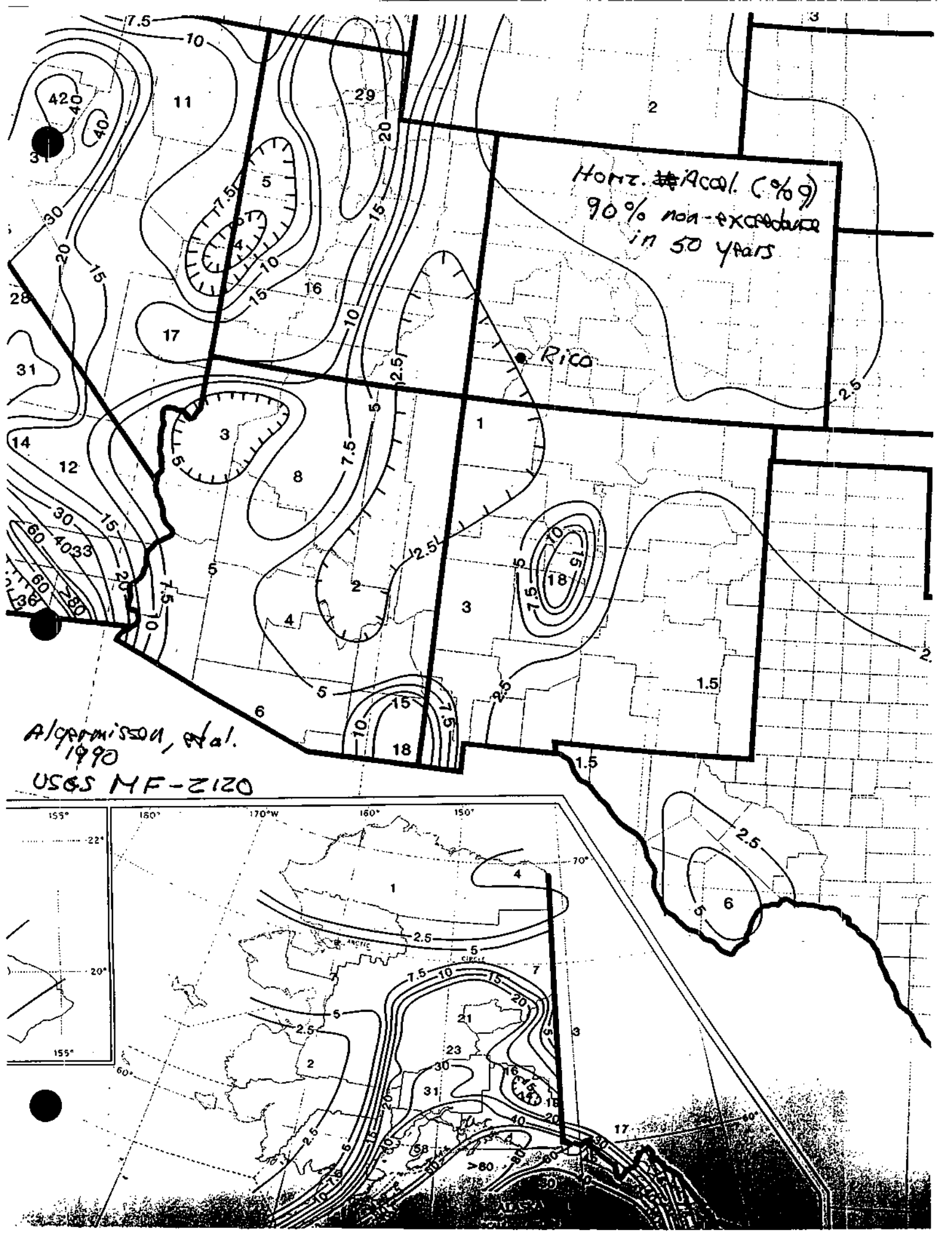
10 0 10 20 MILES

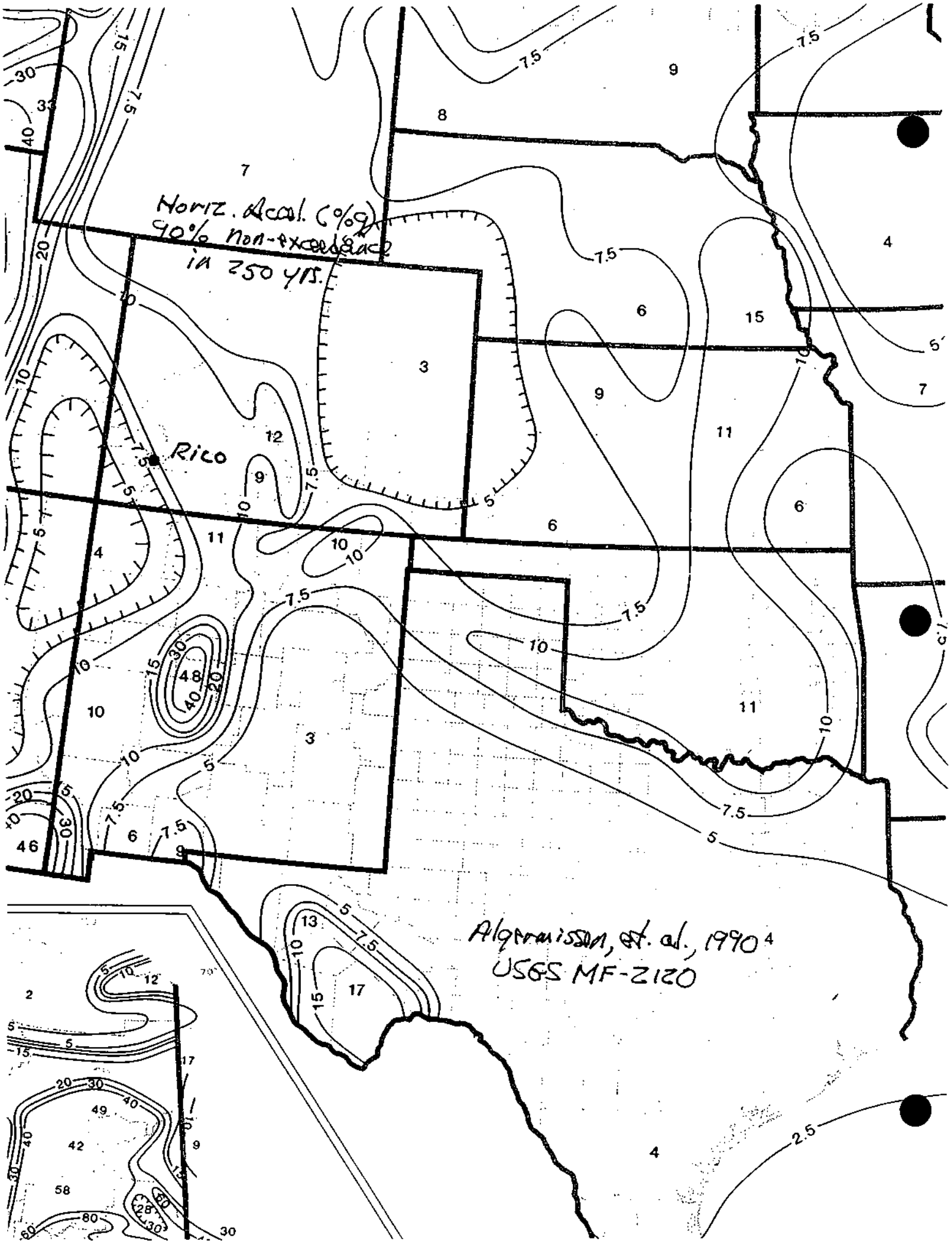
10 0 10 20 KILOMETERS

1" = ± 8 mi

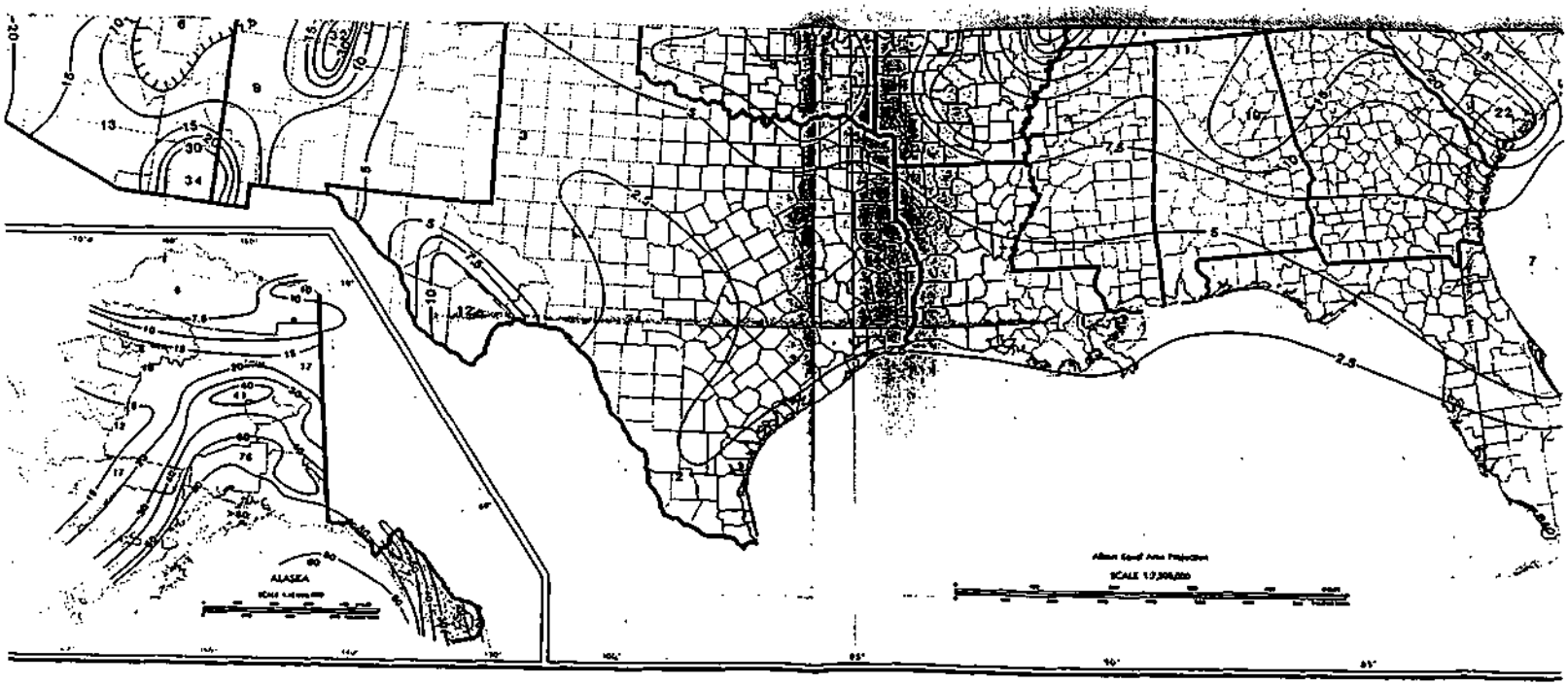
DATUM IS MEAN SEA LEVEL

2D STANDARD PARALLEL SOUTH


Horiz. Accel. (%g)
90% non-exceedance
in 50 years
Rico
Algermissen, et al.
1990
USGS MF-2120


Horiz. Accel. (%g)
90% non-exceedance
in 250 yrs.
Rico
Algermissen, et. al., 1990
USGS MF-2120

MISCELLANEOUS FIELD STUDIES
DEPARTMENT OF THE INTERIOR MAP MF-2120
U.S. GEOLOGICAL SURVEY SHEET 2 OF 2




MAP D.-HORIZONTAL VELOCITY (90 PERCENT PROBABILITY OF NOT BEING EXCEEDED IN 250 YEARS)

# PROBABILISTIC EARTHQUAKE ACCELERATION AND VELOCITY MAPS FOR THE UNITED STATES AND PUERTO RICO

By
S. T. Algermissen, D. M. Perkins, P. C. Thenhaus, S. L. Hanson, and B. L. Bender

1990

(2)

DAEN-ECE-G
DAEN-ECE-D

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
Washington, D. C. 20314

ER 1110-2-1806

Regulation
No. 1110-2-1806

16 May 1983

Engineering and Design
EARTHQUAKE DESIGN AND ANALYSIS FOR
CORPS OF ENGINEERS PROJECTS

1. Purpose. The purpose of this regulation is to provide general guidance and direction for the seismic design and evaluation for all Corps of Engineers civil works projects.

2. Applicability. This regulation is applicable to all field operating activities having civil works responsibilities.

3. References:

a. ER 1130-2-417, Major Rehabilitation Program and Dam Safety Assurance Program.

b. EM 1110-2-1902, Stability of Earth and Rockfill Dams

c. EM 1110-2-2200, Gravity Dam Design

4. Policy. The seismic design for new projects and seismic evaluations for existing projects should be accomplished in accordance with this regulation. The term "project" includes all dams, appurtenant structures, navigation structures and levees that retain or have the potential to retain a permanent pool, and whose failure due to earthquake loading would result in the loss or partial loss of the reservoir that would cause property damage and/or loss of life. Where justifying circumstances exist, requests for departures from this policy should be submitted by the District Commander through the Division Commander to HQ USACE.

5. General. Procedures for selecting design earthquakes and associated site-specific motions are available for use in assessing the resistance of structures to earthquakes. As a minimum, a seismological evaluation should be performed on all projects located in seismic zones 2, 3, and 4 for the purpose of assessing the seismic hazard. For reference, seismic zone maps of the United States and Territories are included in Appendix A.

a. Concrete Structures.

This regulation supersedes ER 1110-2-1806 dated 30 April 1977

ESA FILE COPY

# GROUND FAILURES
## UNDER SEISMIC CONDITIONS

Proceedings of sessions sponsored by the
Geotechnical Engineering Division of the
American Society of Civil Engineers
in conjunction with the
ASCE National Convention in
Atlanta, Georgia, October 9-13, 1994

Geotechnical Special Publication No. 44

**Edited by Shamsher Prakash and Panos Dakoulas**

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345 East 47th Street
New York, New York 10017-2398

- per cent finer than 0.005 mm ≤ 15%
- liquid limit, LL ≤ 35%
- natural water content ≥0.9 LL
- liquidity index, $I_w \leq 0.75$

Soils which satisfy all four criteria are judged vulnerable to liquefaction or significant strength loss. The Chinese criteria are often applied strictly with no account taken of uncertainties in the measurements of the parameters of the criteria. The U.S. Army Corps of Engineers and some major consulting firms now use an error term when applying the criteria.

In connection with remediation studies for Sardis Dam (Finn et al., 1991), the U.S. Army Corps of Engineers reviewed reports on the scatter in measured index properties in their own laboratories over the last 30 years to determine the likely range of variations in test data. In addition tests were also conducted on samples of standard soils of low to medium plasticity in order to establish the scatter in the data from the laboratory of the US Army Corps of Engineers District responsible for Sardis Dam. These standard soils are used to check comparability of testing procedures between different Corps of Engineers' laboratories and private laboratories. As a result of these studies the following changes in measured properties were adopted before applying the Chinese criteria (ignoring the liquidity index):

- decrease the fines content by 5%
- decrease the liquid limit by 2%
- increase the water content by 2%

These changes led to a substantial increase in the extent of liquefiable clayey silt under Sardis Dam. Therefore, an investigation of Chinese procedures was undertaken by Koester (1990). The Chinese determine the liquid limit using a fall cone rather than the Casagrande device generally used in North America. Using a standard Chinese fall cone and following Chinese standard SD 128-007-84, Koester (1990) showed that the fall cone gives a liquid limit about 3% to 4% greater than the Casagrande device. Further studies reported later by Koester (1992) confirm the findings regarding the liquid limit.

On the basis of all the above studies the following changes in measured index properties were finally adopted to account for uncertainty before application of the Chinese criteria:

- decrease the fines content by 5%
- increase the liquid limit by 1%
- increase the water content by 2%



These error bounds may be considered typical of good practice and may be used when more specific data are not available.

## CASE HISTORIES

The previous sections deal primarily with procedures for estimating the potential for triggering liquefaction. If triggering is likely to occur, then it becomes necessary to assess the consequences of liquefaction and what remedial measures to adopt. It is becoming more common in engineering practice to rely on deformation analysis as well as on the traditional factor of safety approach to evaluate the consequences of liquefaction and the options for cost-effective remedial measures.

These uses of deformation analysis will be demonstrated by two case histories from recent practice. The first case involves the evaluation of the potential for flow deformations in a tailings dam. The second case describes the analysis of the proposed nailing of the upstream slope of an embankment dam to firm foundation soils by driving piles across a thin weak horizontal layer in the upstream foundation.

## ST. JOE STATE PARK TAILINGS DAM

Two tailings dams were constructed by the St. Joe Lead Company near Flat River, Missouri, from 1911 to 1965. These dams are designated Original Dam and Main Dam. When the mine closed, the entire processing facility was donated to the State of Missouri. The dams are situated within the zone of influence of the 1811-1812 New Madrid earthquakes. An assessment of the seismic stability of these dams was conducted in 1990 and reported by Vick et al. (1992). An idealized section of the Original Dam is shown in Fig. 8.

The liquefaction resistances of the materials in the dam against the design earthquake were obtained using the liquefaction resistance curve developed by Seed et al. (1985). The resistances so obtained were corrected for overburden pressure and for the initial static shear-stress ratio $\tau_{st}/\sigma'_{vo}$ using the correction factors $K_\sigma$ and $K_\alpha$ given by Seed and Harder (1990).

The post-liquefaction flow deformations of the Original Dam (Fig. 8) were estimated using the program TARA-3FL (Finn and Yogendrakumar, 1989). The analysis is based on a Lagrangian formulation incorporating an adaptive mesh. The progress of deformations as the shear strength drops towards the residual value may be observed by comparing the deformed shapes of the dam in Figs. 9 and 10. Figure 9 shows the deformed shape when the undrained strength

(1) Analysis by the seismic coefficient method will continue to be used to determine the sliding and overturning stability of all concrete structures. The seismic coefficients listed in table 1 should be used for the corresponding zones in Appendix A.

Table 1

| Zone | Damage | Coefficient |
|---|---|---|
| 0 | None | 0.0 |
| 1 | Minor | 0.05 |
| 2 | Moderate | 0.10 |
| 3 | Major | 0.15 |
| 4 | Great | 0.20 |

USE 0.075 for conservatism per Kirkham & Rodgers (1981)

(2) In addition to the stability analysis, a dynamic response type of stress analysis should be performed for concrete structures of the project in seismic zones 3 and 4 and in seismic zone 2 when the site-specific peak ground acceleration for the design earthquakes is 0.15 g or greater.

b. Embankments and Soil Foundations. As a result of advances in the state of the art in recent years, the seismic coefficient method, often referred to as the pseudo-static method, is no longer regarded as being appropriate for analysis of embankment or foundation response to seismic loading. Therefore, its use for this purpose should be discontinued. In general, embankments and soil foundations should be evaluated for instability and/or excessive deformations under earthquake loading by:

(1) determining the types and spatial distribution of embankment and foundation materials,

(2) determining in-situ or anticipated material properties, and,

(3) appropriate analytical techniques to evaluate liquefaction potential and/or to estimate deformations, beginning with the more simplified methods, and progressing as necessary to more rigorous, sophisticated procedures. For existing structures, such an evaluation should begin with a review of available as-built data. Where sufficient as-built data is lacking, or for new structures, detailed field exploratory programs should be carefully planned and executed. The results of an as-built data review, detailed field investigations, and the seismological evaluation, will determine the appropriate dynamic response and/or deformation analyses that should be performed on the project. The evaluation described above for the analysis of embankment and/or foundation susceptibility to liquefaction or excessive deformation will be performed for all projects located in seismic zones 3 and 4, and those projects in zone 2 where embankment or foundation materials exist that are suspect of being susceptible to liquefaction or excessive deformation. Such evaluation and analysis should also be performed regardless of the seismic zone location of the project, where capable faults or recent earthquake epicenters are discovered within a distance that may result in damage to the structure. Defensive design features should be incorporated

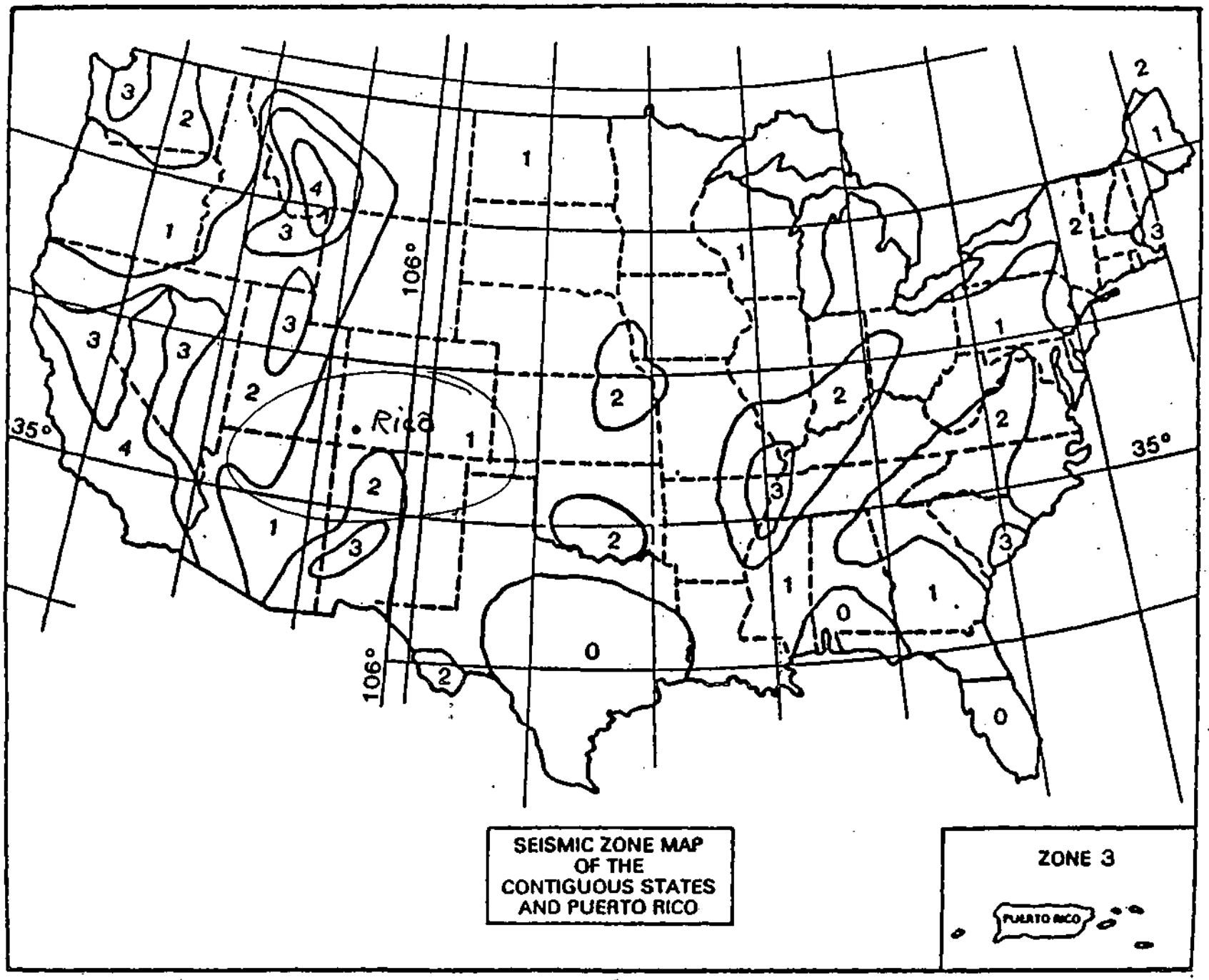

SEISMIC ZONE MAP
OF THE
CONTIGUOUS STATES
AND PUERTO RICO
ZONE 3
PUERTO RICO
Rico
35°
106°

Figure A-1

## EFFECTS OF FINES CONTENT ON LIQUEFACTION RESISTANCE

### Non-Plastic Fines

The data in Seed's resistance chart (Fig. 2) shows that the resistance to triggering liquefaction can be substantially increased by the presence of fines. This increase becomes relatively more important at the lower penetration resistances. These findings from field experience have spurred an interest in the effects of fines content on liquefaction resistance and residual strength. Many laboratory studies have been conducted, primarily on reconstituted sand samples in which various percentages of fines have been incorporated. In spite of these studies, there still appears to be considerable confusion about the effect of fines on liquefaction resistance. The confusion arises from the different ways in which comparisons are made of the liquefaction resistances of sands with various percentages of fines.

Seed et al. (1985) reviewed sites that did and did not liquefy during earthquakes where the fines content was greater than 5%. They found that for the same penetration resistance the liquefaction resistance increased with increasing fines content (Fig. 2). The field data in Fig. 2 shows a strong dependency of liquefaction resistance on fines content. In the case of the field data, for the same normalized penetration resistance $(N_1)_{60}$ the liquefaction resistance increases with increasing fines content.

What the soils being compared have in common, in this case, is the $(N_1)_{60}$ value. If the basis for comparison is changed the conclusion may well be different. For example, Troncoso (1990) compared the cyclic strength of tailings sands with different silt contents ranging from 0 to 30% at a constant void ratio. On this basis of comparison he found that cyclic strength decreased with increased silt content (Fig. 7). Kuerbis and Vaid (1989) studied the effects of fines using samples deposited in a manner that replicated field deposition conditions. They found for the sand tested that up to 20% fines could be accommodated within the sand skeleton and that samples with the same sand skeleton void ratio had the same cyclic strength for fines content less than 20%.

The different conclusions about the effects of fines on liquefaction resistance arising from the different comparison criteria are summarized in Table 2.

Another way of looking at the field data is to note that the penetration resistance of silty sands is somewhat lower than for clean sands at the same cyclic strength. Corrections based on the curves in Fig. 2, can be applied to the $(N_1)_{60}$ values measured in the silty sands and then the curve for clean sands may be used



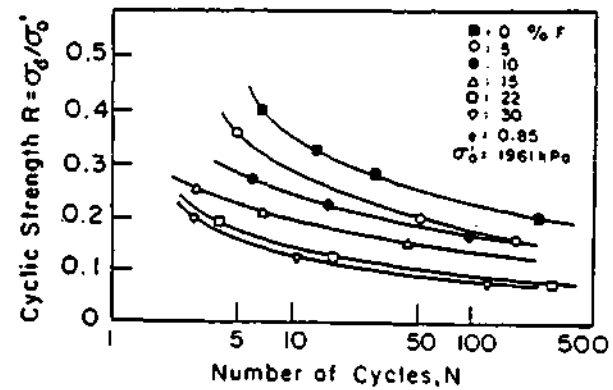



Fig. 7. Variation in cyclic strength with fines content (Troncoso, 1990).

Table 2. Effects of Fines on Cyclic Strength.

| Criterion of Equivalency Clean and Silty Sand | Effect of Fines on Cyclic Strength |
|---|---|
| 1. Same $(N_1)_{60}$ | Increase |
| 2. Same gross void ratio | Decrease |
| 3. Same void ratio in sand skeleton | No change while fines content can be accommodated in sand voids |

to determine cyclic strength for the corrected $(N_1)_{60}$ value. Such corrections have been widely used.

If the fines are plastic, liquefaction criteria based on field data from Chinese earthquakes should be taken into account (Wang, 1979) in determining if the soil will liquefy.

### Plastic Fine-Grained Soils

Liquefaction potential of weak clays is usually determined using the Chinese criteria developed by Wang (1979). These criteria are:

# ESA Consultants

JOB NO. 101.9502.040 SUBJECT Silver Cr. Tailings - SHEET NO. 1 OF

PROJECT Rico Material Properties Summary for Tailings Materials BY DJM DATE 5-23-9

D.M. Geotech (1981)

| | Boring | Depth (ft) | Description | $G_s$ | $\gamma_d$ (pcf) | w (%) | S (%) | e | Shear (psf) |
|---|---|---|---|---|---|---|---|---|---|
| Pond 1 West | B-9 | 20 | Grey Fine Sandy SILT | 3.2 | 106 | 3 | 47 | 0.88 | |
| | | 30 | " | [3.1] | 122 | 17 | 85 | 0.64 | |
| | | 40 | Grey Clayey SILT | [3.1] | 107 | 19 | 73 | 0.81 | |
| | | 50 | " | [3.1] | 107 | 34 | 92 | 0.81 | |
| | | 60 | " | 3.1 | 91 | 35 | 96 | 1.13 | 510* |
| | | 70 | " | [3.1] | 111 | 28 | 117 | 0.74 | 730* |
| | B-24 | 5 | Grey Silty Fine SAND | 3.6 | 133 | 4 | 21 | 0.69 | 320** (1200) |
| | | 15 | Grey Fine Sandy SILT | [3.1] | 106 | 9 | 34 | 0.83 | |
| | | 20 | " | 3.1 | 105 | 9 | 33 | 0.84 | 1740** (1200) |
| | | 40 | Grey Clayey SILT | [3.1] | 93 | 36 | 103 | 1.08 | |
| | | 50 | " | [3.1] | 97 | 34 | 106 | 1.00 | |
| | | 60 | " | [3.1] | 104 | 29 | 104 | 0.86 | |
| | B-26 | 5 | Grey Clayey SILT | [3.1] | 106 | 23 | 86 | 0.83 | |
| | | 15 | " | [3.1] | 88 | 39 | 101 | 1.20 | |
| Pond 1 South | B-23 | 15 | Br/Grey Fine Sandy SILT | [3.6] | 133 | 20 | 104 | 0.69 | |
| | | 25 | Grey " | [3.9] | 146 | 6? | 35 | 0.67 | |
| | | 35 | | 3.9 | 148 | 16 | 97 | 0.65 | 3100** (4000) |
| | | 36 | | [3.9] | 122 | 21 | 82 | 1.00 | |
| Pond M | B-21 | 5 | Br/Yel Sandy SILT: Silty SAND | 3.1 | 92 | 20 | 56 | 1.10 | |
| | | 10 | Br/Grey " " | [3.1] | 109 | 8 | 32 | 0.78 | |
| | | 17 | " " " | [3.1] | 102 | 10 | 35 | 0.90 | |
| | | 20 | Grey Clayey SILT | [3.1] | 91 | 38 | 105 | 1.13 | |
| | | 21 | " | [3.1] | 83 | 44 | 102 | 1.33 | |
| | | 26 | " | [3.1] | 93 | 37 | 106 | 1.08 | |
| | B-11 | 20 | Grey Fine Sandy SILT | 3.5 | 115 | 11 | 43 | 0.90 | 1200** (1500) |
| | | 30 | " (w/some clay) | [3.5] | 136 | 14 | 81 | 0.61 | |

| | | $G_s$ | $\gamma$ |
|---|---|---|---|
| Ave Values | Pond 1 (W) Sandy SILT | 3.15 | 123 |
| | (W) Clayey SILT | 3.1 | 130 |
| | (S) Sandy SILT | 3.9 | 158 |
| | Pond 3 (ML-SM) | 3.1 | 113 |
| | Clayey SILT | | 124 |
| | Sandy SILT | 3.5 | 141 |

* UU Triaxial

** Direct Shear (unknown)

# ESA Consultants

JOB NO. _____ SUBJECT _____ SHEET NO. 2 OF 2

PROJECT _____ BY _____ DATE _____

| | Boring | Depth (ft) | Description | $G_s$ | $\gamma_d$ (pcf) | w (%) | S (%) | e | |
|---|---|---|---|---|---|---|---|---|---|
| Pond 2 | B-22 | 6 | Silty, Clayey GRAVEL w/Sand | [2.7] | 111 | 13 | 68 | 0.52 | |
| | | 26 | Grey Clayey SILT | 3.3 | 95 | 35 | 99 | 1.17 | |
| | | 27 | " | [3.3] | 107 | 29 | 103 | 0.93 | |
| | | 37 | " w/Sand | [3.3] | 120 | 18 | 83 | 0.72 | |
| Pond 4 | B-18 | 6 | Br Sandy SILT | [3.1] | 115 | 22 | 100 | 0.68 | |
| | | 10 | Red/Br Sandy GRAVEL | 2.7 | 118 | 12 | 76 | 0.43 | 1340** (1000) |
| | B-19 | 13 | Br. Sandy SILT | [3.1] | 117 | 15 | 71 | 0.65 | |
| | B-20 | 14 | Br/Grey Silty fine SAND | 2.9 | 122 | 7 | 42 | 0.48 | $\phi' = 40°$ $c' = 0$ |

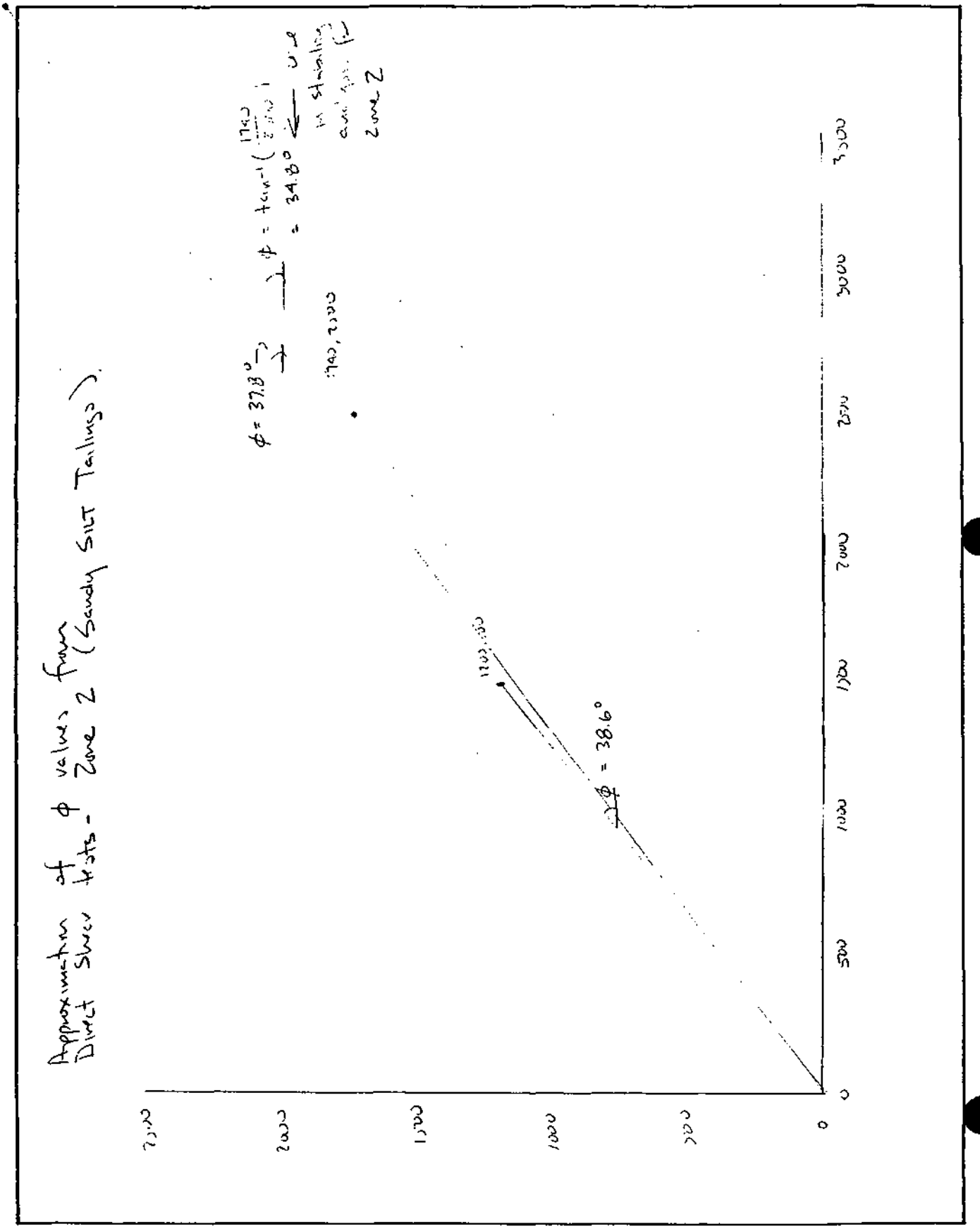
Ave. Values

| | | $G_s$ | $\gamma$ | |
|---|---|---|---|---|
| Pond 4 | Silty GRAVEL w/Sand | 2.7 | 129 pcf | (Zone 1) |
| | Br Sandy SILT | [3.1] | | |

# ESA Consultants

JOB NO. 101.9502 SUBJECT Shear Strength SHEET NO. 1 OF 1

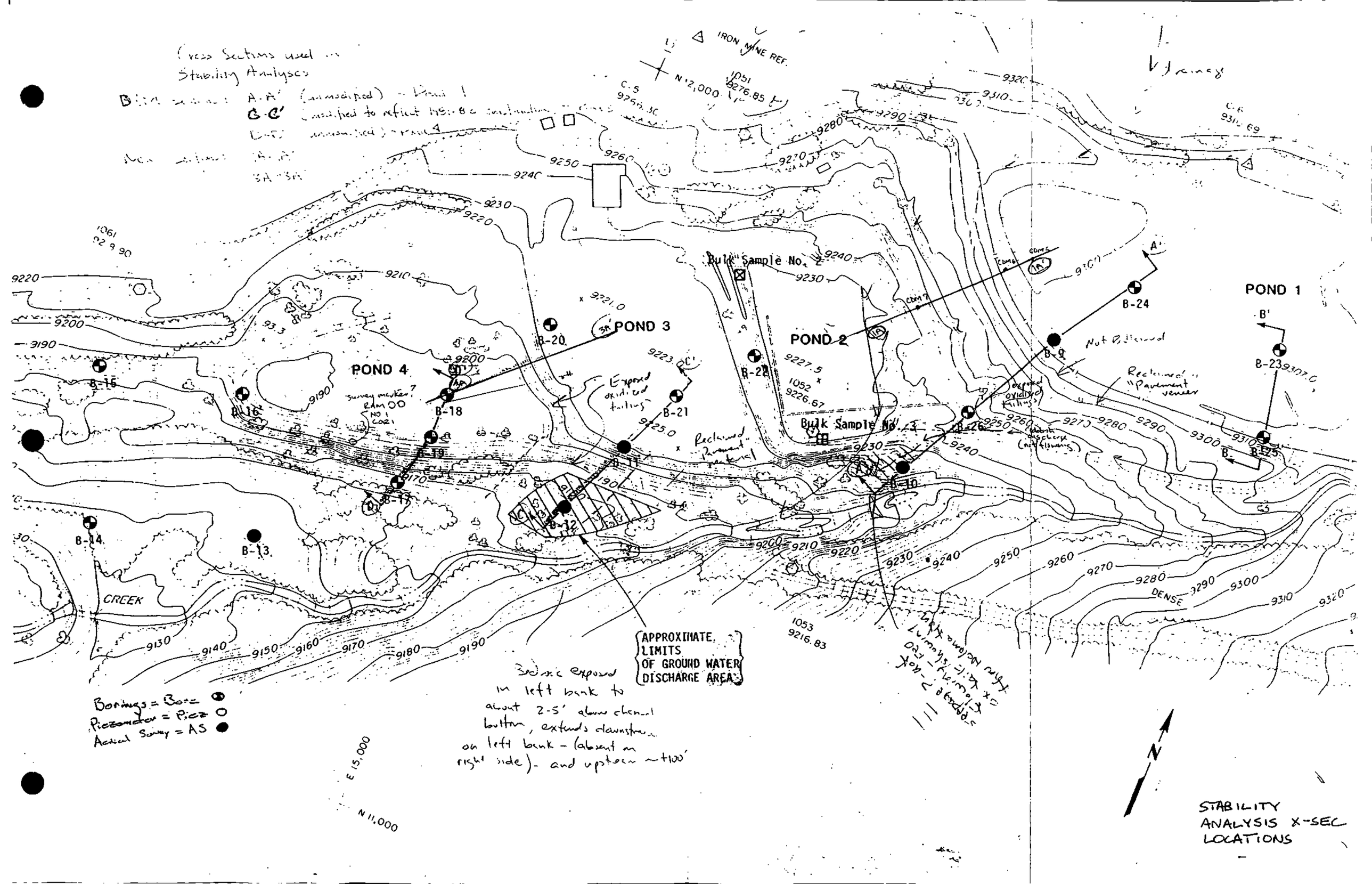
PROJECT Rico Estimates - Silver Cr. Tailings BY DJM DATE 5-79

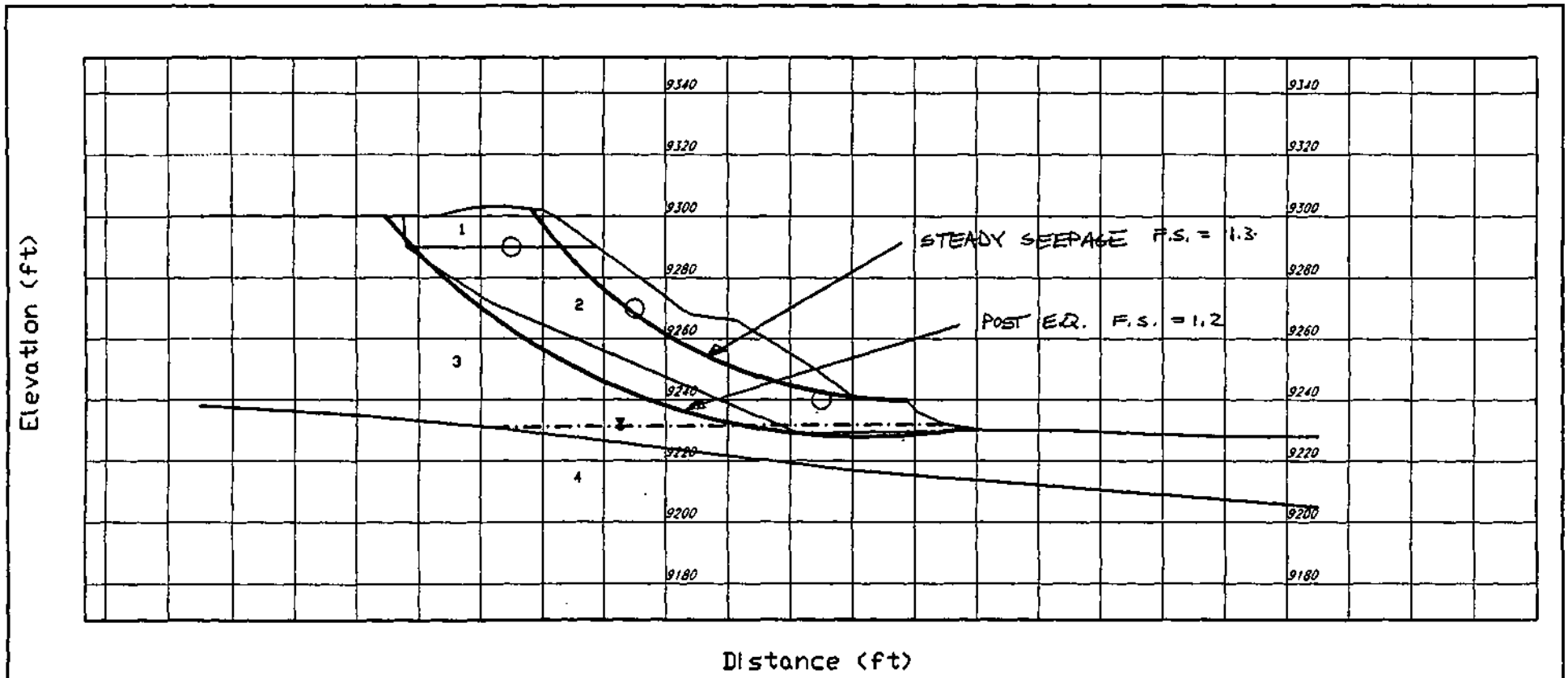


~~TABLE 2~~

SUMMARY OF GEOTECHNICAL INVESTIGATIONS
SILVER CREEK TAILINGS SITE

| STUDY | NO. BORINGS/TYPE | SAMPLES | TESTS CONDUCTED |
|---|---|---|---|
| CDM/Geotek, 1979 | 13/Auger (Locations shown on Sheet 1 of CDM report) | Std. split spoon; Shelby tube | Boring logs; SPT blow counts; field permeability; ground water levels in borings (no piezometers); in-place density and moisture content; gradations; undrained shear strength tests (unconfined compression, unconsolidated-undrained triaxial compression, and laboratory vane shear). |
| D&M, 1981(Aug) | 5/Auger (Locations of B-9 through B-13 shown on Plate 2). Piezometers installed in all borings. | Std. split spoon; D&M "D" sampler; Bulk samples from borrow pit near ponds | Boring logs; SPT blow counts; USCS classification; in-place density and moisture content; gradations; Atterberg limits; specific gravity; pH; soluble sulfates; compaction; shear strength tests (direct shear, unconsolidated-undrained triaxial compression); laboratory permeability; piezometer readings taken between June-July, 1981. |
| D&M, 1981(Oct) | 13/Auger* (Locations of B-14 through B-26 shown on Plate 1). *Except B-17 used rotary drilling with casing. | Std. split spoon; D&M "U" and "D" samplers; Bulk samples from 3 borrow pit locations (shown on Plate 1). | Boring logs; SPT blow counts; USCS classification; in-place density and moisture content; gradations; Atterberg limits; specific gravity; compaction; shear strength tests (direct shear, unconsolidated-undrained and consolidated undrained triaxial compression); laboragory permeability; consolidation. |


Cross Sections used in Stability Analyses
IRON MINE REF.
N 12,000
POND 1
POND 2
POND 3
POND 4
Bulk Sample No. 2
Bulk Sample No. 3
B-9
B-10
B-11
B-12
B-13
B-14
B-15
B-16
B-17
B-18
B-19
B-20
B-21
B-22
B-23
B-24
B-25
B-26
CREEK
DENSE
APPROXIMATE LIMITS OF GROUND WATER DISCHARGE AREA
Bedrock exposed in left bank to about 2-5' above channel bottom, extends downstream on left bank - (absent on right side) - and upstream ~100'
Borings = Bore
Piezometer = Piez
Actual Survey = AS
E 15,000
N 11,000
N
STABILITY ANALYSIS X-SEC LOCATIONS



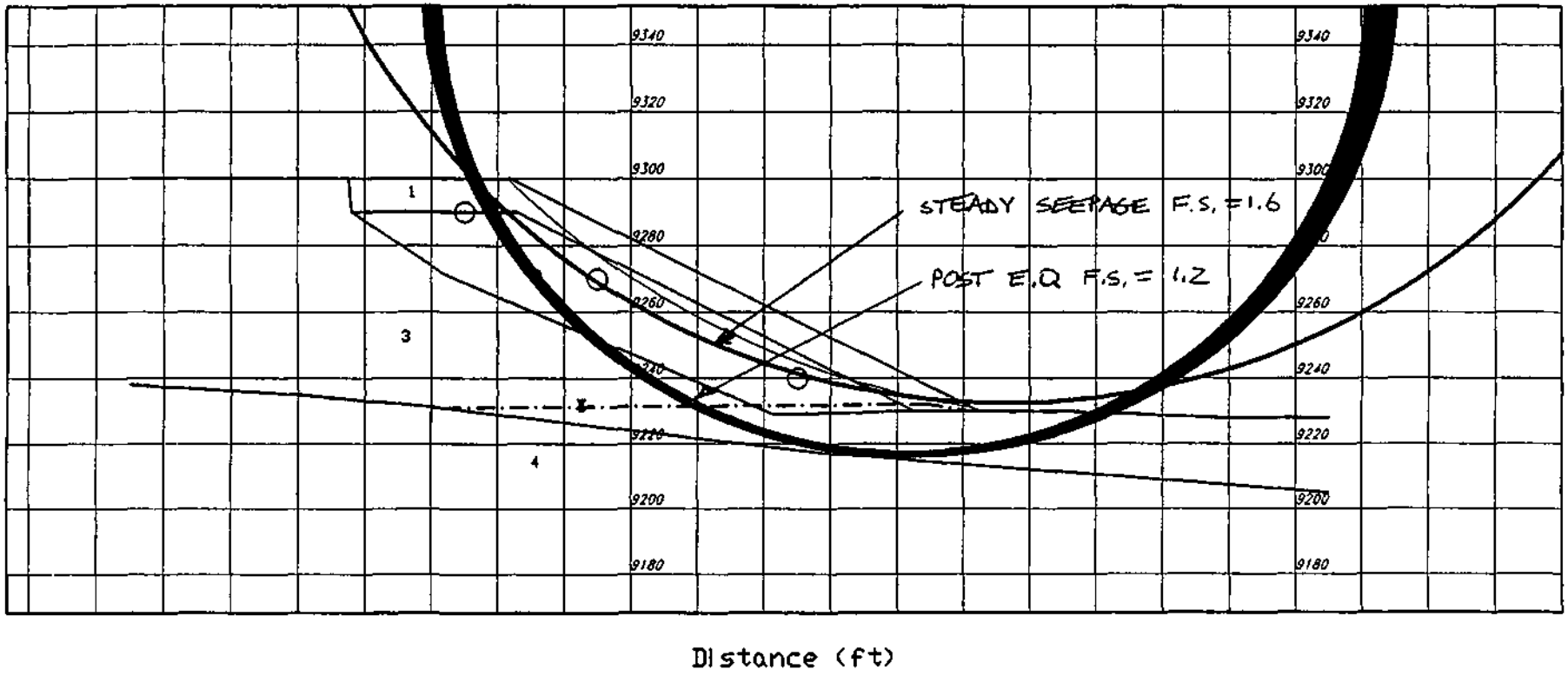

| Material | Strength Static φ' | Strength Static c' (psf) | Strength Post-Cyclic $r_u$ | Strength Post-Cyclic $S_u$ (psf) | Unit Weight (pcf) Moist | Unit Weight (pcf) Sat. | Class |
|---|---|---|---|---|---|---|---|
| Sandy Gravel w/Clay | 38 | 0 | - | - | 130 | 132 | 1 |
| Fine Sandy Silt | 35 | 0 | - | - | 128 | 128 | 2 |
| Clayey Silt Tailings | 30 | 100 | - | - | 130 | 130 | 3 |
| Silty Gravel Foundation | 38 | 0 | - | - | 132 | 132 | 4 |

POST EQ $\phi = 25^{\circ}$

ATLANTIC RICHFIELD COMPANY
RICO TECHNICAL SERVICES

ARGENTINE MILL TAILINGS POND 1
XSEC 1A–1A' – EXISTING CONDITION
STEADY SEEPAGE ANALYSIS

Figure 2



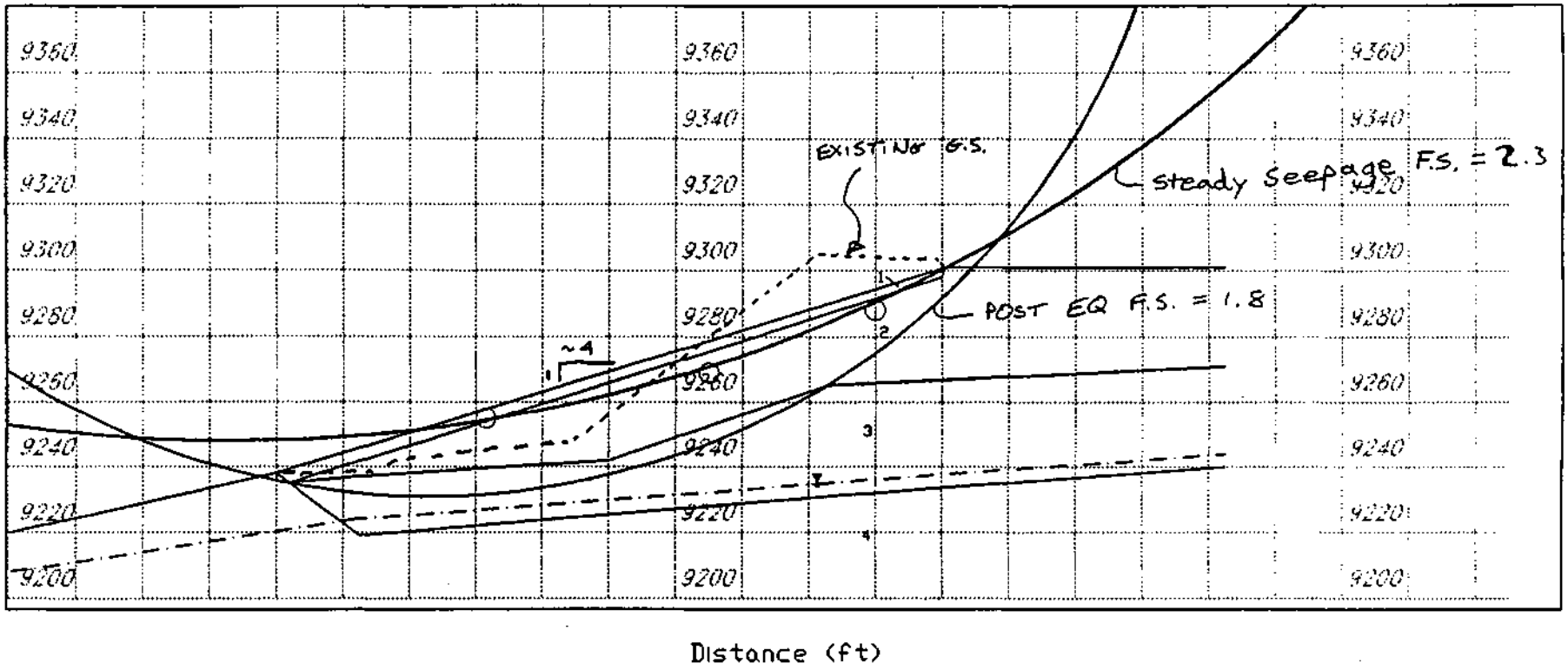

| Material | Strength: Static φ | Strength: Static c (psf) | Strength: Post-Cyclic $r_u$ | Strength: Post-Cyclic $S_u$ (psf) | Unit Weight (pcf): Moist | Unit Weight (pcf): Sat. | Class |
|---|---|---|---|---|---|---|---|
| Sandy Gravel w/Clay | 38 | 0 | – | – | 130 | 135 | 1 |
| Fine Sandy Silt | 26 | 0 | – | – | 128 | 135 | 2 |
| Clayey Silt Tailings | 32 | 100 | – | – | 130 | 130 | 3 |
| Silty Gravel Foundation | 38 | 0 | – | – | 132 | 142 | 4 |

POST-EQ $\phi = 25^\circ$

ATLANTIC RICHFIELD COMPANY
RICO TECHNICAL SERVICES

ARGENTINE MILL TAILINGS POND 1
XSEC 1A-1A' - PROPOSEDCONDITION
STEADY SEEPAGE ANALYSIS

Figure 2



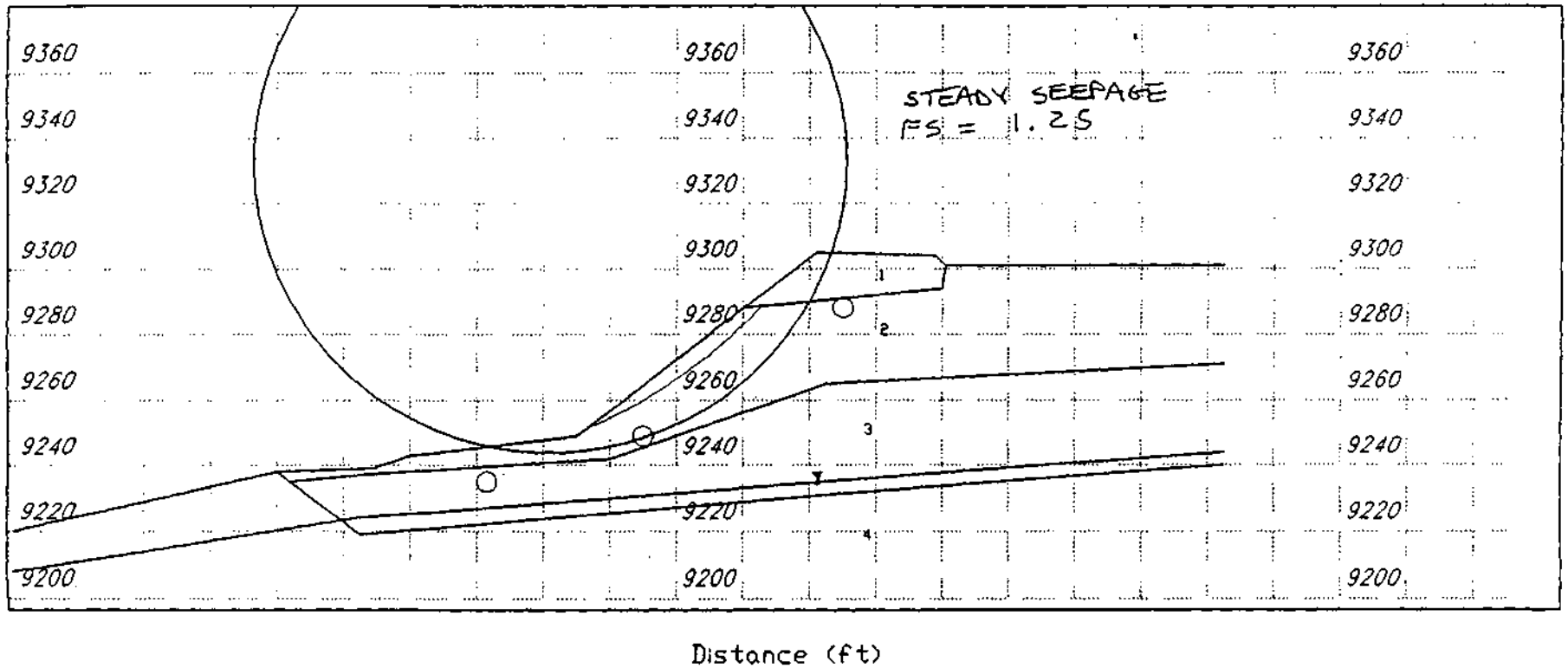

| Material | Strength: Static φ' | Strength: Static c' (psf) | Strength: Post-Cyclic $\tau_c$ | Strength: Post-Cyclic $S_u$ (psf) | Unit Weight (pcf): Moist | Unit Weight (pcf): Sat. | Class |
|---|---|---|---|---|---|---|---|
| Sandy Gravel w/Clay | 38 | 0 | – | – | 132 | 132 | 1 |
| Fine Sandy Silt | 35 | 0 | – | – | 125 | 125 | 2 |
| Clayey Silt Tailings | 32 | 100 | – | – | 130 | 130 | 3 |
| Silty Gravel Foundation | 38 | 0 | – | – | 132 | 132 | 4 |

$\phi = 25°$, $\tau = 0$ for Post-EQ ANALYSIS >(25% STRENGTH REDUCTION)

ATLANTIC RICHFIELD COMPANY
RICO TECHNICAL SERVICES

ARGENTINE MILL TAILINGS POND 1
XSEC A-A' - PROPOSED CONDITION
STEADY SEEPAGE ANALYSIS

Figure 1




| Material | Strength: Static φ' | Strength: Static c' (psf) | Strength: Post-Cyclic $r_u$ | Strength: Post-Cyclic $S_u$ (psf) | Unit Weight (pcf): Moist | Unit Weight (pcf): Sat. | Class |
|---|---|---|---|---|---|---|---|
| Sandy Gravel with | 38 | 0 | -- | -- | 132 | 132 | 1 |
| Fine Sandy Silt | 35 | 0 | -- | -- | 125 | 125 | 4 |
| Clayey Silt Tailings | 32 | 1000 | -- | -- | 130 | 130 | 3 |
| Silty Gravel Foundation | 38 | 0 | -- | -- | 132 | 132 | 1 |

ATLANTIC RICHFIELD COMPANY
RICO

ARGENTINE MILL TAILINGS POND 1

XSEC A-A' (EXISTING CONDITION)

Figure 1

# B5 WETLANDS DESIGN

**Argentine Seep Constructed Wetlands**
**Aerobic Ponds Sludge Accumulation**

| | | |
|---|---|---|
| Average Flow (gpm) | 40 | |
| Maximum Iron Concentration (mg/l) | 22.9 | Use maximum of Iron-T for samples |
| Iron removal (ppd) | 11.00 | Assume complete removal of all iron |
| Iron Hydroxide removed (ppd) | 21.01 | Assume all iron removed converted to iron hydroxide |
| | | |
| Aerobic Cell Volume (acre-ft) | 1.6 | upstream cell only |
| Aerobic Cell Volume (cf) | 69696 | |
| Assumed Usable Percentage | 80 | assumes cell is functional with only 20 % of volume |
| Usable Storage Volume (cf) | 55757 | |

Assumed range of percent by weight sludge of three to ten.

| | |
|---|---|
| Minimum Weight % solids: | 3 |
| Iron Sludge Volume Generated (cf/d): | 11.2 |
| Yearly Sludge Volume produced (cf): | 4097 |
| Storage life of aerobic cell (yrs): | 14 |
| | |
| Maximum Weight % solids: | 10 |
| Iron Sludge Volume Generated (cf/d): | 3.4 |
| Yearly Sludge Volume produced (cf): | 1229 |
| Storage life of aerobic cell (yrs): | 45 |

## Argentine Seep Constructed Wetland

### Anaerobic Cell

**Parameter Values and Criteria Requirement**

| | |
|---|---|
| Minimum Retention (hrs) - HRT | 72 |
| Assumed Media Porosity (%) | 70 |
| Permeability- k (cm/s) | 0.0002 |
| Allowable Gradient - i (f/f) | 0.5 |
| Allowable metals loading - grams/cubic meter/day | 3 |
| Media Thickness (ft) | 3.5 |
| Flow (gpm) | 40 |
| Metals Concentration (Total Zn & 25% Fe, mg/l) | 20.75 |
| | |
| Flow (cfs) | 0.09 |
| Flow/day (af) | 0.18 |
| Permeability (ft/day) | 0.57 |

**Area requirements for treatment retention time criteria**

| | |
|---|---|
| Volume voids reqd (af) | 0.53 |
| Volume Media rqd for retention (af) | 0.76 |
| Area reqd for retention (ac) | 0.22 |

**Area requirements based on permeability**

| | |
|---|---|
| Head reqd (ft) by permeability | 1.75 |
| Area reqd for permeability (ac) | 0.62 |
| Volume voids provided (af) | 1.53 |
| Volume media provided (af) | 2.18 |

**Area requirements based on metals loading**

| | |
|---|---|
| Metals Applied g/day | 4521 |
| Media Volume Reqd (cy) | 1971 |
| Media area (ac) reqd for metals | 0.35 |

**Results**

| | |
|---|---|
| Area Reqd (ac) | 0.62 |
| Head reqd (ft) | 1.75 |
| Media volume if vertical sides to base area (cf) | 95060 |
| Media Volume Provided in Pond configuration (cf) | 75000 |
| Hydraulic Retention Provided (hrs) | 163.7 |
| Hydraulic Retention Provided (days) | 6.8 |
| Metals Loading - grams/cubic meter/day | 2.13 |

## Argentine Seep Constructed Wetland

### Anaerobic Cell Life Calculation

wetland life (yrs) = organic matter, kg/(metal loading, kg/day X 2.5) X percent organic matter available/365 days per yr

| | | |
|---|---|---|
| substrate = | 19.2 | kg/cf |
| substrate (kg) | 1440000 | |
| percent organic matter | 30 | |
| organic matter (kg) | 432000 | |

1. Maximum historic loading: Assume 75 % of iron is removed in aerobic wetland, that zinc will be treated in the anaerobic cell, and that manganese will pass through the anaerobic cell untreated.

| | | | |
|---|---|---|---|
| zinc (mg/l)= | 15 | | |
| manganese (mg/l) = | 5.75 | | |
| metal loading (kg/day) | 4.52 | | |
| | | min | max |
| organic available (%) | | 25 | 50 |
| calculated life (yrs) | | 26 | 52 |

2. Average historic loading: Assume all iron is removed in aerobic wetland, that zinc will be treated in the anaerobic cell and that manganese will pass through the anaerobic cell untreated.

| | | | |
|---|---|---|---|
| zinc (mg/l)= | 5.6 | | |
| metal loading (kg/day) | 1.22 | | |
| | | min | max |
| organic available (%) | | 25 | 50 |
| calculated life (yrs) | | 97 | 194 |

# B6 TAILINGS VOLUME AND ASSAY DATA

THOMAS Engineering Inc.

215 NORTH LINDEN STREET CORTEZ, COLORADO 81321 PHONE: 303-565-4496



Anaconda Copper Co.
September 5, 1980

Volumes for Silver Creek, Columbia and Swan Millsite Settling Ponds near Rico, Colorado

Silver Creek (ARGENTINE MILL TAILINGS)

| Pond # | Vol. including dikes | Vol. without dikes |
|---|---|---|
| 1 | 266,422.54 C.Y. | 156,380.68 C.Y. |
| 2 | 18,184.90 C.Y. | 8,037.91 C.Y. |
| 3 | 45,666.17 C.Y. | 15,036.70 C.Y. |
| 4 | 12,338.32 C.Y. | 2,175.79 C.Y. |

Columbia (Tailings)

44,932.5 C.Y.

Swan (mine waste)

15,078.76 C.Y.

Fredric P. Thomas, PE-LS
Colo. Reg. No. 6728

FREDRIC P. THOMAS REGISTERED 6728 P.E. AND L.S. STATE OF COLORADO

Silver Creek #1

Insitu porosity 40% $e = \frac{0.4}{1-0.4} = 0.67$

$\gamma_D = \frac{3.24(62.4)}{1+0.67} = 121 \text{ lbs/ft}^3$

$266,422.54 \text{ cyd} \times 27 \frac{\text{cu ft}}{\text{cyd}} \times 121 \text{ lbs/ft}^3 \times \frac{1 \text{ ton}}{2000 \text{ lbs}} = \{435,201 \text{ Tons}$

Silver Creek #2

$\gamma_D = \frac{3.34(62.4)}{1+0.67} = 125 \text{ lbs/ft}^3$

$18,184.90 \times 27 \times 125 \times \frac{1}{2000} = \{30,687 \text{ Tons}$

Silver Creek #3

$\gamma_D = \frac{3.17(62.4)}{1.67} = 118 \text{ lbs/ft}^3$

$115,666.17 \times 27 \times 118 \times 1/2000 = \{72,746 \text{ Tons}$

Silver Creek #4

$\gamma_D = \frac{3.00(62.4)}{1.67} = 112 \text{ lbs/ft}^3$

$12,338.32 \times 27 \times 112 \times 1/2000 = \{18,656 \text{ Tons}$

Columbia

$\gamma_D = \frac{3.13(62.4)}{1.67} = 117 \text{ lbs/ft}^3$

$44,922.5 \times 27 \times 117 \times 1/2000 = \{70,971 \text{ Tons}$

Swan Dump

$\gamma_D = \frac{2.67(62.4)}{1.67} = 101 \text{ lbs/ft}^3$

$15,078.76 \times 27 \times 101 \times 1/2000 = \{20,560 \text{ Tons}$

ANACONDA Copper Company
Division of The ANACONDA Company
Denver, Colorado



MADE BY_____ DATE_____ CHECKED BY_____ DATE_____

Silver Creek

455,201 x 1.07 = 465,665.07
30,687 x 1.16 = 35,596.92
72,746 x 0.84 = 61,106.64
18,656 x 1.11 = 20,708.16

557,290 583,077

557,000 tons @ 1.05

The Specific Gravities for each of the ponds and dumps are as follows:

| | | |
|---|---|---|
| ARGENTINE MILL TAILINGS | Silver Creek #1 (Highest Pond) | 3.24 |
| | Silver Creek #2 | 3.34 |
| | Silver Creek #3 | 3.17 |
| | Silver Creek #4 (Lowest Pond) | 3.00 |
| | Columbia Tailing | 3.13 |
| | Swan Dump | 2.69 |

ANACONDA Copper Company Internal Correspondence



Date: October 3, 1980

To: Carla Stout

From: Phillip R. Engelhardt

Subject: Head Assays of Samples from Rico, Colorado

A total of 80 samples from Rico, Colorado were received at the Tucson research center on August 7, 1980 and given the designation 80-131-1 through 80. These included samples from the Silver Creek, Columbia and Swan properties.

These samples were dried and prepared for assaying and further test work. Composites of the samples will be made and these will be assayed for beryllium.

The attached table lists the samples by our MRD number followed by your location designation. The samples were all assayed for silver, gold, lead and zinc.

Phillip R. Engelhardt

PHILLIP R. ENGELHARDT

PRE:sm

Attachment

pc: WBDavis
BLVance
JSuttie

# ASSAYS OF RICO, COLORADO SAMPLES

| MRD No. | Location | No. | oz/ton Ag | oz/ton Au | % Pb | % Zn |
|---|---|---|---|---|---|---|
| 80-131-1 | Swan | 201A } jam | 0.46 | <0.005 | 0.61 | 0.30 |
| 80-131-2 | Swan | 201B | 0.90 | <0.005 | 1.38 | 0.87 |
| 80-131-3 | Swan | 202 out | 0.32 | <0.005 | 0.61 | 0.42 |
| 80-131-4 | Swan | 203A | 1.46 | 0.006 | 2.31 | 1.46 |
| 80-131-5 | Swan | 203B | 2.58 | 0.010 | 2.14 | 1.86 |
| 80-131-6 | Swan | 204 | 0.38 | <0.005 | 0.74 | 0.52 |
| 80-131-7 | Swan | 205 | 1.32 | <0.005 | 1.81 | 0.89 |
| 80-131-8 | Swan | 206 | 0.78 | <0.005 | 1.46 | 0.75 |
| 80-131-9 | Swan | 207 out | 0.16 | <0.005 | 0.64 | 0.38 |
| 80-131-10 | Swan | 208 | 0.54 | <0.005 | 1.25 | 0.47 |
| 80-131-11 | Swan | 209 | 2.28 | <0.005 | 1.08 | 0.81 |
| 80-131-12 | Swan | 210 } jam | 0.44 | <0.005 | 1.39 | 0.53 |
| 80-131-13 | Swan | 210A | 0.98 | <0.005 | 1.93 | 1.56 |
| 80-131-14 | Swan | 211 | 0.84 | 0.006 | 0.52 | 0.69 |
| 80-131-15 | Swan | 211B don't count | 1.84 | 0.005 | 4.83 | 1.96 |
| 80-131-16 | Swan | 212A | 0.98 | 1.09 0.109 | 2.22 | 0.97 |
| 80-131-17 | Swan | 212B | 0.62 | 0.015 | 0.69 | 0.55 |
| 80-131-18 | Swan | 213 | 0.84 | <0.005 | 1.72 | 0.54 |
| 80-131-19 | Swan | 214 | 1.93 | 0.007 | 1.72 | 0.94 |
| 80-131-20 | Swan | 215 | 0.85 | 0.006 | 0.92 | 0.50 |
| 80-131-21 | Swan | 216 | 0.96 | <0.005 | 2.56 | 0.53 |
| 80-131-22 | Swan | 217 | 0.98 | <0.005 | 2.31 | 0.73 |
| 80-131-23 | Swan | 218 | 1.09 | <0.005 | 1.72 | 0.33 |
| 80-131-24 | Swan | 219 | 5.17 | 0.006 | 0.74 | 0.47 |
| 80-131-25 | Swan | 220 | 0.11 | <0.005 | <0.01 | 0.01 |
| 80-131-26 | Columbia | 101 | 0.94 | 0.006 | 0.71 | 2.32 |
| 80-131-27 | Columbia | 102-9 1/2 | 1.52 | 0.010 | 0.88 | 1.27 |
| 80-131-28 | Columbia | 102-17 | 1.52 | 0.006 | 0.84 | 1.08 |
| 80-131-29 | Columbia | 103-14 | 0.84 | 0.006 | 0.83 | 0.90 |
| 80-131-30 | Columbia | 105-14 | 0.64 | 0.006 | 0.61 | 0.77 |
| 80-131-31 | Columbia | 106-17 | 0.76 | 0.008 | 0.61 | 1.84 |
| 80-131-32 | Columbia | 107-11 | 0.92 | 0.006 | 0.98 | 1.08 |
| 80-131-33 | Columbia | 108-11 1/2 | 0.70 | 0.010 | 0.92 | 0.83 |
| 80-131-34 | Columbia | 109-10 | 0.66 | 0.006 | 1.01 | 1.11 |
| 80-131-35 | Columbia | 110-10 | 1.04 | 0.008 | 0.77 | 2.35 |
| 80-131-36 | Columbia | 111-11 1/2 | 0.78 | 0.006 | 0.73 | 1.85 |
| 80-131-37 | Columbia | 112-14 1/2 | 0.60 | 0.010 | 0.44 | 0.55 |
| 80-131-38 | Columbia | 113-10 | 0.70 | 0.006 | 0.81 | 0.69 |
| 80-131-39 | Columbia | 114-10 | 0.96 | 0.010 | 0.61 | 1.31 |
| 80-131-40 | Columbia | 115-55 | 0.60 | 0.010 | 0.61 | 1.31 |
| 80-131-41 | Columbia | 117-10 | 0.60 | 0.006 | 0.78 | 0.87 |
| 80-131-42 | Silver Creek | 2-E | 0.75 | 0.008 | ---- | ---- |
| 80-131-43 | Silver Creek | 2-F | 1.34 | 0.010 | 1.07 | 1.38 |
| 80-131-44 | Silver Creek | 3-D | 0.82 | 0.006 | 0.51 | 0.95 |
| 80-131-45 | Silver Creek | 3-E | 1.40 | 0.008 | 1.11 | 1.13 |
| 80-131-46 | Silver Creek | 4-D | 0.68 | 0.002 | 0.66 | 1.51 |
| 80-131-47 | Silver Creek | 4-E | 1.20 | 0.010 | 0.51 | 0.62 |

ASSAYS OF RICO, COLORADO SAMPLES (continued)

| MRD No. | Location No. | oz/ton Ag | oz/ton Au | % Pb | % Zn |
|---|---|---|---|---|---|
| 80-131-48 | Silver Creek 5-C | 1.76 | 0.008 | 0.93 | 1.76 |
| 80-131-49 | Silver Creek 5-D | 1.12 | 0.006 | 0.83 | 1.61 |
| 80-131-50 | Silver Creek 5-E | 1.22 | 0.008 | 0.61 | 1.62 |
| 80-131-51 | Silver Creek 6-B | 1.44 | 0.006 | 1.42 | 1.82 |
| 80-131-52 | Silver Creek 6-C | 0.80 | 0.006 | 0.81 | 0.97 |
| 80-131-53 | Silver Creek 6-D | 1.00 | 0.008 | 0.85 | 1.11 |
| 80-131-54 | Silver Creek 7-C | 0.91 | 0.022 | 0.71 | 0.82 |
| 80-131-55 | Silver Creek 7-D | 1.16 | 0.008 | 0.80 | 1.07 |
| 80-131-56 | Columbia 116 | 0.72 | 0.002 | 0.64 | 0.57 |
| 80-131-57 | Silver Creek 8-C | 1.08 | <0.005 | 1.38 | 1.39 |
| 80-131-58 | Silver Creek 8-E#1 | 0.94 | <0.005 | 0.93 | 1.21 |
| 80-131-59 | Silver Creek 8-E#2 | 0.56 | <0.005 | 0.55 | 0.96 |
| 80-131-60 | Silver Creek 9-B | 1.16 | <0.005 | 1.72 | 1.53 |
| 80-131-61 | Silver Creek 11-C | 0.78 | <0.005 | 0.57 | 1.10 |
| 80-131-62 | Silver Creek 11-D | 1.16 | 0.006 | 0.63 | 1.09 |
| 80-131-63 | Silver Creek 11-E | 1.22 | 0.008 | 1.11 | 1.82 |
| 80-131-64 | Silver Creek 2-E | 1.16 | 0.008 | 1.17 | 1.80 |
| 80-131-65 | Silver Creek 11-5C | 1.02 | 0.006 | 0.95 | 1.36 |
| 80-131-66 | Silver Creek 11-5D-5 | 1.12 | 0.006 | 1.13 | 2.34 |
| 80-131-67 | Silver Creek 12-C | 1.16 | 0.006 | 0.63 | 0.86 |
| 80-131-68 | Silver Creek 12-D | 0.88 | <0.005 | 1.00 | 1.50 |
| 80-131-69 | Silver Creek 12-E | 1.76 | 0.008 | 2.32 | 3.27 |
| 80-131-70 | Silver Creek 12-5D5 | 0.84 | <0.005 | 1.10 | 1.27 |
| 80-131-71 | Silver Creek 13-D | 0.92 | <0.005 | 1.24 | 1.54 |
| 80-131-72 | Silver Creek 13-E | 0.92 | <0.005 | 1.11 | 1.86 |
| 80-131-73 | Silver Creek 14-D | 0.68 | <0.005 | 0.79 | 2.08 |
| 80-131-74 | Silver Creek 14-E | 0.84 | <0.005 | 0.86 | 1.69 |
| 80-131-75 | Silver Creek 16-E | 1.04 | <0.005 | 1.42 | 1.61 |
| 80-131-76 | Silver Creek 17-E | 1.00 | <0.005 | 1.61 | 1.81 |
| 80-131-77 | Silver Creek 18-E | 1.44 | <0.005 | 2.86 | 2.37 |
| 80-131-78 | Silver Creek 19-E | 1.02 | <0.005 | 1.63 | 1.44 |
| 80-131-79 | Silver Creek 98 | 0.84 | <0.005 | 0.81 | 1.12 |
| 80-131-80 | Silver Creek 99 | 0.80 | <0.005 | 1.01 | 2.69 |

SKYLINE LABS, INC.
SPECIALISTS IN EXPLORATION GEOCHEMISTRY
12090 WEST 50TH PLACE • WHEAT RIDGE, COLORADO 80033 • TEL.: (303) 424-7718

# REPORT OF ANALYSIS

JOB NO. DBZ 156
FEBRUARY 11, 1980

Anaconda Company
Attn: Larry Barrett
555 17th Street
Denver, Colorado 80217

SAMPLES FROM 13 BOREHOLES IN SILVER CREEK TAILINGS (ARGENTINE MILL TAILINGS)

Analysis of 24 Tailing Samples

| ITEM | SAMPLE NO. | Ag (ppm) | Cu (%) | Pb (%) | Zn (%) | |
|---|---|---|---|---|---|---|
| 1 | TP-01 | 15. | .073 | .49 | 1.8 | |
| 2 | TP-02 | 14. | .051 | .595 | 1.15 | |
| 3 | TP-03 | 5.2 | .13 | .74 | 1.55 | |
| 4 | TP-04 | 2.2 | .014 | .068 | .11 | (alluvium) |
| 5 | TP-05 | 4.8 | .018 | .325 | .475 | (alluvium) |
| 6 | TP-06 | 7.8 | .017 | .043 | .13 | (alluvium) |
| 7 | TP-07 | 15. | .04 | .72 | 1.3 | |
| 8 | TP-08 | 22. | .077 | .655 | .66 | |
| 9 | TP-09 | .6 | .004 | .014 | .16 | (alluvium) |
| 10 | TP-10 | 40. | .066 | 1.35 | 2.15 | |
| 11 | TP-11 | 26. | .045 | 1.1 | 1.6 | |
| 12 | TP-12 | 20. | .025 | 1.05 | 1.75 | |
| 13 | TP-13 | 28. | .095 | .655 | 1.9 | |
| 14 | TP-14 | 38. | .019 | 2.05 | 1.5 | |
| 15 | TP-15 | 17. | .036 | .535 | .95 | |
| 16 | TP-16 | 28. | .17 | 1.15 | 1.3 | |
| 17 | TP-17 | .8 | .009 | .013 | .082 | (alluvium) |
| 18 | TP-18 | 8.6 | .025 | .23 | .465 | (alluvium) |
| 19 | TP-19 | 24. | .077 | .6 | 1.3 | |
| 20 | TP-20 | 11. | .115 | .435 | .62 | (alluvium) |
| 21 | TP-21 | 2.8 | .008 | .046 | .115 | (alluvium) |
| 22 | TP-22 | 2.2 | .008 | .033 | .093 | (alluvium) |
| 23 | TP-23 | 2. | .013 | .056 | .11 | (alluvium) |
| 24 | TP-24 | .8 | .007 | .005 | .019 | (alluvium) |

Edwin V. Post
for Gordon H. VanSickle
Manager

SAMPLES FROM BORE HOLES IN SILVER CREEK TAILINGS AT RICO (ARGENTINE MILL TAILINGS)

BONDAR-CLEGG INC.

12980 W. CEDAR DR., LAKEWOOD, CO. 80228 PHONE: 989-1404 TELEX: 45-693

# Geochemical Lab Report

Extraction: Cu,Pb,Zn,Ag; Hot Aqua Regia
Au; Fire Assay & Hot Aqua Regia

Method: Atomic Absorption

Fraction Used:

Report No.: 80 - 229 P.O. 4708

From: Anaconda Copper Co.

Date: april 24, 19 80

| SAMPLE NO. | Cu ppm | Pb ppm | Zn ppm | Ag ppm | Au ppb | | | REMARKS |
|---|---|---|---|---|---|---|---|---|
| TP-25 | 308 | 4600 | 7000 | 19. | 45 | | | DH 1 @ 15' |
| 26 | 540 | 18500 | G20000 | 45. | 70 | | | DH 1 @ 20' |
| 27 | 750 | 5600 | 19800 | 88. | 130 | | | DH 1 @ 30' |
| 28 | 820 | 1175 | 15200 | 51. | 300 | | | DH 1 @ 40' |
| 29 | 600 | 18750 | 15600 | 13. | 30 | | | DH 2 @ 5' |
| 31 | 420 | 5800 | 11550 | 29. | 190 | | | DH 3 @ 20' |
| 32 | 315 | 7500 | 8550 | 23. | 160 | | | DH 3 @ 25' |
| 33 | 269 | 6200 | 8000 | 19. | 80 | | | DH 3 @ 30' |
| 34 | 740 | 3800 | G20000 | 52. | 190 | | | DH 3 @ 35' |
| 35 | 285 | 5400 | 13750 | 20. | 140 | | | DH 3 @ 40' |
| 36 | 465 | 3200 | 11000 | 22. | 265 | | | DH 2 @ 70' |
| in alluvium 37 | 137 | 860 | 1175 | 8.2 | 80 | | | DH 3 @ 75' |
| 38 | 67 | 330 | 675 | 2.4 | 20 | | | DH 3 @ 80' |
| 39 | 590 | 10100 | 16200 | 24. | 185 | | | DH 4 @ 20' |
| 40 | 480 | 6750 | G20000 | 24. | 155 | | | DH 4 @ 25 |
| 41 | 339 | 5900 | 18700 | 23. | 175 | | | DH 4 @ 35 |
| 42 | 510 | 13000 | 15850 | 32. | 175 | | | DH 4 @ 45' |
| 43 | 1085 | 5700 | 9600 | 21. | 125 | | | DH 4 @ 55' |
| 44 | 655 | 2400 | 7200 | 15. | 60 | | | DH 4 @ 55-57.5 |
| 45 | 540 | 2850 | 9050 | 13. | 110 | | | DH 4 @ 60 |
| 46 | 1100 | G20000 | G20000 | 74. | 115 | | | DH 5 @ 15 |
| 47 | 710 | 8000 | 9200 | 26. | 90 | | | DH 5 @ 35 |
| 48 | 355 | 8400 | 8900 | 23. | 140 | | | DH 5 @ 40 |
| in alluvium 49 | 139 | 430 | 695 | 2.0 | 35 | | | DH 5 @ 70 |
| 50 | 141 | 390 | 860 | 11. | 25 | | | DH 6 @ 2 |
| 51 | 258 | 780 | 2100 | 31. | 90 | | | DH 6 @ 4 |
| 52 | 605 | 11750 | 17700 | 45. | 230 | | | DH 6 @ 19 |
| 53 | 615 | 8200 | G20000 | 35. | 205 | | | DH 6 @ 25 |
| 54 | 480 | 4300 | G20000 | 20. | 105 | | | DH 6 @ 29 |
| 55 | 1060 | 8100 | G20000 | 55. | 140 | | | DH 6 @ 49 |
| | | | | | | | | |

# BONDAR-CLEGG INC.

## Geochemical Lab Report

Report No. 50 - 229

Page No 2

| SAMPLE NO. | Cu ppm | Pb ppm | Zn ppm | Ag ppm | Au ppb | | | REMARKS |
|---|---|---|---|---|---|---|---|---|
| TP-56 | 620 | 4200 | 19800 | 28. | 40 | | | DH6 @ 54 |
| 57 | 845 | 10500 | 8500 | 34. | 55 | | | DH6 @ 59 |
| 58 | 470 | 16000 | 10600 | 29. | 105 | | | DH6 @ 64 |
| in alluvium 59 | 108 | 240 | 470 | 3.4 | 70 | | | DH6 @ 69 |
| 60 | 1100 | 4300 | 9200 | 17. | 80 | | | DH7 @ 15 |
| in alluvium 61 | 51 | 175 | 475 | 1.6 | 5 | | | DH7 @ 5 |
| in alluvium 62 | 32 | 110 | 340 | 0.6 | 10 | | | DH7 @ 15 |
| in alluvium 63 | 93 | 560 | 1425 | 2.2 | 25 | | | DH9 @ 45 |
| 64 | 1675 | 2500 | G20000 | 46. | 120 | | | DH10 @ 20 |
| 65 | 364 | 1720 | 14000 | 16. | 100 | | | DH10 @ 35 |
| 66 | 373 | 2600 | 3750 | 12. | 65 | | | DH11 @ 5 |
| in alluvium 67 | 31 | 120 | 375 | 0.4 | 5 | | | DH11 @ 25 |
| 69 | 182 | 1475 | 4200 | 4.8 | 20 | | | DH12 @ 10 |
| in alluvium 70 | 33 | 100 | 165 | 0.4 | 5 | | | DH13 @ 5 |
| | | 0.60% | 1.15% | 0.76 oz/ton | | | | |
| | | | | | | | | G denotes greaterthan. |

# PHASE I AND PHASE II
# ENVIRONMENTAL SITE ASSESSMENT
# RICO, COLORADO

WALSH ENVIRONMENTAL SCIENTISTS AND ENGINEERS, INC.

May 1995

95

*PRIVILEGED AND CONFIDENTIAL*

# PHASE I AND PHASE II ENVIRONMENTAL SITE ASSESSMENT, RICO, COLORADO

March 14, 1995

Submitted to: John R. Jacus, Esquire
c/o Davis, Graham, and Stubbs
370 17th Street
Denver, Colorado 80202
Counsel for Rico Renaissance, L.L.C. formerly known as Rico Properties, L.L.C.

Submitted by: _____
Deb Anderson, REM
Audit and Compliance Manager

_____
David P. Buscher, Soil Scientist/Ecological Engineer

Reviewed by: _____
James P. Walsh, Principal in Charge

WALSH ENVIRONMENTAL SCIENTISTS AND ENGINEERS, INC.
4888 Pearl East Circle, Suite 108
Boulder, Colorado 80301

Walsh Project No. 1897-010
Revised 5/12/95

*PRIVILEGED AND CONFIDENTIAL*

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## EXECUTIVE SUMMARY

A Phase I Environmental Site Assessment (ESA) with limited water and soil sampling was conducted on approximately 3,000 acres in and near the town of Rico, Colorado in Dolores County, Colorado. Based on information obtained during the Phase I ESA, a Phase II ESA was conducted on selected properties within the study area. Rico is located in the southwest corner of the state in the San Juan Mountains. The properties assessed are located between latitudes 37° 43' 45" and 37° 40' and longitudes 108° 00' and 108° 3' 45".

The Phase II sampling was conducted to obtain information on the metals concentrations in soil at the various map units. Special emphasis was placed on characterizing map units such as waste rock piles, mine tailings, and fill material that may contain elevated concentrations of metals. Many of the parcels studied were made up of more than one map unit. Therefore, if a sample of waste rock was taken from a property that contained waste rock, fill, and native soil, the sample may not be indicative of the metals concentration on the entire property. This preferential or selective sampling may result in the reporting of values for some properties which are significantly higher than values that might be obtained for those properties if employing randomized or grid sampling. This approach was considered most appropriate to aid counsel and the client in evaluating the risks of potential environmental liability associated with the parcels included within the scope of this ESA.

A records review, interviews, aerial photograph interpretation, a visual site inspection, and soil sampling indicate that some properties within the study area have been impacted by past mining activities. Some properties within Rico have also been impacted by underground storage tanks (USTs) at or near the properties, mine waste used as fill material, hazardous substances on the property, and suspect asbestos in buildings.

The properties studied were ranked as high, medium, or low risk based on the map unit, site-specific sampling, and a subjective assessment of the risk relative to other properties within the study area. Map units with a high ranking include the following:

- alluvium mixed with mine waste material (Al/MW)
- alluvium mixed with mill tailings (Al/T)
- acid mine drainage (AMD)
- clinker/fill/alluvium (C/F/A)
- contaminated mine drainage (CMD)
- clinker with mine waste (C/MW)
- dump debris (DD)

- disturbed soil (DS)
- fill material (F)
- fill material mixed with mine waste (F/MW)
- fill material mixed with mill tailings (F/T)
- leaking UST sites
- mine waste spoils (MW)
- mine waste and borrow areas (MW/BA)
- slag mixed with mine waste (S/MW)
- tailings impoundments (TP)
- wetlands mixed with tailings (WL/T)
- wastewater ponds (WWP)

These areas were ranked as high risk due to elevated metals concentrations in mine waste materials or due to other environmentally significant impacts (e.g., USTs). Rankings of areas mapped as native soil (map unit NS) and wetlands (WL) were dependent on soil analytical data, soil type, and proximity to high risk areas.

The key findings of the investigation are listed below.

- There are numerous mine sites within the study area where waste rock and tailings are evident. There is visible contamination downgradient of some of these sites where stormwater has transported mine wastes off site. Seepage from the mill site on Silver Creek is also visibly impacting the creek. The Colorado Department of Public Health and Environment (CDPHE) has not issued stormwater discharge permits for any of these mine sites.

- The analytical data from limited selective sampling indicate that concentrations of lead up to 12,000 milligrams per kilogram (mg/Kg) are present at some properties within the study area where fill material, mine tailings, waste rock, and slag are visible. Samples from these areas were selected to characterize the mapping units which were suspected to have elevated metals concentrations. Samples taken from properties that appeared to have native soil contained lead concentrations ranging from 62 mg/Kg to 9,300 mg/Kg with a mean value of 858 mg/Kg. Soil samples from some properties, especially in the southeast portion of the study area, did not contain elevated concentrations of lead. Samples in these areas contained lead concentrations of 62 mg/Kg to 260 mg/Kg which is well within background levels for lead in soil. Properties ranked as low risk have soil lead concentrations of less than 400 mg/Kg.

- The Rico-Argentine site (as described in the U.S. Environmental Protection Agency's (EPA) Site Investigation Prioritization (SIP), Rico-Argentine, Rico, Colorado, dated October 11, 1994 (URS, 1994) which is included as Appendix J) is currently under study by the EPA. The Rico-Argentine Mine was identified in 1984 as being a potential environmental problem, and a site inspection was conducted at that time. EPA is reportedly planning on conducting an Expanded Site Inspection (ESI) of the Rico area (as defined by the EPA in the SIP) that will include sampling of residential soils, drinking water wells, surface water and sediment in Silver Creek and the Dolores River, and sampling of potential source materials. This ESI will be conducted as part of the Comprehensive Environmental Response, Compensation, and Liability Act process of determining if the Rico-Argentine site (CERCLIS ID No. 980952519) should be included as a Superfund site on the National Priority List (NPL). Following completion of the ESI, the site will be scored using the Hazard Ranking System. Sites scoring above 28.5 using this system are placed on the NPL. Additional studies (Remedial Investigation and Feasibility Study) are then conducted prior to cleanup of such sites. The current expanded study was triggered because of high mercury concentrations in downstream reservoirs on the Dolores River.

- A waste pond located in a tailings area on the south side of Rico appears to intermittently overflow and mine tailings are discharged to the Dolores River during overflow periods. Visible contamination is evident in the drainages downgradient of this pond.

- Fill material on Lots 36 to 40, Block 1 was composite sampled and analyzed using the Toxicity Characteristic Leaching Procedure (TCLP) methodology for metals. The sample extract contained 21 milligrams per liter (mg/L) lead and the regulatory level for characteristic hazardous wastes is 5 mg/L. Four composite samples for total lead were taken on these lots. The sample from Lots 36 to 38 (fill, waste rock, and tailings) contained 1,500 mg/Kg lead; the sample from Lots 39 and 40 (fill, waste rock, and tailings) contained 7,700 mg/Kg lead; and two samples taken from Lot 40 (native soil with some fill) contained 830 mg/Kg and 230 mg/Kg lead.

- Soil samples taken from near the septic tanks and leach line at the Assay Building contained concentrations of metals generally higher than those from a background sample taken near the Assay Building, but within the range of concentrations found in other samples taken in the Rico area. The soil excavated from around the septic system was analyzed using the TCLP methodology and this sample was found to contain metals concentrations below the regulatory levels used to determine if a material is a hazardous waste.

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- The analytical data from the former highway department facility show that petroleum hydrocarbon contamination is present in a limited portion of the soil at the property. The total volatile hydrocarbon (TVH) and total extractable hydrocarbon (TEH) concentrations in the soil near the tank piping exceed the CDPHE Remedial Action Category III regulatory levels (500 mg/Kg TVH/TEH). The TEH and TVH concentrations at the base of the tank excavation were well below the regulatory levels. The TCLP metals concentrations were also below the regulatory levels.

- There is one 55-gallon drum of unknown materials stored at the former highway department property.

- Lot 1, Block 1 is a reported leaking UST site. The CDPHE file for this facility indicated that soil contamination (288 mg/Kg total petroleum hydrocarbons) was detected at the time two USTs were removed from the site. The extent of impacted soil and potentially impacted ground water has not been determined.

- Several suspect asbestos-containing materials were identified in the buildings included in this study.

- Several chemical containers were found in the Assay Building including methyl isobutyl ketone; 1,1,1-trichloroethane; acetone; and potassium ferrocyanide.

- A 55-gallon unlabeled drum that reportedly contains kerosene is stored in the Burley Building.

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# PHASE I AND PHASE II ENVIRONMENTAL SITE ASSESSMENT RICO, COLORADO

## 1.0 INTRODUCTION

This report presents the findings of a Phase I Environmental Site Assessment (ESA) conducted on approximately 3,000 acres of land in and near Rico, Colorado and Phase II ESA sampling conducted on selected properties within the study area. This assessment was conducted by Walsh Environmental Scientists and Engineers, Inc. (WALSH) at the request of Rico Renaissance, L.L.C., formerly known as Rico Properties, L.L.C., and its legal counsel. The objective of this assessment is to provide information regarding the environmental condition of the subject properties prior to possible acquisitions, so as to assist legal counsel in advising Rico Renaissance, L.L.C. The information developed regarding environmental conditions is intended to aid Rico Renaissance, L.L.C. in its evaluation of properties for possible acquisition.

The Phase I ESA consisted of a review of available city, county, state, and federal documents; examination of historical and recent aerial photographs; interviews with local residents and agencies; a visual inspection of the properties of interest; and limited soil and surface water sampling. The mining claims and properties within the town were mapped based on soil type. The properties studied were then ranked as high, medium, or low risk relative to other properties within the study area. The ranking was based on the map unit and site-specific sampling. Using the information from the Phase I ESA, Phase II studies were conducted at several of the properties in the study area because of site-specific environmental concerns. Listings of the contacts made for conducting this ESA are included in Table 1 and Appendix A.

The Phase II sampling was conducted to obtain information on the metals concentrations in soil at the various map units. Special emphasis was placed on characterizing map units such as waste rock piles, mine tailings, and fill material that may contain elevated concentrations of metals. Many of the parcels studied were made up of more than one map unit. Therefore, if a sample of waste rock was taken from a property that contained waste rock, fill, and native soil, the sample may not be indicative of the metals concentration on the entire property. This preferential or selective sampling may result in the reporting of values for some properties which are significantly higher than values that might be obtained for those properties if employing randomized or grid sampling. This approach was considered most appropriate to aid counsel and the client in evaluating the risks of potential environmental liability associated with the parcels included within the scope of this ESA.

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The procedures used in conducting this Phase I ESA meet or exceed the American Society of Testing and Materials (ASTM) Standard E-1527-93 for performing Phase I ESAs as adopted on March 15, 1993 (ASTM, 1993), with one exception. Section 11.5 of ASTM E-1527-93 requires that the report of the Phase I ESA shall include "the environmental professional's opinion of the impact of recognized environmental conditions in connection with the property." At the client's request, WALSH has not included such opinions in this report.

## 2.0 SITE DESCRIPTION

### 2.1 Site Location and Description

The study area is located in southwest Colorado in the San Juan mountains and includes developed and undeveloped properties in the town of Rico and numerous mining claims outside the town limits. The general area studied is shown on Figure 1A. The site is located between latitudes 37° 43' 45" and 37° 40' and longitudes 108° 00' and 108° 3' 45".

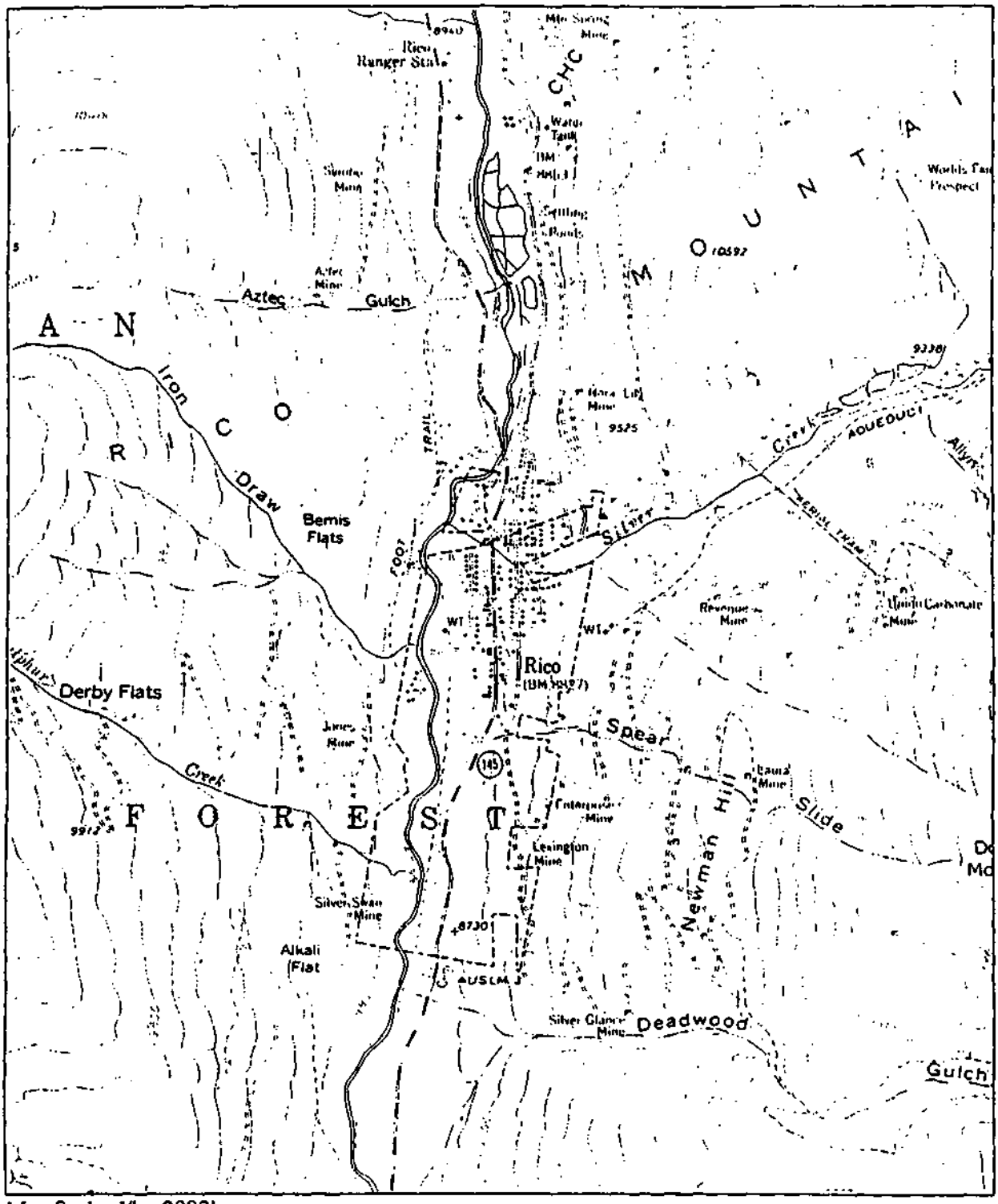
According to the Dolores County Assessor's office, the properties studied are owned by Rico Development Corporation. The prior owner of the properties was Anaconda Minerals Company. The properties are mostly bordered by national forest lands except for properties within the town limits.

### 2.2 Regional and Site Geology

The study area lies within the Rico Mining District which is near the east end of Dolores County, Colorado in the San Juan Mountains. The majority of town sits on fan deposits and mineralized sedimentary and igneous rocks. The area east of town is made up of talus and slope wash, and the northeast portion is composed of sulfide-rich sedimentary and igneous rocks. The west portion of the study area is composed of talus and slope wash, and sedimentary and igneous rocks. Surficial material south of town is predominantly of talus and slope wash, torrential fans, and landslide deposits. Alluvium occurs along the floodplains of the Dolores River (U.S. Geological Survey, 1975).

### 2.3 Aerial Photograph Review

Available historical aerial photographs from 1976 and 1992 were reviewed. The 1992 photographs were available in stereographic pairs allowing three-dimensional viewing of the area. The 1976 photograph was in color.




Map Scale: 1" = 2000'

Map Source: USGS Rico Quadrangle
Colorado 7.5 minute Series (Topographic)
1960 Photoinspected 1975.

N

Walsh
Environmental Scientists and Engineers, Inc.

Vicinity Map

| Job 1897-010 | Date 8/94 | Figure 1A |
|---|---|---|

1897VM1a.CDR RD 8/1/94

The 1976 photograph shows numerous mining sites where waste rock spoils and mine tailings were visible. The photograph also shows the Rico-Argentine Mine's water treatment ponds located north of Rico. These ponds discharge to the Dolores River. A sulfuric acid manufacturing plant is located just north of these ponds and a large area of dead trees is visible just east of the plant. There are several above-ground storage tanks (AGSTs) associated with this plant. Another set of ponds associated with the Rico-Argentine Mine are visible along Silver Creek, east of Rico.

The 1992 photographs show the area much as it appears today. Tailings impoundments, numerous mine waste spoils, and wastewater ponds at the Rico-Argentine Mine sites on the Dolores River and Silver Creek are still evident; however, the sulfuric acid plant is gone. The tree-kill area is still visible although new tree growth is evident in this area.

## 3.0 PUBLIC RECORDS REVIEW

An environmental records search of several pertinent agency records was conducted. The search focused on properties within an area 1.5 miles north, 1.5 miles south, 1 mile east, and 1 mile west of the center of Rico. Table 1 lists the records searched.

### 3.1 Federal Records

#### *3.1.1 Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Sites*

CERCLA provides a system for prioritizing existing areas of known contamination for remediation. The U.S. Environmental Protection Agency (EPA) ranks the CERCLA Information System (CERCLIS) sites according to risk based on the Hazard Ranking System score. Higher risk sites are placed on the National Priority List (NPL) and these sites are then considered Superfund sites.

There is one listed CERCLIS site within the study area: the Rico-Argentine Mine located 1 mile north of Rico. The EPA file for this facility was reviewed and there were several reports on file pertaining to studies conducted at the mine. Various studies were completed throughout 1984 and 1985. Elevated concentrations of metals in water (beryllium, iron, manganese, and zinc) and sediment (arsenic, cadmium, copper, iron, lead, manganese, and zinc) were detected in the samples taken; however, drinking water standards were not exceeded in any of the samples. In 1985, EPA determined that no further action was required at the site.

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## TABLE 1 LIST OF AGENCY SOURCES

| Source Category | Specific Source | Search Distance | Updated by Source | Obtained from Source |
|---|---|---|---|---|
| National Priority List | CERCLIS Site Event List | 1 mile | 5/13/94 | 5/16/94 |
| CERCLIS | CERCLIS Site Event List | 1 mile | 5/13/94 | 5/16/94 |
| State Superfund | CDPHE list of private cleanup sites | 1 mile | undated | 4/1/93 |
| RCRIS Generators | Facility List | adjacent sites | 5/16/94 | 5/16/94 |
| RCRA Corrective Action | Corrective Action List | 1 mile | 5/24/94 | 5/24/94 |
| RCRA TSDs | TSD Notifiers List | 1 mile | 5/16/94 | 5/16/94 |
| Underground Storage Tank (USTs) Leaks | Old List - (leaks listed through 9/30/90) | 1/2 mile | 10/90 | 11/27/90 |
| | Old List (10/90 to 12/31/92) | 1/2 mile | 2/94 | 2/23/94 |
| | Updated List (1994) | 1/2 mile | 2/94 | 2/23/94 |
| | Trust Fund List | 1/2 mile | 12/93 | 12/28/93 |
| Registered USTs | State UST List | adjacent sites | 10/8/93 | 10/8/93 |
| Landfills | CDPHE Current Landfills Data-base | 1/2 mile | 12/93 | 12/27/93 |
| | CDPHE Historic Database | 1/2 mile | 9/90 | 1/14/93 |
| ERNS Spills | Federal ERNS List | site only | 5/15/94 | 5/15/94 |

RCRIS = Resource Conservation and Recovery Act (RCRA) Inventory System
ERNS = Emergency Response Notification System
TSD = Treatment, storage, and disposal
CERCLIS = Comprehensive Environmental Response, Compensation, and Liability Information System
CDPHE = Colorado Department of Public Health and Environment

In January 1994, the no-further-action designation was removed from the site when elevated mercury concentrations were found in fish in the reservoirs near Dolores, Colorado. During the assessment of possible sources for this mercury contamination, the Rico-Argentine Mine site was listed as a potential source of metals contaminants in the Dolores River. An EPA contractor has reviewed the available data on the site and prepared a report for EPA regarding recommendations for further study in the area. If additional sampling is conducted, it will probably be started in fiscal year 1995.

There are no NPL sites within the study area.

### *3.1.2 Resource Conservation and Recovery Act (RCRA)*

The RCRA Hazardous Waste Notifiers List is an inventory of registered transporters; burner/blenders; and large, small, and very small quantity generators of hazardous wastes. Large quantity generators generate more than 1,000 kilograms (2,205 pounds) of hazardous waste per month. Small quantity generators generate 100 kilograms (220 pounds) to 1,000 kilograms per month, and very small quantity generators (VSQGs) generate less than 100 kilograms of hazardous waste per month.

The RCRA Hazardous Waste Notifiers List was searched for the subject property and adjacent sites. There was one transporter listed: the Anaconda Minerals Company located 1 mile upstream from Rico, and one VSQG, the Colorado Department of Transportation (CDOT) on State Highway 145. The Anaconda Company site is the same facility discussed in Section 3.1.1 above.

The Treatment, Storage, and Disposal Facilities List was reviewed and there are no listed facilities within 1 mile of the subject property.

### *3.1.3 Emergency Response Notification System (ERNS)*

Spill reports received by the EPA regarding hazardous substance incidents are maintained in an on-line database called ERNS. When a reportable quantity of a hazardous substance is released, the National Response Center must be notified within 24 hours and these reports are also included in ERNS. There has been one hazardous substance spill reported in the study area. This incident occurred at the Rico-Argentine Mine area north of Rico. EPA investigated the discharge of mine wastewater without treatment from the Rico Development/Anaconda Acid/Blaine Mine area in April 1990. The affected waterways were the Dolores River and Silver Creek.

## 3.2 State Agency Records

### *3.2.1 Landfills/Solid Waste Activities*

Records from the CDPHE were reviewed for landfills within the study area. CDPHE maintains a database of known open and closed landfills in the state. Three landfills with approximate locations and three landfills with unknown locations were identified from this source. Following is a listing of the landfill information:

| Name | Location | Waste Type |
|---|---|---|
| Rico SWDS | 1 mile east of Rico, S36,T40N,R11W | municipal waste |
| Anaconda Minerals Argentine | S24,T40N,R11W - ponds | unknown |
| Union Carbide (sic) | Dolores County near Rico | mill waste, tailings, radioactive |
| Ramco Acid Plant | S13,T40N,R11W | mill waste, tailings, into Dolores River |
| Mineral M&M Inc. | S26,T40N,R11W | mill waste, tailings, into Dolores River |
| Rico Mill | S13,T40N,R11W near Rico | mill waste, refuse, radioactive |

Based on the section locations given for these landfills, it is likely that all of these landfills are located within the study area.

### *3.2.2 Leaking Underground Storage Tanks (USTs)*

Several lists compiled by the CDPHE were searched for leaking USTs in the vicinity of the site. The lists identify locations where releases have been reported; where closures were conducted; where spills, overfills, or upgrades have occurred; and where contamination or tank leaks have been reported. Sites are not removed from the lists even if remediation has occurred and the site is no longer considered contaminated.

There was one reported leaking UST located within the study area, the Keith Duncan site on Lot 1, Block 1 in Rico. A review of the file for this site was conducted at the CDPHE. The file contained a notification that two USTs were being removed from the site in August 1989. They were a 1,000-gallon unleaded gasoline tank and a 2,000-gallon regular gasoline tank. The file also contained a letter from the San Juan Basin Health Department addressed to CDPHE reporting that the two tanks had been removed, the excavation had appeared clean, and a composite soil sample was taken from the excavation. The sample contained 288 milligrams per kilogram (mg/Kg) total petroleum hydrocarbons (TPH) and 2.5 mg/Kg

Extraction Procedure Toxicity lead. The San Juan Basin Health Department recommended that no further investigations of the site should be performed.

### *3.2.3 Registered Underground Storage Tanks (USTs)*

There are two facilities with registered USTs located within the study area and one with an unknown location. Information on registered tanks was obtained from the Colorado Department of Labor, Oil Inspection Section, UST inventory for the state of Colorado. The sites are listed below:

| Facility | Address | Tank Status |
|---|---|---|
| Rico Town Shop | Campbell Street | 2 tanks in use |
| CDOT - Rico | 211 N. Highway 145 | 2 tanks in use |
| US West - Whitewater | RR 250663, Rico | 1 tank in use |

There is a convenience store located on the south end of Rico that sells gasoline. No AGSTs were visible at this facility; therefore, it is assumed that the facility has unregistered USTs.

### *3.2.4 National Pollutant Discharge Elimination System*

Rico Development Corporation holds a permit for the discharge of treated wastewater from the Rico-Argentine Mine (CO-0029793). The CDPHE permit file was reviewed and several violation notices issued to Rico Development Corporation were contained in the file. There are two outstanding Notices of Violation and Cease and Desist Orders for the facility. One was issued in June 1993 and the other in January 1994. Several letters of violation have been issued to Rico Development Corporation for permit limitation violations and for submitting late reports to CDPHE. The site is also listed on EPA's Quarterly Non-Compliance Report for permit effluent violations and reporting violations.

The discharge from the St. Louis Tunnel failed the whole effluent toxicity test in September 1993 and April 1994. This test is used to determine toxicity to the biota by exposing fathead minnows and Ceriodaphnia dubia (water flea) to various dilutions of the discharged wastewater. The mortality rate for these organisms exceeded the permit limitations.

CDPHE regulations appear to require that stormwater discharge from inactive mines be permitted. CDPHE notified Rico Development Corporation that a stormwater permit was required and their attorney responded that the stormwater regulations did not apply to this

facility because it is inactive. At the time of the file review, CDPHE had not taken any enforcement action against Rico Development Corporation regarding the lack of permitting for stormwater discharges.

## 3.3 Local Agency Records

### *3.3.1 Ownership Report*

According to the Dolores County Assessor's office, the properties included in this study are owned by the Rico Development Corporation. The previous owner of the property is listed as the Anaconda Mining Company.

### *3.3.2 Rico Fire Department*

A representative of the Rico Fire Department was contacted to determine if any hazardous materials incidents, spills, or fires had occurred on or near the subject properties within the town of Rico. There were reportedly no fires or incidents at the subject properties in town.

### *3.3.3 Denver Public Library*

Sanborn Fire Insurance maps for the town of Rico were reviewed at the Denver Public Library. The 1899 Sanborn Fire Insurance map showed the main downtown area which was bounded by Mantz Avenue to the north, Campbell Street to the south, Garfield to the east, and Silver to the west. Several insets were included on the Sanborn Fire Insurance map showing the Grand View Mining and Smelting Company, Enterprise Mining Company, Colorado Milling and Concentrating Company, and the Rico and Aspen Consolidated Mining Company. There were no specific location references for these sites; however, there were notations that they were located 0.75 mile to 1.5 miles south of the post office. The post office was located on Glasgow Avenue in the approximate center of town.

# 4.0 VISUAL SITE INSPECTION

## 4.1 Subject Property

The study area was inspected by WALSH personnel on June 13 through 16, 1994. This inspection included a visual assessment of the study area and taking a limited number of soil and water samples from various properties. Photographs of the property are included in Appendix B.

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The study area was identified using maps provided by the client that showed properties of interest within the town of Rico and mining claims within and near Rico. Significant mine sites were identified using aerial photography prior to inspection. Areas that appeared to be native soil and forest were inspected by visually observing the area from existing roads. Some areas were not accessible and were only observed from a distance, such as from a side slope across a drainage. The study area and mapping units are shown on the figures included in Appendix E.

Four developed properties in Rico were inspected: the Burley Building, the theater/cafe, the Assay Building, and the former CDOT facility. Two small houses were included in the study area; however, access to these buildings was not obtained.

The Burley Building is a former office building located on Glasgow Avenue that is mostly vacant except for a small office area occupied by Rico Properties. The Anaconda Mining Company previously occupied the building. There are suspect asbestos-containing materials (ACMs) in this building including wall board, ceiling materials, and floor tile. There is an unlabeled 55-gallon drum on the main level of the building that reportedly contains kerosene (personal communication, Webster, 1994). There are also paint containers, plastic cement, and numerous core samples stored in the building.

The theater/cafe building is located adjacent to the Burley Building to the north and is currently vacant. The interior of the building is in poor condition and several potential ACMs were identified including wall board, ceiling materials, and floor tile. There is a boiler in the basement of the building that has suspect asbestos-containing insulation. There was an empty 55-gallon drum stored in the basement.

The Assay Building is located on the east side of Glasgow Avenue, north of the Burley and theater buildings. The Assay Building was a laboratory used to determine the mineral content of ores. There were several chemical containers (most of them empty), remaining in the building including methyl isobutyl ketone; potassium ferrocyanide; hydrogen peroxide; acetone; 1,1,1-trichloroethane; ammonium hydroxide; and a container (approximately 15-gallons) that contains a small amount of liquid that is reportedly acid (personal communication, Foster, 1994). There was an area of heavy oil staining in the northeast corner of the building on what appeared to have been an equipment pad. Rico does not have a municipal wastewater treatment system and therefore each building has an individual septic system. Wastewater generated at the Assay Building was discharged to an individual septic system.

The former CDOT property is located on Glasgow Avenue across the street from the Assay Building. There are two buildings and a shed on the property. The site was used by CDOT

to fuel and repair vehicles. There were five 55-gallon drums stored on the property. One drum was partially full and was labeled "Delvac 1330," two drums were used for trash, and the remaining two drums were empty. Soil staining was evident on the west side of the northernmost building and there was a disturbed area near this building where it appeared that USTs had been located. There was wall board in the northernmost building that may be transite, an ACM. There was a large oil stain inside the southernmost building where a small drill rig and pump were stored. The USTs from this site were removed when Anaconda Minerals Company acquired the property. CDPHE did not have any reports on file for this facility and it is unknown whether any soil samples were taken when the tanks were removed.

The town of Rico uses surface water from Silver Creek as their drinking water source. The water intake is upgradient of the Rico-Argentine Mine site. At the time of the inspection, the CDPHE was recommending that drinking water be boiled because of inadequate disinfection of the water.

## 4.2 Map Units

### *4.2.1 Methods of Delineating Map Units*

Map units were identified and delineated using aerial photography, by visual inspection, and by digging shallow observation pits (6 to 25 inches deep). Areas containing similar materials were grouped together by map units. For example, areas containing native soil mixed with various amounts of mine waste were mapped as the same map unit.

### *4.2.2 Map Unit Descriptions*

There were 23 map units identified and delineated in the study area. Table 2 in Appendix C describes the composition and locations of each map unit. The map units and properties of interest are shown on Figures 1 through 4 in Appendix E.

## 4.3 Environmental Ranking System

The properties studied were ranked as high, medium, or low risk based on the map unit, site-specific sampling, and a subjective assessment of the risk relative to other properties within the study area.

A high-risk property was considered to be a property that had identified environmental concerns such as waste rock or tailings, USTs, visible contamination, or where sample analyses

revealed contamination. A site was considered to be medium risk if the property was adjacent to, or downgradient from, a high-risk site and could be impacted by contamination from the high-risk site. A low-risk site was a site with native soils, no obvious contamination, and not in close proximity to a high-risk site. Areas located just upgradient from a high-risk site may also be rated as low risk. Low risk sites may have been impacted; however, this study did not identify any specific risk factors on these sites. If there were potential risks at the site such as fill material that had not been sampled and analyzed, the site is ranked as unknown risk. Due to the time constraints on completing the project, not all properties were sampled enough to sufficiently characterize the risks.

Table 3 in Appendix D lists each property, the risk ranking, and comments about the property. Figures showing the study area are included in Appendix E.

### 4.4 Wetland Identification

Soils in two areas surrounded by wetlands were excavated to 12 inches and observed to determine the presence of hydric soils as defined by the Federal Manual for Delineating Jurisdictional Wetlands (1987). One observation point was excavated at each of the two sites. Neither of the two sites exhibit hydric soils and are not jurisdictional wetlands.

Prior to any development in potential wetlands areas, the wetlands and non-wetlands will need to be delineated based on soils, vegetation, and hydrology. The development must then be approved by the Army Corp of Engineers.

### 4.5 Surrounding Properties

The majority of the study area is bordered by San Juan National Forest. Properties within the town of Rico are bordered by undeveloped lots and various buildings. Neighboring properties considered as high risk include Lot 1, Block 1 which is identified as a leaking UST site, and the Dolores County shop property which has registered USTs.

## 5.0 SOIL SAMPLES

Surficial soil samples were taken from several properties within the study area. Samples from properties where the predominant material was native soil, mine waste, fill mixed with mine waste, alluvium, and slag mixed with mine waste were obtained.

## 5.1 Soil Sample Collection

Forty-eight soil samples were collected from the study area to evaluate metal concentrations in soils, fill, and mine waste materials in the study area. These samples were both single point grab samples (discrete samples) and composite samples. The composite samples consisted of sample aliquots from two to four areas within a claim or town parcel and were used to provide broader sampling coverage of the study area. The distance between aliquots was determined by the property size. Sample depths varied from 0 to 7 inches. Samples collected from depths greater than 7 inches were of various types of fill material. Samples collected from a depth of 0 to 7 inches were of native soil or some type of mine waste material. The composition, sample type, depth increment, and location of each soil sample collected are described in Table 4 in Appendix F. Soil sample locations are shown in Figures 1 through 4 in Appendix E.

All soil samples were collected using a decontaminated shovel. Sampling equipment was decontaminated with Alconox™ soap and distilled water after every sample was taken. The collected soil material was placed into ziplock plastic bags or glass sample containers, stored in a cooler containing ice, and then sent to the laboratory for analysis. The chain-of-custody records are included with the laboratory data in Appendix G.

The samples were analyzed for metals using an ICP Screen (EPA Method 6010) and a manual cold-vapor technique (EPA Method 7471). A few of the samples were also analyzed using the Toxicity Characteristic Leaching Procedure (TCLP) method of analysis. Table 5 in Appendix F shows the analytical results, and copies of the laboratory data are included in Appendix G.

## 5.2 Soil Analyses and Results

Environmentally significant findings were discovered at several of the properties, especially where mine waste, tailings, and fill material were evident. Elevated concentrations of metals such as lead, cadmium, and zinc were detected on all the properties sampled where mine waste, fill, or tailings were visible. Some elevated concentrations of these metals were also detected on properties that appeared to be native soil. There were several properties where no elevated concentrations of metals were detected.

Sampling conducted on September 7, 1994 on the Smuggler, Yankee Boy, Hillside #2, Hillside, Home, Sam Patch, and Little Ada North claims; Group tract; Warner K. Patrick tract; and Blocks 1, 2, 10, 11, 38, and 39 was designed to identify potential high concentrations of metals. Areas with visual contamination were specifically selected for sampling during

this sampling event and may not be indicative of metals concentrations on the entire property.

The lead concentrations were highly variable throughout the study area, and variances were also seen when multiple samples were taken from the same parcel. The shaded metals values listed in Table 5, Appendix F denote elevated concentrations. Concentrations were considered elevated at 400 mg/Kg or higher based on recently published EPA guidance documents (EPA, 1994a and 1994b) that recommend further evaluation of areas where the lead concentration in bare soil in residential areas exceeds 400 mg/Kg.

Several samples were taken at Lots 36 to 40, Block 1 where installation of a septic system is planned. The first composite sample was taken on Lots 39 and 40 at a depth of 0 to 4 inches. This sample contained 1,500 mg/Kg lead. The second sample was a composite taken from 0 to 8 feet in a trench excavated on Lots 36 to 38. This sample contained 7,700 mg/Kg total lead and 21 milligrams per liter (mg/L) TCLP lead. The next two samples were taken from a trench excavated on Lot 40. The trench was excavated from the approximate center of the lot to the west about 20 feet. One composite sample from 0 to 3 feet was taken from the east end of the trench and one from the west. These samples contained 830 mg/Kg and 230 mg/Kg lead, respectively.

## 6.0 WATER SAMPLES

### 6.1 Water Sample Collection

Water samples were obtained from the Dolores River, Silver Creek, and from a spring near the Mountain Springs mine. Three samples were taken from the river; one from upgradient of the study area near the ABG Mine, one directly downstream of the discharge from the Rico-Argentine Mine treatment ponds, and one at the downstream edge of the study area. The sample from Silver Creek was taken downstream of the discharge entering the creek from the Rico-Argentine Mill approximately 1 mile east of Rico. The samples were collected in plastic sample bottles and were preserved with nitric acid. The samples were analyzed for total metals using an ICP Screen (EPA Method 6010) and a manual cold-vapor technique (EPA Method 7471).

### 6.2 Water Analyses Results

The highest metals concentration were found in the sample from the Mountain Springs mine. The pH of this water was very low (pH = 3.9). These acidic conditions contribute to the

metals being in solution. The concentrations of iron, manganese, and zinc directly downgradient of the Rico-Argentine Mine discharge were elevated when compared to the other samples taken from the river; however, the water quality standards established for these parameters in the Dolores River were not exceeded. The detection limits for arsenic, cadmium, copper, lead, mercury, selenium, and silver were not low enough to determine if these water quality standards had been exceeded. The high detection limits were the result of running screening analyses for gross metals contamination rather than more precise drinking water analyses. Table 6 in Appendix F shows the analytical results and copies of the laboratory data are included in Appendix G.

## 7.0 ASSAY BUILDING

### 7.1 Site Assessment

On June 30, 1994, the septic tanks and leach line at the Assay Building were exposed using a backhoe to facilitate sampling of soils adjacent to the tanks and lines. The excavation was started on the north side of the building where the tanks were reportedly located. The area from the center of the building to the northeast corner of the building was excavated to a depth of about 4 feet without encountering the tanks. The area east of the building was then excavated and the tanks were located in this area about 5 feet below ground surface (bgs). There were two 200- to 300-gallon capacity fiberglass tanks in series. The bottom of the tanks were moist; however, there was insufficient liquid or sludge in the tanks to obtain a sample. The leach line ran from the northernmost tank to the northeast corner of the building and then ran west to near the northwest corner of the building. The leach line consisted of perforated 4-inch PVC pipe.

During the excavation process, field monitoring for hydrogen cyanide gas and volatile organic compounds (VOCs) was conducted. A photo-ionization detector (PID) was used to screen for VOCs. The detection limit of the PID is one part per million (ppm) isobutylene equivalency. The highest VOC reading was 15 ppm from near the septic tanks. Hydrogen cyanide was not detected at any time.

After the tanks and pipe were exposed, grab samples were obtained from near the leach line and septic tank directly downgradient of the tanks, and near the southwest corner of the property. The samples were taken from 5 to 8 feet bgs. The area at the west end of the leach line was excavated to a depth of 12 feet to determine if shallow ground water was present close to the leach line. Ground water was not encountered in this test pit. After the subsurface samples were taken, a composite sample of the excavated soil was taken to deter-

mine if the soil would need to be classified as a hazardous waste. Following completion of the sampling activities, the trench and test pits were backfilled with the excavated material because of the safety hazard of leaving the trench open. Photographs of the excavated areas are included in Appendix B.

Samples from near the tanks and leach line were analyzed for VOCs, semi-volatile organic compounds (SVOCs), metals, cyanide, and sulfate. The composite sample of the excavated soil was analyzed using the TCLP method for VOCs, SVOCs, metals, pesticides, and herbicides. The sampling locations are shown on Figure 5 in Appendix E and are listed in Table 7 in Appendix F.

All soil samples were collected using a decontaminated shovel. Sampling equipment was decontaminated with Alconox™ soap and distilled water after each sample was taken. The collected soil was placed into the appropriate sample containers, stored in a cooler containing ice, and then sent to the laboratory for analysis.

## 7.2 Site Assessment Findings

Soil samples were taken from a trench and test pits near the septic tanks and leach line for the Assay Building. The samples were analyzed for metals using an ICP Screen (EPA Method 6010) and a manual cold-vapor technique (EPA Method 7471), VOCs (EPA Method 8240), SVOCs (EPA Method 8270), and cyanide and sulfate (EPA Method SW-846). The analytical results are included in Table 8 in Appendix F and copies of the laboratory data are in Appendix G.

The analytical data show that the concentration of certain metals in the soil adjacent to the leach line are elevated when compared to on-site background concentrations (Sample SP-06). The concentrations of cadmium, lead, manganese, mercury, and silver in samples taken along the leach line are higher than the concentrations typically detected in the western U.S.; however, they are within the range of concentrations found in other samples taken in the Rico area. The composite sample analyzed using the TCLP analyses revealed that the metals concentrations were well below the regulatory levels for determining if a material is a hazardous waste. VOCs, SVOCs, and cyanide were not detected at concentrations exceeding the detection limit and the sulfate concentrations were within the normal range for soils.

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# 8.0 FORMER HIGHWAY DEPARTMENT PROPERTY

## 8.1 Site Assessment

On August 17, 1994, the area where USTs were located at the former highway department property was excavated and soil samples were taken to determine if petroleum hydrocarbon contamination was present in the soil. There were reportedly three USTs at the site; two 1,000-gallon diesel tanks and one 500-gallon gasoline tank. The tanks were removed in 1986 (personal communication, Todd Jones, CDOT, 1994).

The excavation was started on the south side of the main building by the walk-through door. The first trench was excavated in the approximate center of the tank installation area. The soils consisted of fill material with brick debris in the first 5 to 6 feet. At 6 to 7 feet the soil appeared to be natural clay and silty/clay soil with large cobbles and boulders. The excavation was then expanded to the east and west and similar fill material and soil was encountered. Tank piping was exposed near the building in the northeast corner of the excavation near the former location of the fuel pumps. A small area of visibly contaminated soil was evident and a hydrocarbon odor was detected in the soil in this area.

During the excavation process, field monitoring for VOCs was conducted using a PID. The detection limit of the PID is 1 ppm isobutylene equivalency. The highest VOC reading was 13 ppm in the headspace from a sample near the tank piping. The excavated soils were monitored and no hydrocarbon vapors were detected.

Three grab samples were obtained from the excavation, two from the interface of the fill material and the natural soils where the bottom of the tanks would have been located (about 7 feet bgs) and one sample from near the tank piping (2 to 3 feet bgs). After the samples were obtained, the excavation was backfilled with the removed material. Ground water was not encountered in the excavation. Photographs of the excavated areas are included in Appendix B.

Each of the three samples were analyzed for benzene, toluene, ethylbenzene, and total xylenes (BTEX), TVH, TEH, and TCLP metals. The sampling locations are shown on Figure 6 in Appendix E.

All soil samples were collected using a decontaminated shovel. Sampling equipment was decontaminated with Alconox™ soap and distilled water after each sample was taken. The collected soil was placed into the appropriate sample containers, stored in a cooler containing ice, and then sent to the laboratory for analysis.

## 8.2 Site Assessment Findings

Soil samples were taken from the area where three USTs were formerly located. The samples were analyzed for BTEX (EPA Method 8020), TVH/TEH (Modified EPA Method 8015), and TCLP metals (EPA Methods 3010, 6010, and 7470). The analytical results are included in Tables 9 and 10 in Appendix F and copies of the laboratory data are in Appendix G.

The analytical data show that petroleum hydrocarbon contamination is present in the soil at the property. The TVH and TEH concentrations in the soil near the tank piping exceeds the CDPHE Remedial Action Category III regulatory levels (500 mg/Kg TVH/TEH). This contamination is limited to a small area near the tank piping. The TEH and TVH concentrations at the base of the tank excavation were below the regulatory levels. The TCLP metals concentrations were also below the regulatory levels. Because the USTs were removed prior to December 22, 1988, assessment of the areal extent of contamination at the site is not required under CDPHE regulations unless specifically requested.

# 9.0 RICO TOWN DUMP

An assessment of the waste deposited at the former Rico dump site was conducted. Several trenches were excavated at the site using a backhoe. The trenches were excavated to determine the depth and type of waste disposed in the landfill, and to facilitate taking samples of the soils underlying the landfill. It appeared that trash was placed in long trenches and then covered with about 1.5 to 2 feet of fill. The trash extends to 13 feet deep in places. An access road is proposed for over the landfill, and the proposed road site is relatively free of thick trash deposits. The landfill dimensions are about 160 feet (north/south) by 140 feet (east/west).

A total of 11 trenches were excavated at the site. Six of the trenches did not contain waste materials. Four of the trenches contained little waste, and one trench in the southwest corner of the dump contained large amounts of waste. Two soil samples were taken at the site, one from a trench containing a small amount of trash on the west/central portion of the dump at a depth of 6 feet (just above bedrock). Debris in this trench consisted primarily of soil and cobbles but included glass, cans, plastic, black-stained soil, wood, and paper. The second sample was taken from the trench in the southwest corner of the site that contained pipes, wire, cans, a hot water heater, pails, pans, glass, plastic, rugs, lumber, rubber, and clothes. The sample was taken at a depth of about 14 feet, which was 2 feet below the disposed wastes.

Each of the samples was analyzed for VOCs, SVOCs, and total metals. No detectable concentrations of the target compounds were found in the VOC and SVOC analyses. The metals results are included in Table 5 in Appendix F. Copies of the laboratory data are in Appendix G.

## 10.0 CONCLUSIONS

WALSH's conclusions for this Phase I and Phase II ESA are based on information provided by the client, available public records, discussions with selected personnel and government agencies, the general site conditions determined by a visual inspection, and data from site sampling. Environmental legislation passed in the 1970s and 1980s initiated the current practice of maintaining environmental records and facility inspection reports. Prior to the 1970s, activities may have adversely impacted the subject area without being documented by government agencies. There is also no guarantee that the current record-keeping requirements are adhered to by all facilities.

A records review, interviews, aerial photograph interpretation, visual site inspection, and generalized sampling indicates that several properties within the study area have been impacted by past mining activities. Other properties in Rico have been impacted by USTs at or near the properties, mine waste used as fill material, hazardous substances on properties, and suspect ACMs in buildings. Based on this limited evaluation, a number of properties do not appear to have been impacted.

The properties studied were ranked as high, medium, or low risk based on the map unit, site-specific sampling, and a subjective assessment of the risk relative to other properties within the study area. Map units with a high ranking include the following:

- alluvium mixed with mine waste material (Al/MW)
- alluvium mixed with mill tailings (Al/T)
- acid mine drainage (AMD)
- clinker/fill/alluvium (C/F/A)
- contaminated mine drainage (CMD)
- clinker with mine waste (C/MW)
- dump debris (DD)
- disturbed soil (DS)
- fill material (F)
- fill material mixed with mine waste (F/MW)
- fill material mixed with mill tailings (F/T)

- Leaking UST sites
- mine waste spoils (MW)
- mine waste and borrow areas (MW/BA)
- slag mixed with mine waste (S/MW)
- tailings impoundments (TP)
- wetlands mixed with tailings (WL/T)
- wastewater ponds (WWP)

These areas were ranked as high risk due to elevated metals concentrations in mine waste materials or due to other environmentally significant impacts (e.g., USTs). Rankings of areas mapped as native soil (map unit NS) and wetlands (WL) were dependent on soil analytical data, soil type, and proximity to high risk areas.

The key findings of the investigation are listed below.

- There are numerous mine sites within the study area where waste rock and tailings are evident. There is visible contamination downgradient of some of these sites where stormwater has transported mine wastes off site. Seepage from the mill site on Silver Creek is also visibly impacting the creek. The CDPHE has not issued stormwater discharge permits for any of these mine sites.

- The analytical data from limited selective sampling indicate that concentrations of lead up to 12,000 mg/Kg are present at some properties within the study area where fill material, mine tailings, waste rock, and slag are visible. Samples from these areas were selected to characterize the mapping units which were suspected to have elevated metals concentrations. Samples taken from properties that appeared to have native soil contained lead concentrations ranging from 62 mg/Kg to 9,300 mg/Kg with a mean value of 858 mg/Kg. Soil samples from some properties, especially in the southeast portion of the study area, did not contain elevated concentrations of lead. Samples in these areas contained lead concentrations of 62 mg/Kg to 260 mg/Kg which is well within background levels for lead in soil. Properties ranked as low risk have soil lead concentrations of less than 400 mg/Kg.

- The Rico-Argentine site (as described in the EPA's SIP, Rico-Argentine, Rico, Colorado, dated October 11, 1994 (URS, 1994) which is included as Appendix J) is currently under study by the EPA. The Rico-Argentine Mine was identified in 1984 as being a potential environmental problem, and a site inspection was conducted at that time. EPA is reportedly planning on conducting an Expanded Site Inspection (ESI) of the Rico area (as defined by the EPA in the SIP) that will include sampling

of residential soils, drinking water wells, surface water and sediment in Silver Creek and the Dolores River, and sampling of potential source materials. This ESI will be conducted as part of the CERCLA process of determining if the Rico-Argentine site (CERCLIS ID No. 980952519) should be included as a Superfund site on the NPL. Following completion of the ESI, the site will be scored using the Hazard Ranking System. Sites scoring above 28.5 using this system are placed on the NPL. Additional studies (Remedial Investigation and Feasibility Study) are then conducted prior to cleanup of such sites. The current expanded study was triggered because of high mercury concentrations in downstream reservoirs on the Dolores River.

- A waste pond located in a tailings area on the south side of Rico appears to intermittently overflow and mine tailings are discharged to the Dolores River during overflow periods. Visible contamination is evident in the drainages downgradient of this pond.

- Fill material on Lots 36 to 40, Block 1 was composite sampled and analyzed using the TCLP methodology for metals. The sample extract contained 21 mg/L lead and the regulatory level for characteristic hazardous wastes is 5 mg/L. Four composite samples for total lead were taken on these lots. The sample from Lots 36 to 38 (fill, waste rock, and tailings) contained 1,500 mg/Kg lead; the sample from Lots 39 and 40 (fill, waste rock, and tailings) contained 7,700 mg/Kg lead; and two samples taken from Lot 40 (native soil with some fill) contained 830 mg/Kg and 230 mg/Kg lead.

- Soil samples taken from near the septic tanks and leach line at the Assay Building contained concentrations of metals generally higher than those from a background sample taken near the Assay Building, but within the range of concentrations found in other samples taken in the Rico area. The soil excavated from around the septic system was analyzed using the TCLP methodology and this sample was found to contain metals concentrations below the regulatory levels used to determine if a material is a hazardous waste.

- The analytical data from the former highway department facility show that petroleum hydrocarbon contamination is present in a limited portion of the soil at the property. The TVH and TEH concentrations in the soil near the tank piping exceed the CDPHE Remedial Action Category III regulatory levels (500 mg/Kg TVH/TEH). The TEH and TVH concentrations at the base of the tank excavation were well below the regulatory levels. The TCLP metals concentrations were also below the regulatory levels.

- There is one 55-gallon drum of unknown materials stored at the former highway department property.

- Lot 1, Block 1 is a reported leaking UST site. The CDPHE file for this facility indicated that soil contamination (288 mg/Kg total petroleum hydrocarbons) was detected at the time two USTs were removed from the site. The extent of impacted soil and potentially impacted ground water has not been determined.

- Several suspect ACMs were identified in the buildings included in this study.

- Several chemical containers were found in the Assay Building including methyl isobutyl ketone; 1,1,1-trichloroethane; acetone; and potassium ferrocyanide.

- A 55-gallon unlabeled drum that reportedly contains kerosene is stored in the Burley Building.

## 11.0 RECOMMENDATIONS

Based on the findings of this Phase I and Phase II ESA, WALSH makes the following recommendations.

- Sites rated as high risk have significant potential for environmental liability. Sites ranked as medium risk may also have significant potential for environmental liability and may require more thorough evaluation prior to acquisition to more accurately determine the risk. Sites ranked as low risk, based on the level of inquiry used for preparing this report, do not appear to have high concentrations of metals in the soil. Additional site evaluation may be required based on the client's requirements.

- The fill material at Lots 36 to 40, Block 1 should be properly managed, especially if the site is used for installation of a septic tank and leach field system.

- All areas with visual contamination, mine tailings, slag, waste rock, and other visible contaminant migration have significant potential to create environmental liability for a prospective purchaser.

- Surveys should be conducted of some properties to determine if the identified risk factor is located on a property of interest.

- A wetlands survey should be conducted prior to purchase of properties that may be wetlands (e.g., Max Boehmer tract, Rico Smelting Company tract).

- An asbestos survey should be conducted on the buildings studied prior to renovation or demolition of the buildings.

- The chemicals stored in the Assay Building, Burley Building, theater building, and the former CDOT buildings will need to be characterized and properly disposed if the current owner does not remove these chemicals prior to property transfer.

## 12.0 QUALIFICATIONS AND LIMITATIONS

WALSH has performed a Phase I ESA of properties in and near Rico, Colorado in conformance with the scope and limitations of ASTM Practice E-1527, with one exception. Section 11.5 of ASTM E-1527-93 requires that the report of the Phase I ESA shall include "the environmental professional's opinion of the impact of recognized environmental conditions in connection with the property." At the client's request, WALSH has not included such opinions in this report. The qualifications of the personnel preparing this assessment are included in Appendix I.

This assessment was limited and it did not include:

- Collection, testing, or chemical analysis of any samples of ground water, wastewater, building materials, or other material which was or could have been observed on-site, except those specifically mentioned in this report;

- Interviews, except as specifically noted in this report, with past owners, tenants, employees, or neighboring landowners regarding past site use, waste generation and disposal practices (including disposal at remote sites), or manufacturing processes which may have contributed to environmental contamination at the property;

- Evaluation of the potential risks associated with identified concerns from records searches that could not be located in relation to the subject property, or sites where no records were available for review.

The sources of information obtained to perform this assessment include documents, oral statements, and other information from parties outside of WALSH's control. The accuracy of the information cannot be guaranteed by WALSH. If additional information concerning

site environmental conditions becomes available, the conclusions presented in this report will not be considered valid unless this information is reviewed and the conclusions and recommendations of this report are modified and approved in writing by WALSH. The conclusions presented in this report are based on field observations, limited laboratory analyses, and WALSH's professional experience under similar conditions. Additional sampling and testing could alter the conclusions of this report. This report was prepared only for the use of our client, the client's agents, and their legal counsel. The scope of the project and findings of the report were limited based on conversations with the client and their counsel. WALSH is not responsible for use of the information in this report by third parties.

## 13.0 REFERENCES

American Society of Testing and Materials (ASTM). 1993. Standard Practice for ESAs: Phase I ESA Process. E1527-93.

Personal Communication with Stan Foster, Rico realtor and resident, 1994.

Personal Communication with Todd Jones, CDOT, 1994.

Personal Communication with Wayne Webster, property owner, 1994.

URS Consultants Inc. October 11, 1994. *Site Inspection Prioritization, Rico-Argentine, Rico, Colorado.*

U.S. Environmental Protection Agency (EPA), Office of Solid Waste and Emergency Response. 1994a. *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities.* OSWER Directive #9355.4-12

U.S. Environmental Protection Agency (EPA), Office of Prevention, Pesticides and Toxic Substances. 1994b. *Guidance on Residential Lead-Based Paint, Lead-Contaminated Dust, and Lead-Contaminated Soil.*

U.S. Geological Survey. 1975. Topographic Map of the Rico Quadrangle, Colorado.

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# APPENDIX A

# AGENCY/PERSONAL CONTACT LIST

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## APPENDIX A

## AGENCY/PERSONAL CONTACT LIST

The following agencies/people have been contacted for this Phase I ESA conducted on an area in and around Rico, Colorado.

Mr. Wayne Webster - Subject property owner

Mr. Stan Foster - Rico realtor and resident

Dolores County Assessor

Pat Smith - EPA Project Manager, Rico-Argentine Mine

Denver Public Library - Sanborn Fire Insurance maps

Colorado Division of Natural Resources - Mine claim information

U.S. Bureau of Mines - Rick Salsbury

Colorado Division of Minerals and Geology - Maggie Van Cleef - Colorado Inactive Mine Inventory Problem Areas Data

U.S. Bureau of Land Management - Harriet Ohlerking - Mine claim information

U.S. Geological Survey - Historical topographic maps

CDPHE - Hazardous Materials and Waste Management Division; Water Quality Division

# APPENDIX B

# SITE PHOTOGRAPHS

# PHOTOGRAPHIC RECORD

Photo 1. Area east of the former acid plant where the tree kill occurred. Facing southeast.

Photo 2. Treatment ponds at Rico-Argentine Mine. Facing west.

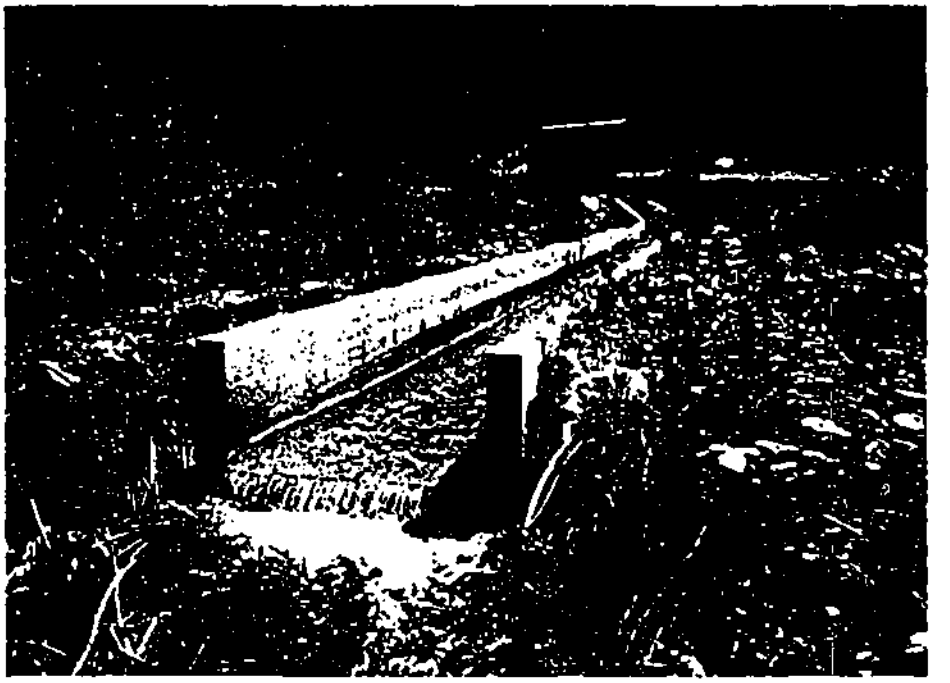

Photo 3. The St. Louis Tunnel discharging water from the treatment ponds shown in Photo 2.

Photo 4. Small pond south of Rico and east of Dolores River with large area of mine tailings. Facing northeast.

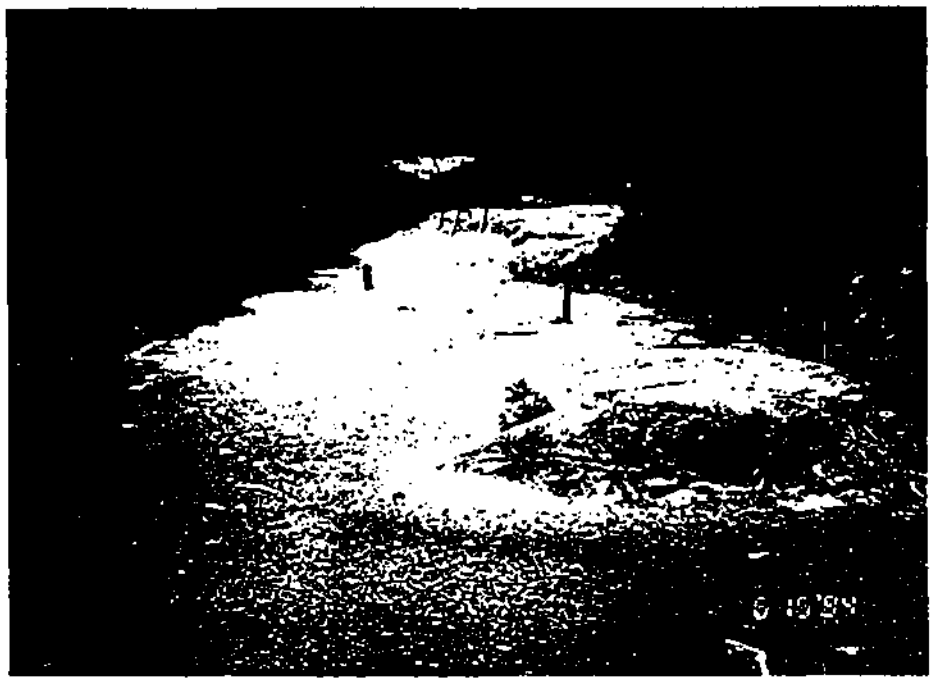

Photo 5. Drainage leading from pond in Photo 4 that flows to the Dolores River. Facing north.

Photo 6. Tailings pile and contaminated pond east of the ABG Mine and the Dolores River. Facing west.

Photo 7. Discharge from the Rico-Argentine Mill site that discharges to Silver Creek. Facing west/southwest.

Photo 8. Drainage from the Mountain Springs Mine that flows to the Dolores River. Facing northwest.

Photo 9. Waste rock at the Lexington Mine southeast of Rico. Facing east.

Photo 10. Debris disposed at a small dump site south of Rico.

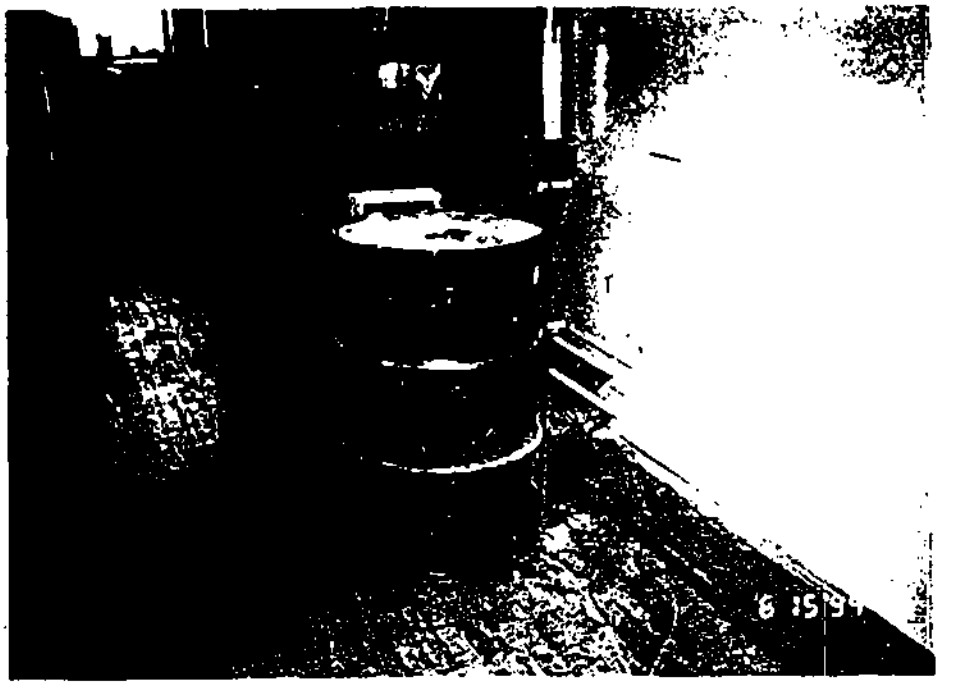

Photo 11. Drum in Burley Building that reportedly contains kerosene.

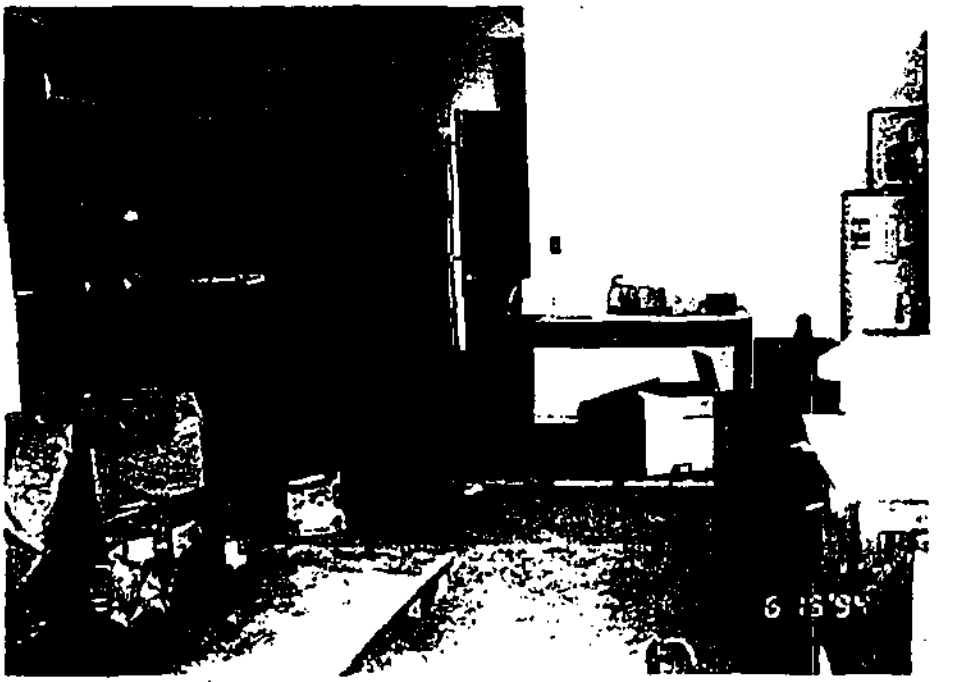

Photo 12. Interior of Assay Building showing chemical containers on counter and floor.

Photo 13. Excavated trenchline along north side of Assay building. Facing east.

Photo 14. Septic tank location on east side of Assay building. Facing north.

Photo 15. Perforated PVC leach line on the north side of the Assay building.

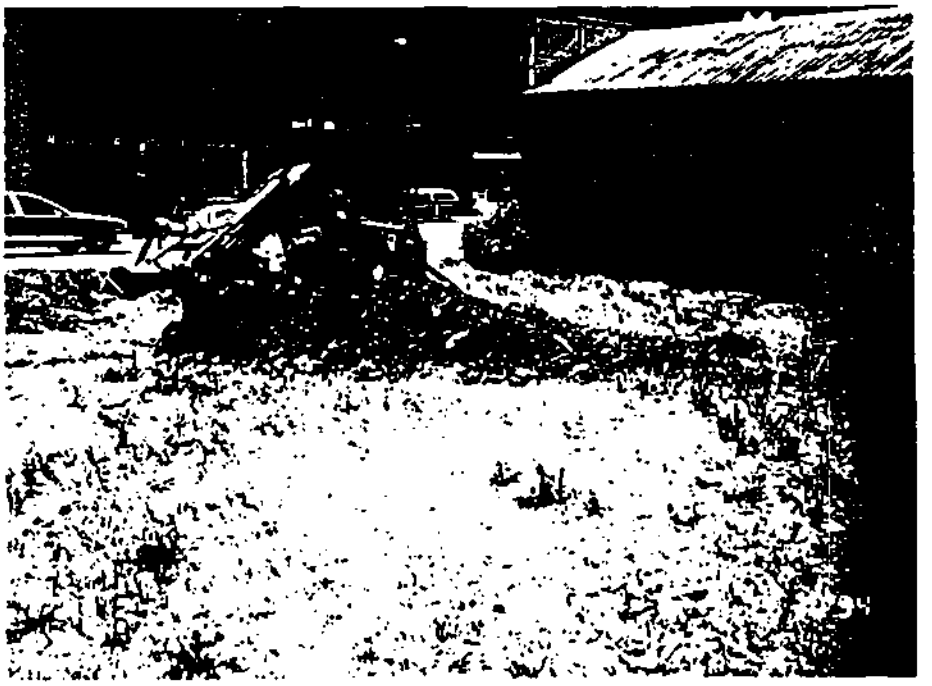

Photo 16. Test pit near the southwest corner of the property where sample SP06 was taken. Facing northwest.

Photo 17. Trench excavated near proposed road location in former town dump.

Photo 18. Excavated debris from trench dug in the former town dump.

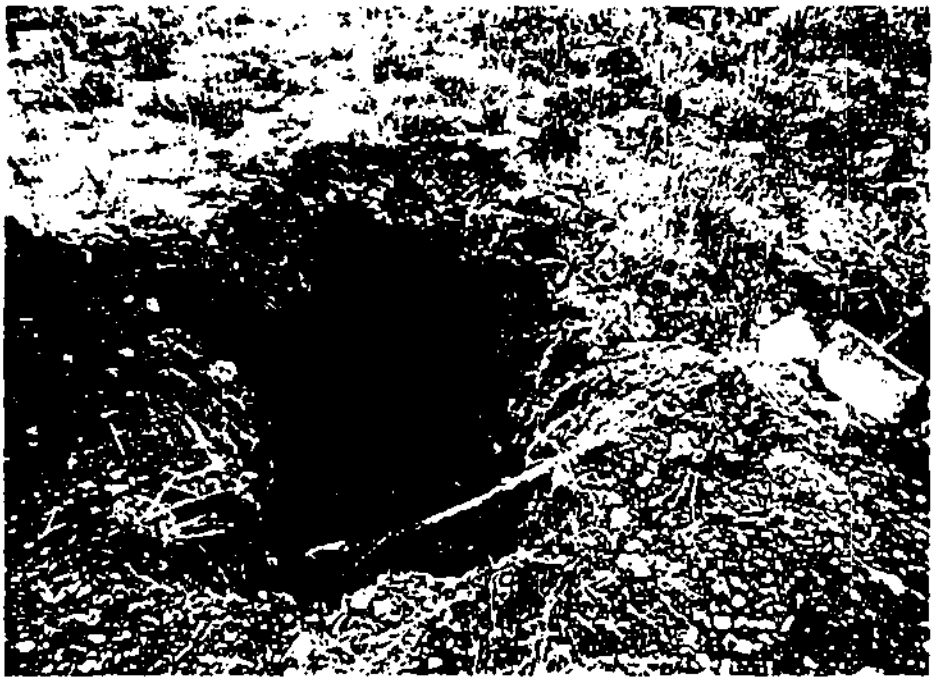

Photo 19. Trench excavated in former town dump showing small amount of debris.

Photo 20. Former underground storage tank location at previous CDOT facility with 55-gallon drums stored outside the building. Facing east.

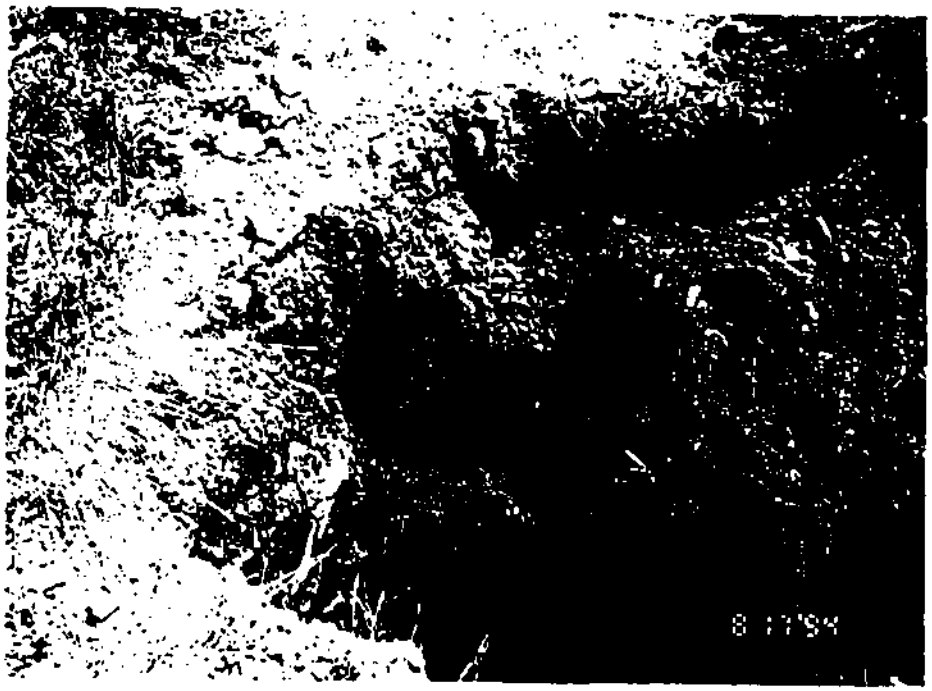

Photo 21. Tank piping in center of photo where contaminated soil was identified.

# APPENDIX C

# MAP UNITS

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## TABLE 2 MAP UNITS

AH: Avalanche hazard area. These areas consist of avalanche chutes and exhibit evidence of recent avalanches.

Al/MW: Alluvium mixed with mine waste material. These deposits consist of rounded alluvial gravel and cobbles, and sediments mixed with various types of mine waste material, including mineralized waste rock and at times mill tailings. This map unit occurs along the floodplains of the Dolores River and Spring Creek.

Al/T: Alluvium mixed with mill tailings. This map unit consists of alluvial material that is mixed with mine mill tailings. These deposits occur along portions of the floodplains of the Dolores River.

AMD: Acid mine drainage deposits. This map unit consists of fine grain, iron-stained sediments and occur in areas that drain several of the mine sites. These deposits are generated from acids produced from sulfides that occur in mill tailings and mineralized waste rock.

BC: Buildings and concrete. This map unit consists of buildings and concrete and little or no soil material. This unit occurs along Glasgow Avenue.

C/F/A: Clinkers and fill material mixed with alluvium. This map unit consists of clinkers (generated from train engines) and fill material (including brick fragments, coal and charcoal) mixed with alluvial gravel and cobbles. This unit occurs at the former train depot.

CMD: Contaminated Mine Drainage. This map unit consists of areas where stormwater has carried contaminants from tailings piles and mine waste areas downgradient to surface water. The impacted surface waters are the Dolores River and Silver Creek.

C/MW: Clinkers mixed with mine waste. This map unit consists of clinkers, which were generated from train engines, mixed with mine waste. The mine waste includes both mill tailings and mine waste rock. This unit occurs at the former train depot adjacent to a tailings impoundment.

DA: Disturbed alluvium. This map unit is composed of alluvial material including sediments, gravel, and cobbles that have been disturbed by construction activities. This unit occurs along the Dolores River and at the confluence with Silver Creek.

DD: Dump debris. This unit consists of dump debris and fill about three feet thick. The debris contains glass, brick, porcelain, and metal fragments, and plastic. This unit occurs in one area along the Dolores River.

DS: Disturbed soil. This map unit consists of native soil that has been disturbed by construction activities. This unit occurs in portions of Block 19 and 20.

F: Fill material. This map unit may consist of any of the following materials: alluvial gravel and cobbles; native soil that has been used as fill; brick, metal, and glass fragments; lumber; and coal and charcoal. This unit was identified within the Rico town limits.

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F/MW: Fill material mixed with mine waste. This map unit consists of various types of fill material mixed with angular mineralized mine waste rock. This unit occurs in a couple locations within the Rico town limits.

F/T: Fill material mixed with mill tailings. This map unit consists of construction fill including bricks and milled lumber, mill tailings, and some mine waste rock. This unit occurs on the west side of Rico at the former Pro Patria Mill site.

LUST: Leaking Underground Storage Tanks. This map unit may or did contain USTs. This unit occurs within the Rico town limits.

MW: Mine waste. This map unit consists of mine waste spoils and other materials associated with mine sites, such as lumber, shaft and adit openings, shaft headframes, and mine buildings. This map unit occurs at most mine sites in the study area.

MW/BA: Mine waste and borrow area. This map unit consists of mine waste rock and talus and slope wash material, some of which has been removed and probably used as fill material to cover tailings impoundments. This unit occurs east of the former acid treatment plant.

NS: Native soil. This map unit consist of native soil which is generally free of any types of visible mine waste under a cursory inspection. The native soils were derived from fans, talus and slope wash, landslide deposits, and various types of sedimentary and igneous rocks.

S/MW: Slag mixed with mine waste. This map unit consists of slag, probably from smelting operations, mixed with mineralized and angular mine waste rock. This unit occurs at the Homestake claim on the north side of Rico.

TI: Tailing impoundments. This map unit consists of the fine grain mill tailings impoundments. Tailing impoundments occur at the Argentine mill site, and at several localities along the Dolores River.

WL/T: Wetlands and tailings. This map unit consists of wetlands that contains some mill tailings. This unit occurs along the floodplains of the Dolores River.

WT: Wetlands. This map unit consists of areas that may contain Corps of Engineers jurisdictional wetlands. These areas possibly contain hydric soils and wetland vegetation. This map unit occurs along the floodplains of the Dolores River.

WWP: Wastewater Ponds. This map unit consists of wastewater ponds used to treat water from the St. Louis tunnel. The water from the ponds discharges to the Dolores River.

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# APPENDIX D

# RISK RANKINGS

TABLE 3 ENVIRONMENTAL HAZARD RANKING OF MINING CLAIMS IN STUDY AREA

| Claim | M.S. | Fraction* | Map Unit Sampl | Risk | Comments | Pre-acquisition Recommendations |
|---|---|---|---|---|---|---|
| A.B.G. | 676 | west 1/4 | MW/NS | High | contains mine waste | |
| | | east 1/4 | MW/NS | High | contains mine waste | |
| | | center | NS | Med. | close proximity to mine waste | sample surface soils |
| Aetna | 1956 | west 1/2 | MW/NS | High | contains mine waste | |
| | | east 1/2 | NS | Low | native soil, up grad. from mine waste | |
| Aetna | 6796 | west 2/3 | NS | Low | native soil | |
| Alta | 6191 | | NS | Low | native soil | |
| Apex | 11583A | | MW/NS | High | contains mine waste | |
| Argentine | 15233 | | NS | Med. | may contain mine drainage | sample surface soils |
| Aspen | 6512 | west 1/2 | MW/NS | High | contains mine waste | |
| | | east 1/2 | NS | Low | native soil, up grad. from mine waste | |
| Avalanche | 1682 | | NS | Med. | down grad. from mine waste | sample surface soils |
| Bald Eagle | 10122 | | NS | Low | native soil | |
| Barnum | 7365 | | NS | Low | native soil | |
| Bed Rock | 8030 | | NS | Low | native soil | |
| Bell | 5911 | | NS | Low | native soil | |
| Bertha S. | 1955A | | NS | Low | native soil | |
| Big Blue | 7365 | | NS | Low | native soil | |
| Big Strike | 7601 | west 2/3 | TP/MW | High | tailings, mine waste | |
| | | east 1/3 | NS | Low | native soil, up grad. from mine waste | |
| Black Chief | 1649 | | NS | Low | native soil | |
| Black Cloud | 8098 | | NS | Low | native soil | |
| Black George | 2485 | | NS | Low | native soil | |
| Black Hawk | 20568 | | NS | Low | native soil | |
| Black Night | 8135 | | NS | Low | native soil | |

TABLE 3 ENVIRONMENTAL HAZARD RANKING OF MINING CLAIMS IN STUDY AREA

| Claim | M.S. | Fraction* | Map Unit Sampl | Risk | Comments | Pre-acquisition Recommendations |
|---|---|---|---|---|---|---|
| Bourbon | 5132 | | NS | Low | native soil | |
| Brittle Silver | 7458 | | NS/MW | Med. | possible mine waste | sample soils & survey |
| Buckeye & Ma | 7894 | | NS | Low | native soil | |
| Buehler | 20738 | | MW/NS | High | contains small mine waste piles | |
| Bullion | 7599 | north 1/4 | MW/NS | High | contains mine waste | |
| | | south 3/4 | NS | Low | native soil, up grad. from mine waste | |
| Burghard | 8070 | | MW/NS | High | contains mine waste | |
| C.H.C. | 1040 | | NS | Med. | close proximity to mine waste | survey claim, sample surface soils |
| C.H.R. | 20740 | | NS | Low | native soil | |
| C.V.G. | 6725 | west 1/3 | NS/MW/CMD | High | mine waste, contaminated drainage | |
| | | east 2/3 | NS | Low | native soil | |
| Caledonia | 10122 | west 1/2 | NS | Low | native soil | |
| | | east 1/2 | NS | Med. | contains small mine shaft | sample surface soils, inspect shaft |
| Caselton | 20740 | | NS | Low | native soil | |
| Cashier | 15233 | | MW/ NS | High | contains mine waste | |
| Catskill | 7062 | | MW/NS/TP | High | contains mine waste & tailings | |
| Cerebus | 19665 | | NS | Low | native soil | |
| Chestnut | 435 | | MW/NS | High | contains mine waste | |
| Clen Campbell | 1807 | north 1/4 | MW/NS | High | contains mine waste | |
| | | south 3/4 | NS | Low | native soil, up grad. from mine waste | |
| Cobbler | 5274 | | NS | Low | native soil | |
| Columbia Millsi | 365B | | S/MW/NS | High | slag, mine waste | |
| Confidence | 1447 | | NS | Low | native soil | |
| Contact | 6895 | | NS | Low | native soil | |
| Contention No. | 7565 | | NS | Low | native soil | |

TABLE 3 ENVIRONMENTAL HAZARD RANKING OF MINING CLAIMS IN STUDY AREA

| Claim | M.S. | Fraction* | Map Unit Sampl | Risk | Comments | Pre-acquisition Recommendations |
|---|---|---|---|---|---|---|
| Cornucopia | 11667 | | NS | Low | native soil | |
| Crebec | 6130 | NW 1/4 | NS | Med. | contains small waste dump | sample dump |
| | | SE 3/4 | NS | Low | native soil | |
| Cross | 940 | | NS | Low | native soil | |
| Crown Point | 7365 | | NS | Low | native soil | |
| D. And B.B. | 8539 | | NS | Low | native soil | |
| Dayton | 2540 | | NS | Low | native soil | |
| Dayton No.2 | 11636 | | NS | Low | native soil | |
| Denver | 7601 | west 2/3 | NS/MW/ RS-10 | High | mine waste tailings, 160 mg/kg Pb in NS | |
| | | east 1/3 | NS | Low | native soil, up grad. from mine waste | |
| Devide | 20568 | | NS | Low | native soil | |
| Dude | 7049 | | NS | Low | native soil | |
| Dudess | 7049 | | NS | Low | native soil | |
| E.R.G. | 7013 | | NS | Low | native soil | |
| Eclipse | 7269 | | NS | Med. | close proximity to mine waste | sample surface soils |
| Eighty-Eight | 7348 | | NS | Low | native soil | |
| Ella D. | 5659 | | MW/NS | High | contains mine waste | |
| Elliott | 1536A | | NS | Med. | proximity to slag and mine waste | |
| Elliott Millsite | 1536B | | TI | High | contains tailings impoundment | |
| Enterprise | 5916 | west 1/3 | MW/NS | High | contains mine waste | |
| | | east 2/3 | NS | Low | native soil, up grad. from mine waste | |
| Ethlena | 6136 | north 1/2 | NS | Med. | close to mine waste, small mine shaft | sample surface soils, inspect shaft |
| | | south 1/2 | MW/NS | High | contains mine waste | |
| Eureka | 1880 | north 1/3 | NS | Med. | contains small adit | sample surface soils, inspect adit |

TABLE 3 ENVIRONMENTAL HAZARD RANKING OF MINING CLAIMS IN STUDY AREA

| Claim | M.S. | Fraction* | Map Unit Sampl | Risk | Comments | Pre-acquisition Recommendations |
|---|---|---|---|---|---|---|
| | | south 2/3 | NS | Low | native soil | |
| Eureka | 6285 | | NS | Low | native soil | |
| Evening Call | 8029 | | NS | Low | native soil | |
| Evening Star | 7565 | | NS | Low | native soil | |
| Excelsior | 1451A | | NS | Low | native soil | |
| Excelsior Millsit | 1451B | | NS | Low | native soil | |
| Excelsior | 8141 | | NS | Low | native soil | |
| Excelsior No.2 | 8141 | | NS | Low | native soil | |
| Exchequer | 5132 | | MW/NS | High | contains mine waste | |
| Falcon | 2151 | west 2/3 | NS | Med. | close to mine waste, small adit | sample surface soils, inspect adit, survey claim |
| | | east 1/3 | NS | Low | native soil | |
| Florence | 1452A | | NS | Low | native soil | |
| Fraction | 11814 | | NS/AH | Low | avalanche hazard area | |
| Franklin | 564 | center | NS | Med. | close proximity to mine waste | survey claim, sample surface soils |
| | | west 1/3,ea | MW | High | contains mine waste | |
| G.L.P. | 8017 | | NS | Low | native soil | |
| Gem of Beauty | 7164 | | NS | Low | native soil | |
| Gen. Logan | 2476 | | MW/NS | High | contains mine waste | |
| Gen. O.O How | 2478 | | NS | Low | native soil | |
| Gen. Sheridan | 2479 | west 1/3 | MW/NS | High | contains mine waste | |
| | | east 2/3 | NS | Low | native soil, up grad. from mine waste | |
| Gen. Sherman | 2477 | | MW/NS | High | contains mine waste | |
| Gertie | 781 | | MW/NS | High | contains small mine waste dump | |
| Gipsy | 2499 | | MW/NS | High | contains mine waste | |

TABLE 3 ENVIRONMENTAL HAZARD RANKING OF MINING CLAIMS IN STUDY AREA

| Claim | M.S. | Fraction* | Map Unit | Sampl | Risk | Comments | Pre-acquisition Recommendations |
|---|---|---|---|---|---|---|---|
| Golden Age | 5956 | | NS | | Med. | close proximity to mine waste | |
| Golden Fleece | 2261 | west 1/3 | MW/NS | | High | contains mine waste | |
| | | east 2/3 | AH/NS | | Low | avalanche hazard area | |
| Goliath | 19665 | | NS | | Low | native soil | |
| Grand View | 383 | NW 1/2 | NS | | Low | native soil | |
| | | SE 1/2 | NS | | Med. | contains small adit | sample surface soils, inspect adit |
| Group Millsite | 11583B | | NS/MW | | High | may contain mine waste | survey claim, sample surface soils |
| H.B. | 7013 | | NS | | Low | native soil | |
| Hal Pointer | 8017 | | NS | | Low | native soil | |
| Half Loaf | 8017 | | NS | | Low | native soil | |
| Hardscrabble | 8070 | | MW/NS | | High | contains mine waste | |
| Harvey | 914 | east 1/3 | MW/NS | | High | contains mine waste | |
| | | west 2/3 | NS | | Med. | native soil, up grad. from mine waste | |
| Hiawatha | 6393 | | NS | | Low | native soil | |
| Highland Chief | 8017 | | NS | | Low | native soil | |
| Hillside | 7994 | | NS | Hillsid | High | native soil, mine waste on road, 2800 mg/kg Pb | |
| Hillside No.2 | 7994 | | NS | Hillsid | High | native soil, mine waste on road, 9100 mg/kg Pb | |
| Home | 8031 | | NS | Home | Low | native soil, 300 mg/kg Pb | |
| Homestake & | 410 | | TI/S/MW | RS-13 | High | contains tailings, slag, and mine waste, 4800 mg/kg Pb | |
| Honduras | 7843 | | NS | | Low | native soil | |
| Hope | 939 | | NS | | Low | native soil | |
| Humbolt | 15233 | north 1/2 | NS | | Med. | close proximity to mine waste | sample surface soils |
| | | south 1/2 | MW/NS | | High | contains mine waste | |
| Independent | 7601 | north 1/4 | MW/NS | | High | contains mine waste | |

TABLE 3 ENVIRONMENTAL HAZARD RANKING OF MINING CLAIMS IN STUDY AREA

| Claim | M.S. | Fraction* | Map Unit | Sampl | Risk | Comments | Pre-acquisition Recommendations |
|---|---|---|---|---|---|---|---|
| | | south 3/4 | NS | | Low | native soil, up grad. from mine waste | |
| Ingersol | 413 | east 1/4 | MW/NS | | High | contains mine waste | |
| | | west 3/4 | NS | | Low | native soil, up grad. from mine waste | |
| Iron Clad | 1428 | | MW/NS | | High | contains mine waste | |
| Iron Rod | 8140 | | NS | | Low | native soil | |
| Isabelle | 2039 | | AH/NS | | Low | avalanche hazard area | |
| James Blaine | 15233 | south 1/2 | MW/NS | | High | contains mine waste | |
| | | north 1/2 | NS | | Med. | close proximity to mine waste | sample surface soils |
| Kearney | 5133 | NW 1/4 | MW/NS | | High | contains mine waste | |
| | | SE 1/4 | MW/NS | | High | contains mine waste | |
| | | center | NS | RS-08 | Med. | close proximity to mine waste, 140 mg/kg Pb | |
| Kitchen | 5917 | | MW/NS/AH | | High | contains mine waste, avalanche hazard | |
| Last Chance | 20388 | | NS | | Med. | may contain small shaft | survey claim and sample surface s |
| Last Chance | 6512 | | NS | | Med. | close proximity to mine waste | survey claim and sample surface s |
| Last Chance | 8622 | | MW/NS | | High | contains mine waste | |
| Laura | 5913 | south 1/2 | AH/MW | RP-01 | High | avalanche hazard, mine shaft, 8500 mg/Kg Pb | |
| | | north 1/2 | NS | | Low | native soil | |
| Leap Year | 6105 | north 2/3 | NS | | Low | native soil | |
| | | south 1/3 | NS | | Med. | close proximity to mine waste | sample soils |
| Lelia Davis | 1256 | | NS | | Low | native soil | |
| Little Bernard | 6406 | | NS | | Low | native soil | |
| Little Carrie | 6960 | | NS | | Low | near avalanche hazard area | |
| Little Casper | 19665 | | NS | | Low | native soil | |
| Little George | 8017 | | NS | | Low | native soil | |
| Little George | 8017 | | NS | | Low | native soil | |

TABLE 3 ENVIRONMENTAL HAZARD RANKING OF MINING CLAIMS IN STUDY AREA

| Claim | M.S. | Fraction* | Map Unit | Sampl | Risk | Comments | Pre-acquisition Recommendations |
|---|---|---|---|---|---|---|---|
| Ext. | | | | | | | |
| Little J. Horner | 20740 | | NS | | Med. | native soil, possible mine waste on sample soils, survey W. side | |
| Little Johnny | 10122 | | NS | | Low | native soil | |
| Little Lulu | 8017 | | NS | | Low | native soil | |
| Little Maggie | 8070 | | NS | | Low | native soil | |
| Lone Tree | 12303 | | AH | | Low | avalanche hazard area | |
| Lookout | 1683 | north 1/3 | MW/NS | | High | contains mine waste | |
| | | south 2/3 | NS | | Low | native soil, up grad. from mine waste | |
| Lota | 6154 | | NS/MW | | High | mine waste | |
| Lottie | 8223 | | NS | | Low | native soil | |
| Lowland Chief | 8017 | | NS | | Low | native soil | |
| Lucy | 1456 | | NS | | Low | native soil | |
| Maid of Aust. | 1587 | | NS | | Low | native soil | |
| Major | 384 | SE 1/2 | NS | | Med. | contains small adit | sample surface soils, inspect adit |
| | | NW 1/2 | NS | | Low | native soil | |
| Mammoth | 20500 | | MW/NS | | High | contains mine waste | |
| Mariquita | 1450 | | NS | | Low | native soil | |
| Martha | 20619 | | MW | | High | contains mine waste and former acid plant | |
| Mary | 6205 | north 1/2 | MW/NS | | High | contains mine waste | |
| | | south 1/2 | NS | | Low | native soil, up grad. from mine waste | |
| McIntire | 12302 | | NS | | Low | close to avalanche hazard area | |
| Merrimac | 962 | | NS | | Low | native soil | |
| Mervin | 20619 | east of river | WL | | High | wetlands and former acid plant | |
| | | west of rive | WL/NS | RS-06 | Low | native soils & wetlands, 90 mg/kg Pb | |

TABLE 3 ENVIRONMENTAL HAZARD RANKING OF MINING CLAIMS IN STUDY AREA

| Claim | M.S. | Fraction* | Map Unit Sampl | Risk | Comments | Pre-acquisition Recommendations |
|---|---|---|---|---|---|---|
| Millie | 7988 | north 1/2 | MW/NS | High | contains mine waste | |
| | | south 1/2 | NS | Low | native soil, up grad. from mine waste | |
| Monarch | 20387 | | MW/NS | High | contains mine waste | |
| Mountain Boy | 20387 | | NS | Low | native soil | |
| Mtn. Monarch | 1454 | | NS | Low | native soil | |
| Mtn. Spring | 6129 | | MW/NS | High | contains mine waste | |
| Nancy Hanks | 8017 | | NS | Low | native soil | |
| N.A. Cowdrey | 6317 | west 3/4 | NS | Low | native soil | |
| | | east 1/4 | NS | High | may contain mine waste | survey claim |
| New Discovery | 1461A | west 3/4 | NS | Low | native soil | |
| | | east 1/4 | NS | Med. | contains small mine waste dump | sample dump |
| New Year | 1538 | west 2/3 | MW | High | contains mine waste | |
| | | east 1/3 | AH/NS | Low | avalanche hazard area | |
| Night Watch | 5976 | | NS | Low | near avalanche hazard area | |
| Nora Lilly | 1010 | NE 1/2 | MW/NS | High | contains mine waste | |
| | | SW 1/2 | NS | Med. | close proximity to mine waste | sample soils |
| Ontario | 5923 | | AH/MW | High | avalanche hazard area, mine waste | |
| Pasadena | 6434 | | NS | Low | native soil | |
| Paymaster | 997 | north 1/2 | MW/NS | High | contains small mine waste dump | sample waste dump |
| | | south 1/2 | NS | Low | native soil | |
| Pelican | 363 | | MW, NS | High | contains mine waste | |
| Peru | 1455 | | NS | Low | native soil | |
| Pewer Dollar | 8098 | | NS | Low | native soil | |
| Phoenix | 362 | | MW/NS | High | contains mine waste | |
| Pigeon | 665 | | MW/NS | High | contains mine waste | |

TABLE 3 ENVIRONMENTAL HAZARD RANKING OF MINING CLAIMS IN STUDY AREA

| Claim | M.S. | Fraction* | Map Unit | Sampl | Risk | Comments | Pre-acquisition Recommendations |
|---|---|---|---|---|---|---|---|
| Pittsburgh | 941 | | NS | | Low | native soil | |
| Pluto | 8985 | | NS | | Low | native soil | |
| Premier | 5132 | south 3/4 | NS | | Low | native soil | |
| | | north 1/4 | NS | | Med. | contains small adit | sample soils, inspect adit |
| Princeton | 2258 | | MW | | High | mine waste | |
| Pro Patria No.1 | unkno | SE 1/4 | AH | | Low | avalanche hazard area | |
| | | NW 1/4 | NS | | Low | near avalanche hazard area | |
| Pro Patria No.7 | unkno | SE 1/2 | AH | | Low | avalanche hazard area | |
| | | NW 1/2 | NS | | Low | near avalanche hazard area | |
| Redeemer | 12304 | | NS | | Low | native soil | |
| Robber State | 1464 | | NS | | Low | native soil | |
| Roger Tighbor | 7784 | | NS | | Med. | close proximity to mine waste | sample surface soils |
| Royal Turk | 8020 | | NS | | Low | native soil | |
| S.M.G. | 7986 | | NS | | Low | native soil | |
| Sam Patch | 8031 | | NS | S. Pat | High | native soil, mine waste & fill, 12,000 mg/kg Pb | |
| Santa Clara | 664 | east 1/2 | NS | | Low | native soil | |
| | | west 1/2 | NS | | High | mine waste | |
| Santa Cruz | 6132 | east 1/4 | NS | | Low | native soil | |
| | | west 3/4 | NS | | Med. | close proximity to mine waste | sample surface soils |
| Selenide | 7459 | | NS | | Med. | close proximity to mine waste | sample surface soils, survey |
| Shamrock | 5832 | east 1/4 | MW/NS | RP-04 | High | contains mine waste, 4.3 mg/L TCLP-Pb, 0.66 mg/L TCLP-Cd | |
| | | west 3/4 | NS | | Low | native soil, up grad. from mine waste | |
| Shehocton | 8017 | | NS | | Low | native soil | |
| Silver Age | 5831 | west 2/3 | NS | | Med. | contains small mine workings | sample surface soils, inspect worki |

TABLE 3 ENVIRONMENTAL HAZARD RANKING OF MINING CLAIMS IN STUDY AREA

| Claim | M.S. | Fraction* | Map Unit | Sampl | Risk | Comments | Pre-acquisition Recommendations |
|---|---|---|---|---|---|---|---|
| | | east 1/3 | AH | | Low | avalanche hazard area | |
| Silver Belt | 8020 | | NS | | Low | native soil | |
| Silver Cache | 1655 | | NS | | Low | native soil | |
| Silver Glance | 6201 | | MW/NS | | High | contains mine waste | |
| Silver Gl. No.2 | 6201 | west 1/2 | MW/NS | | High | contains mine waste | |
| | | east 1/2 | NS | | Med. | native soil, up grad. from mine waste | |
| Silver Gl. No.4 | 7976 | | NS | | Med. | native soil, downgrad. from mine waste | |
| Skeptical No.1 | 1900 | south 1/3 | NS | | Low | native soil | |
| | | north 2/3 | AH/NS | | Med. | avalanche hazard and small shaft | |
| Slide | 20740 | | NS | | Low | native soil | |
| Slide-Top | 20740 | | NS | | Low | native soil | |
| Smuggler | 5912 | | NS | Smug-gler | High | native soil, mine waste on road, 420 mg/kg Pb | |
| Snowflake | 5909 | | NS | | Low | native soil | |
| Snow Flake | 6216 | east 1/4 | MW/NS | | High | contains mine waste | |
| | | west 3/4 | NS | | Med. | native soil, up grad. from mine waste | |
| South Park | 1563 | | NS/MW | | High | native soil | mine waste on e. and w. ends |
| Stanley No.1 | 6095 | east 1/3 | AH | | Low | avalanche hazard area | |
| | | west 2/3 | NS | | Low | near avalanche hazard area | |
| Stanley No.2 | 6095 | | NS | | Low | native soil | |
| Stanley No.3 | 6095 | | NS | | Low | native soil | |
| Star | 6199 | | NS | | Low | native soil | |
| Star Route | 5970 | | NS | | Low | native soil | |
| Stephanite | 7980 | | NS | | Low | native soil | |
| Stony Point | 1489 | | NS | | Low | native soil | |

TABLE 3 ENVIRONMENTAL HAZARD RANKING OF MINING CLAIMS IN STUDY AREA

| Claim | M.S. | Fraction* | Map Unit | Sampl | Risk | Comments | Pre-acquisition Recommendations |
|---|---|---|---|---|---|---|---|
| Sun Up | 5910 | | AH/MW/NS | | High | avalanche hazard, mine waste | |
| Syndicate | 2185A | north 1/4 | MW/NS | | High | contains mine waste | |
| Telegraph | 780 | | NS | | Low | native soil | |
| Thompson | 6394 | | MW/NS | | High | contains mine waste | |
| Timberline | 20740 | | NS | | Low | native soil | |
| Tip Top | 1248 | | NS | | Low | native soil | |
| Tom Thumb | 20740 | | NS | | Low | native soil | |
| Town of Rico Tract | | | NS | | Low | native soil | |
| Trails End | 20568 | | NS | | Low | native soil | |
| Triangle | 20347 | west 1/3 | MW/NS | | High | contains mine waste | |
| | | east 2/3 | NS | | Med. | native soil, up grad. from mine was sample soil | |
| Tunnelsite | | | NS | | Low | native soil | |
| Uncle Ned | 915 | | MW/NS | | High | contains mine waste | |
| Undine | 1090 | | NS/MW | | High | mine waste, small adit | sample surface soils, inspect adit |
| Vestal | 6252 | west 1/2 | MW/NS | | High | contains mine waste | |
| | | east 1/2 | NS | | Low | native soil, up grad. from mine waste | |
| Wabash | 617 | south 1/2 | MW/NS | | High | contains mine waste | |
| | | north 1/2 | NS | | Med. | native soil, close proximity to mine | sample soils |
| Wellington | | | NS | | Med. | close proximity to mine waste | sample soils, survey claim |
| W.L. Stevens | 7017 | west 1/2 | MW/NS | | High | contains mine waste | |
| | | east 1/2 | NS | | Med. | close proximity to mine waste | sample soils |
| Worlds Fair | 15233 | | MW/NS | | High | contains mine waste | |
| X-Ray | 19665 | | NS | | Low | native soil | |
| Yankee Boy | 6969 | | NS | Y. Boy | High | native soil, trench & road with mine waste, 6,500 mg/kg Pb | |
| Yellow Jacket | 364 | west 1/2 | MW/NS | | High | contains mine waste | |

TABLE 3 ENVIRONMENTAL HAZARD RANKING OF MINING CLAIMS IN STUDY AREA

| Claim | M.S. | Fraction* | Map Unit Sampl | Risk | Comments | Pre-acquisition Recommendations |
|---|---|---|---|---|---|---|
| | | east 1/2 | NS | Med. | close proximity to mine waste | sample surface soils |
| Zona K. | 8228 | | NS | Med. | close proximity to mine waste | sample surface soils |
| Zulu | 1452A | | NS | Low | native soil | |

* fractions of claims are estimated

TABLE 3 ENVIRONMENTAL HAZARD RANKING OF RICO CITY BLOCKS AND TRACTS

| Block/Track | Lot | Map Unit | Risk | Sample | Comments | Pre-acquisition Recommendations |
|---|---|---|---|---|---|---|
| Block 1 | 3-6 | BC | Medium* | | adjacent to LUST property and elevated Pb fill | evaluate LUST property, conduct asbestos survey, dispose of chemicals |
| Block 1 | 17-20 | F | High | RS-18 | fill material of unknown origin | 830-1400 mg/kg Pb |
| Block 1 | 39-40 | F/MW | High | RS-02 | contains mine waste, 230-1500 mg/kg Pb | determine remediation options |
| Block 1 | 36-38 | F/MW | High | T-03 | contains mine waste, 21 mg/kg TCLP Pb | determine remediation options |
| Block 2 | 9-12 | F | High | RS-16 | fill material of unknown origin, 650-750 mg/kg Pb | |
| Block 4 | 39, 40 | NS | Low | | native soil | |
| Block 6 | 39, 40 | F | Unknown | RS-14 | fill material of unknown origin | sample not analyzed at client's request |
| Block 10 | 1-40 | NS | Low | BK 10 | native soil, 190 mg/kg Pb | |
| Block 11 | 2-4 | NS | Low | | native soil | |
| Block 11 | 11-29 | NS | Low | BK 11 | native soil, 62 mg/kg Pb | |
| Block 11 | 32-34 | road | Low | | road | |
| Block 12 | 23-26 | F | High | | fill material of unknown origin | sample soils |
| Block 13 | 12-16 | LUST | High* | DOT 1,2,3 | 610 mg/kg TVH | dispose of drummed waste |
| Block 14 | 21-28 | F | Medium* | | former assay office | dispose of chemical wastes, sample surficial fill material |
| Block 14 | 31-40 | F | Medium | RS-04 | low metal conc., Cd slightly elevated | |
| Block 19 | 1-3 | NS | Low | | native soil | |
| Block 19 | 7-9 | DA | Medium | | adjacent to elevated Pb sites | sample soils |
| Block 19 | 11-20 | DA/DS | High | RS-22 | disturbed soil, 2000 mg/kg Pb | |
| Block 19 | 21-25 | AI/MW | High | | contains mine waste material | |
| Block 19 | 30-35 | DA | High | RS-23 | disturbed soil, 800 mg/kg Pb | |
| Block 19 | 36-40 | WL | Medium | | adjacent to elevated Pb sites | delineate wetlands, sample soils |

TABLE 3 ENVIRONMENTAL HAZARD RANKING OF RICO CITY BLOCKS AND TRACTS

| Block/Track | Lot | Map Unit | Risk | Sample | Comments | Pre-acquisition Recommendations |
|---|---|---|---|---|---|---|
| Block 20 | SE | MW | High | RP-03 | former Atlantic Cable Mine site, 7000 mg/kg Pb | |
| Block 20 | 21-40 | DS/MW | High | RS-21 | disturbed soil, 3400 mg/kg Pb | |
| Block 21 | 1 | F/MW | High | RS-15 | contains mine waste, 3900 mg/kg Pb | |
| Block 21 | 4 | NS | Medium | | native soil adjacent to elevated Pb site | sample soils |
| Block 24 | 21-30 | MW | High | | contains mine waste | |
| E. of Block 24 | | NS | High | | contains debris, close to mine waste | sample soils |
| Block 25 | 1-14 | Al/MW | High | RS-28 | contains mine waste, 3500 mg/kg Pb | |
| Block 25 | 15-28,35-40 | WL | Medium | | adjacent to elevated Pb sites | sample soils |
| Block 25 | 29-34 | MW | High | | mine waste | |
| Block 28 | 1-20 | F/DS/MW | High | | contains mine waste, 1000 mg/kg Pb | |
| Block 29 | 1-5 | NS | Low | | native soil | |
| Block 38 | 21-40 | NS | Low | BK 38 | native soil, 84 mg/kg Pb | |
| Block 39 | 1-20,28-40 | NS | Low | BK 39 | native soil, 96 mg/kg Pb | |
| Block 39 | 21-27 | L | Medium | | former town dump | |
| AE Arms Tract N. | (west 1/2) | NS | Medium | | close proximity to high risk | sample soils |
| AE Arms Tract N. | (east 1/2) | WL,MW | High | RS-26 | wetlands, contains mine waste, old landfill debris, 1600 mg/kg Pb | |
| AE Arms Tract | (west 1/3) | NS | Medium | | close proximity to high risk | sample soils |
| AE Arms Tract | (east 2/3) | MW | High | RS-27 | mine waste, elevated Cd,Mn,Ag | |
| AE Arms Tract S. | (west 1/2) | NS | Medium | | close proximity to mine waste | sample soils |
| AE Arms Tract S. | (east 1/2) | WL | Low | | possible wetlands | delineate wetlands |
| Atl. Cable Sub. | 41-44 | NS | Low | RS-05 | native soil, 280 mg/kg Pb | |
| FG Day Tract | (west 1/3) | NS | Medium | | close proximity to mine waste | |
| FG Day Tract | (east 2/3) | MW | High | | mine waste | |
| Graveyard Tr. | | NS | Low | | | |
| Group Tract | | NS | Low | RS-01 | native soil, 100-260 mg/kg Pb | |

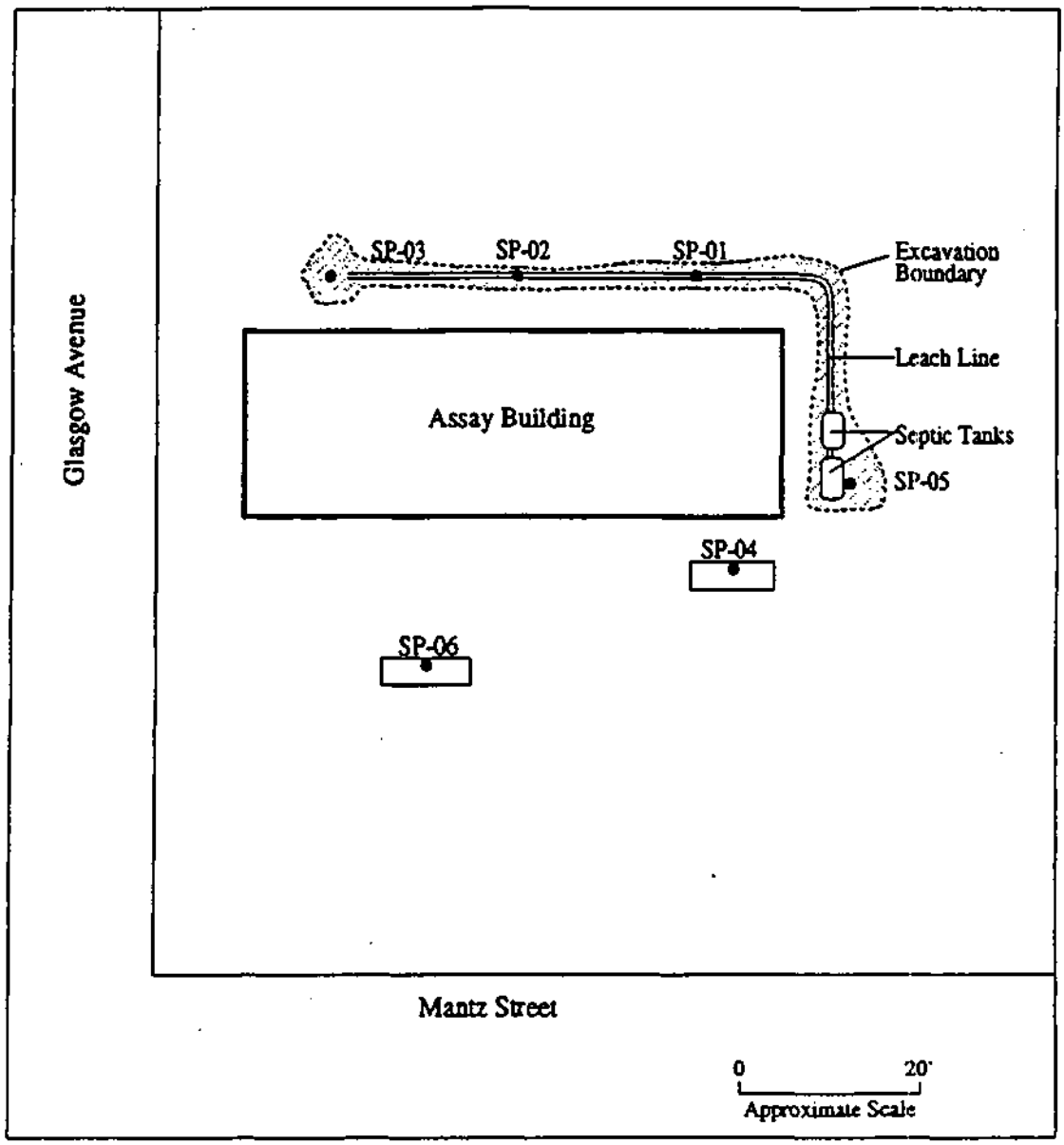
TABLE 3 ENVIRONMENTAL HAZARD RANKING OF RICO CITY BLOCKS AND TRACTS

| Block/Track | Lot | Map Unit | Risk | Sample | Comments | Pre-acquisition Recommendations |
|---|---|---|---|---|---|---|
| Little ADA Tr. S. | | NS | Low | | native soil | |
| Little ADA Tr. N. | | NS | Low | Ada N | native soil, 77 mg/kg Pb | |
| Max Boehmer Tr. | (west 3/4) | NS | Low | | native soil | |
| Max Boehmer Tr. | (east 1/4) | WL | Low | | possible wetlands | delineate wetlands |
| Pasadena Red. T. | (west 1/3) | WL | Low | | possible wetlands | delineate wetlands |
| Pasadena Red. T. | (east 2/3) | NS | Medium | | proximity to high risk | sample soils |
| Rico Smelting Tr. | (west 1/2) | WL,C/MW | High | | wetlands and clinker with mine waste | sample soils |
| Rico Smelting Tr. | (east 1/2) | NS | Medium | | proximity to high risk | sample soils |
| Rico Town Dump | | L | Medium | T-01,2 | former landfill | |
| Roys Tract | (west 1/2) | WL/DA | High | RS-20 | possible wetlands, contains fill 2000 mg/kg Pb | |
| Roys Tract | (east 1/2) | C/F/A/Al/T | High | RS-25 | contains slag and mine waste, 1200 mg/kg Pb | |
| RGS Tract | (west 1/2) | WL | High | RS-19 | possible wetlands, 12,000 mg/kg Pb | |
| RGS Tract | (east 1/2) | TP | High | | tailings impoundment, contaminated stormwater discharge | |
| RGS Y | (west 1/3) | MW | High | | contains mine waste | |
| RGS Y | (east 2/3) | WL | High | | adjacent to tailings & mine waste | sample soils |
| Tremble Tract | | Al/T/C | High | | contains mill tailings, clinker, mine waste | |
| Warner K. Patrick | | NS | High | RS-17 | native soil, 540-9,300 mg/kg Pb | |
| Winkfield Tr. East | | TP/C/MW | High | | mine waste, contaminated water discharge, tailings | |
| Winkfield Tr. West | (west 1/3) | MW | High | | contains mine waste | |
| Winkfield Tr. West | (east 2/3) | WL | Medium | | adjacent to tailings | sample soils |
| Winkfield Tract | (west 1/4) | MW | High | | contains mine waste | |
| Winkfield Tract | (east 3/4) | WL | Medium | | possible wetlands, adjac. to mine waste | sample soils |

* These sites may be reduced to low risk following completion of mitigation measures such as proper removal and disposal of chemicals stored at the buildings, completion of an asbestos survey, and characterization of soil contaminants.

# APPENDIX E

# FIGURES OF STUDY AREA




*Explanation*

SP-06 Soil Sampling Location and Designation

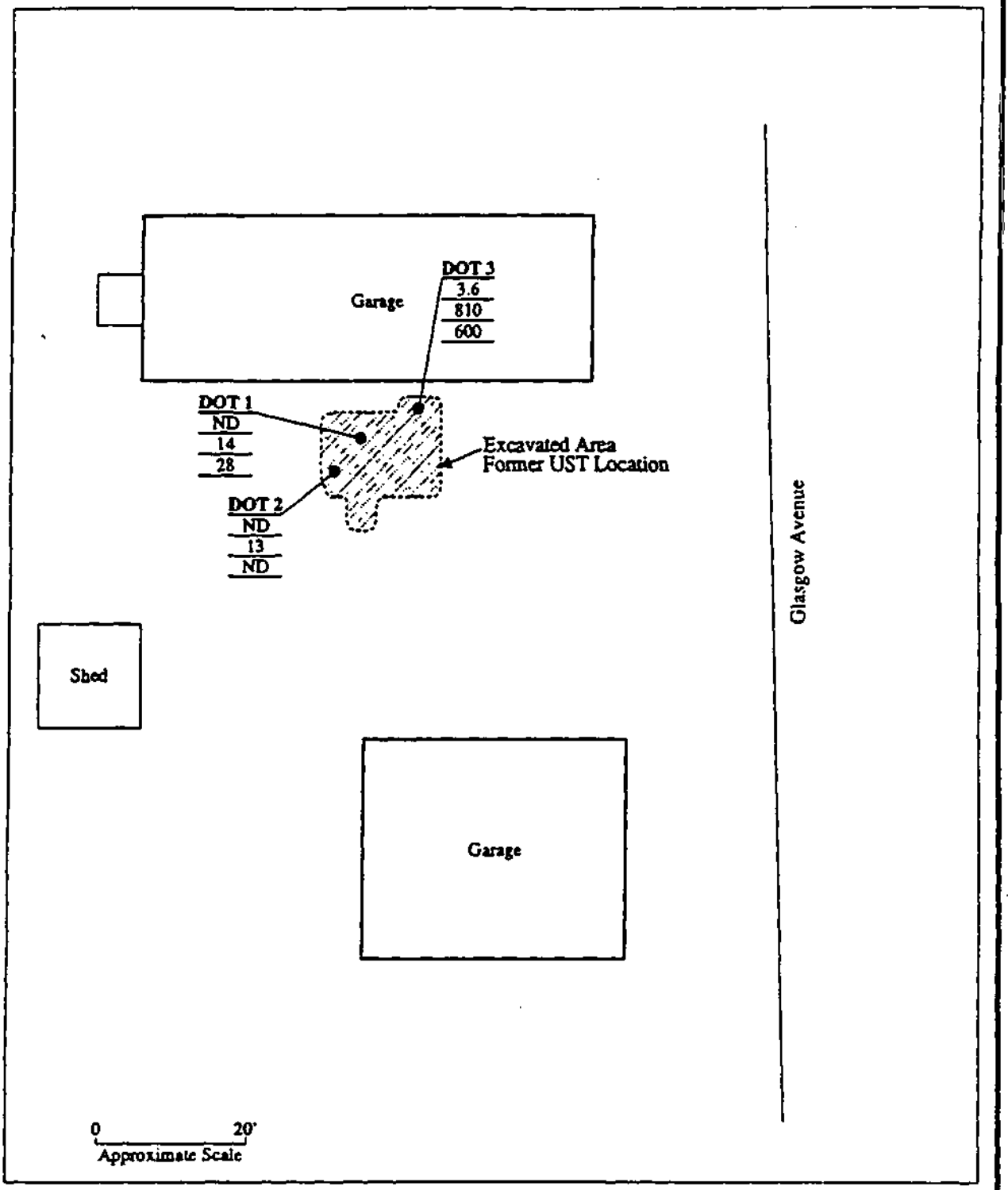
N

Walsh
Environmental Scientists and Engineers, Inc.

Site Map

| Job 1897-020 | Date 8/94 | Figure 5 |
|---|---|---|

1897SMQa.CDR RB 8/31/94




**Explanation**

Soil Sample Location, and Designation
DOT 2
BTEX mg/kg
TVH mg/kg
TEH mg/kg

N

Walsh
Environmental Scientists and Engineers, Inc.

Site Map

| Job 1897-040 | Date 8/94 | Figure 6 |
|---|---|---|

1897sm4a.CDR RB 8/31/94

*PRIVILEGED AND CONFIDENTIAL*

# APPENDIX F

# TABLES OF SAMPLE DESCRIPTIONS AND ANALYTICAL RESULTS

*PRIVILEGED AND CONFIDENTIAL*

## TABLE 4 SOIL SAMPLE DESCRIPTIONS

RS-01: RS-01 was collected in coniferous forest from the Group Tract which is located on the south side of Rico. This sample was a three-point composite sample from 0 to 2 inches depth. The sample consists of native soil (map unit NS) derived from talus and slope wash material.

RS-02: RS-02 was collected from Block 1, lots 39 and 40 located behind Rico Properties. The sample was collected from the upper 4 inches from a 20-inch deep observation hole. From 0 to 20 inches, there was fill material consisting of alluvium, angular rocks containing iron staining (possibly mine waste rock), brick and metal fragments, and some coal and glass fragments. The sample is from map unit F.

RS-03: RS-03 was a three-point composite collected from Block 21, lot 1, which is located just east of the Atlantic Cable mine site. The sample was from 0 to 4 inches depth and consisted of fill material of alluvial cobbles and angular mineralized rocks (possibly mine waste rock). This sample is from map unit F/MW.

RS-04: RS-04 was collected from Block 14, lots 36-40 south of Silver Creek, east of Glasgow Avenue. This sample was a four-point composite from roughly 0 to 7 inches depth. The sample consisted of fill material, rounded to angular cobbles and gravel, and brick and glass fragments (map unit F).

RS-05: RS-05 was collected from the Atlantic Cable Subdivision in lots 41-44, which is located in northeast Rico. This sample was a three-point composite from 0 to 2 inches depth. The sample consisted of native soil (map unit NS) derived from various types of sedimentary rocks.

RS-06: RS-06 was collected north of Rico along the western floodplain of the Dolores River west of the former acid plant. This sample was a three-point composite from 0 to 2 inches depth. The sample consisted of native soil derived from alluvium and stream gravel and may be located in jurisdictional wetlands (map unit WL).

RS-07: RS-07 was collected uphill from the Spill mine (also known as Mountain Springs mine) in an area adjacent to mine workings. This sample was a three-point composite from 0 to 2 inches depth. The sample consisted of native soil (map unit NS) derived from sedimentary and igneous rocks.

RS-08: RS-08 was collected downhill from the Spill mine in an area adjacent to mine workings. This sample was a three-point composite from 0 to 2 inches depth. The sample consisted of native soil (map unit NS) derived from sedimentary and igneous rocks.

RS-09: RS-09 was a three-point composite collected in a drainage down-gradient from the Spill Mine. The drainage is stained red from iron precipitation from the mine site. The sample was from 0 to 2 inches depth and consisted of red-stained alluvial sediments generated by acid mine drainage (map unit AMD).

RS-10: RS-10 was collected in a stand of dead trees on the steep hillside just east of the former acid plant. This sample was a four-point composite from 0 to 2 inches depth and consisted of native soil (map unit NS) derived from talus and slope wash.

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RS-11: RS-11 was a two-point composite collected from Block 4, lot 40 and Block 2, lot 11 near the Rico Hotel. The sample was from 0 to 2 inches depth and consisted of native soil (map unit NS) derived from talus and slope wash.

RS-12: RS-12 was a four-point composite collected from Block 12, within lots 31 and 36 and Block 25, within lots 5 and 11. Blocks 12 and 25 are located on the west side of Rico in the floodplain of the Dolores River. The sample was from 0 to 2 inches depth and consisted of alluvium mixed with mine waste rock (map unit Al/MW).

RS-13: RS-13 was a four-point composite collected from the Homestake claim on the north end of Rico. The sample was from 0 to 2 inches depth and consisted of native material, slag, mine waste rock, and coal (map unit S/MW).

RS-15: RS-15 was a three point composite from 0 to 6 inches depth from Block 21, lot 1.
The sample consisted of fill material (map unit F) mixed with native soil. The fill material contained some mineralized mine waste.

RS-16: RS-16 was collected from Block 2, lots 9-12. The sample was a three point composite from 0 to 8 inches depth. The sample consisted of both fill material and possible some native soil (map unit F).

RS-17: RS-17 was a three point composite from 0 to 2 inches depth collected from the Warner K. Patrick Tract. The sample consisted of native soil (map unit NS).

RS-18: RS-18 was collected from Block 1, lots 16-20. The sample was a three point composite from 0 to 5 inches depth and consisted of fill material and native soil (map unit F). The fill material contained charcoal and glass and porcelain fragments.

RS-19: RS-19 was a four point composite from 0 to 2 inches depth. It was collected from wetlands (map unit WL) along the east side of the Dolores River and west of Block 28.

RS-20: RS-20 was collected from wetlands along the east side of the Dolores River and west of Block 27. The sample was a four point composite from 0 to 2 inches depth and consisted of native soil (map unit WL).

RS-21: RS-21 was collected from Block 20, lots 21-27. The sample was a four point composite from 0 to 2 inches depth and consisted of disturbed native soil (map unit DS).

RS-22: RS-22 was collected from Block 19, lots 13-20. The sample consisted of native soil that has been disturbed by construction activities (map unit DS). The sample was a four point composite from 0 to 2 inches depth.

RS-23: RS-23 was collected from Block 19, lots 7-9 and 29-36. The sample consisted of alluvium disturbed from construction activities (map unit DA) and was a four point composite from 0 to 2 inches depth.

RS-24: RS-24 was collected from disturbed soil (map unit DS) from Block 28, lots 6-20. The sample was a four point composite from 0 to 2 inches depth.

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**RS-25:** RS-25 was collected from the former train depot site. The sample consisted of clinkers and fill material mixed with alluvium (map unit C/F/A). The sample was a four point composite from 0 to 2 inches.

**RS-26:** RS-26 was collected in dump debris (map unit DD) along the Dolores River. The sample was a three point composite from 0 to 6 inches depth.

**RS-27:** RS-27 was collected from wetlands (map unit WL) along the east side of the A.E. Arms Tract. The sample consisted of native soil and was a four point composite from 0 to 2 inches depth.

**RS-28:** RS-28 was collected from Block 25, lots 1-4. This sample consisted of disturbed alluvium and possibly some mine waste (map unit Al/MW). It was a four point composite from 0 to 2 inches depth.

**Smuggler:** This sample was collected from the Smuggler claim in northwest Rico. This sample was a four-point composite from 0 to 2 inches in depth. The sample contained native soil and road base materials.

**Yankee Boy:** This sample was collected from the Yankee Boy claim in northwest Rico. This sample was a four-point composite from 0 to 2 inches. This sample contained native soil and sediment from a trench.

**Hillside #2:** This sample was collected from the Hillside #2 claim in northwest Rico. This sample was a five-point composite from 0 to 2 inches. This sample contained native soil and road base material.

**Hillside:** This sample was collected from the Hillside claim in northwest Rico. This sample was a four-point composite from 0 to 2 inches. This sample contained native soil and road base material.

**Home:** This sample was collected from the Home claim in west Rico. This sample was a five-point composite from 0 to 2 inches. This sample contained native soil and road base material.

**Sam Patch:** This sample was collected from the Sam Patch claim in west Rico. This sample was a four-point composite from 0 to 2 inches. The sample contained fill and mine waste from the east part of the claim.

**Ada North:** This sample was collected from the Little Ada Tract North in south Rico. This sample was a four-point composite from 0 to 2 inches. The sample contained native soil.

**Group:** This sample was collected from the Group tract in south Rico. This sample was a six-point composite from 0 to 2 inches. The sample contained native soil, including soil from the area downgradient of the Apex claim mine waste pile.

**BK10:** This sample was collected from Block 10 in south Rico. This sample was a three-point composite from 0 to 2 inches. The sample contained native soil.

**BK11:** This sample was collected from Block 11 in south Rico. This sample was a three-point composite from 0-2 inches. The sample contained native soil.

**BK38:** This sample was collected from Block 38 in south Rico. This sample was a three-point composite from 0-2 inches. The sample contained native soil.

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BK39: This sample was collected from Block 39 in south Rico. This sample was a six-point composite from 0-2 inches. The sample contained native soil.

Lots 17-20: This sample was collected from Lots 17-20, Block 1 in Rico. This sample was a six-point composite from 0-2 inches. The sample contained fill material.

School lots: This sample was collected from Lots 9-12, Block 2 in Rico. This sample was a five-point composite from 0-2 inches. The sample contained fill material.

Patrick: This sample was collected from the Warner K. Patrick Tract in northeast Rico. This sample was a three-point composite from 0-2 inches. This sample contained native soil which had some orange staining evident.

RP-01: RP-01 was collected from a mine-waste spoil pile at the Laura Mine site, which is located about 1/2 mile east of Rico. This sample was a three-point composite from 0 to 2 inches depth. The sample contained mineralized (sulfides) waste material (map unit MW).

RP-02: RS-02 was collected from a mine spoil at the Lexington Mine site, which is located on the southeast side of Rico. This sample was a three-point composite from 0 to 2 inches depth. The sample contained mineralized waste material (map unit MW).

RP-03: RP-03 was a three-point composite from Block 20, lots 30 and 31 which is the former Atlantic Cable Mine site. This sample was from 0 to 3 inches and consisted of mineralized (pyrite and sphalerite) rock and soil (map unit MW).

RP-04: PR-04 was collected from a small mine waste dump (map unit MW) on the Shamrock claim. The sample consisted of dump material and was a three point composite from 0 to 6 inches depth.

RA-01: RA-01 was a discrete grab sample collected along Silver Creek down gradient from the Argentine tailings impoundments. The sample was from 0 to 4 inches depth and consisted of alluvium and mine waste (map unit Al/MW).

T-01: T-01 was collected from the former city landfill. The sample was a grab sample from 6 feet depth just above bedrock and consisted of reddish-brown sandy clay loam. Trash debris extended from 1.5 feet below the surface to bedrock.

T-02: T-02 was collected from the former city landfill. The sample was a grab sample from 14 feet below the surface and about one foot below the trash debris. The sample consisted of reddish-brown sandy clay loam. Trash debris extended from 1.5 feet below the surface to 13 feet depth.

T-03: T-03 was collected from Block 1, lots 36-38. The sample was a composite from 0 to 8 feet depth and consisted of fill material and possibly some mine waste material.

Trench 1: This sample was collected from Lot 40, Block 1. The sample was a three-point composite from the east end of a trench excavated to a depth of 3 feet. The sample was of fill material.

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Trench 2: This sample was collected from Lot 40, Block 1. The sample was a three-point composite from the west end of a trench excavated to a depth of 3 feet. The sample was of native soil with small amounts of fill material.

TABLE 5 METAL CONCENTRATIONS IN SOIL SAMPLES

| Sample ID | Location | Depth (in) | Map Unit | Al mg/kg | Sb mg/kg | As mg/kg | Ba mg/kg | Be mg/kg | Cd mg/kg | Cr mg/kg | Co mg/kg | Cu mg/k | Fe mg/kg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RS-01 | Group Tract | 0-2 | NS | 17000 | ND | ND | 110 | ND | ND | 19 | 10 | 27 | 23000 |
| RS-02 | Blk 1, lot 36-40 | 0-4 | F/MW | 15000 | ND | 62 | 170 | ND | 7 | 21 | 7 | 190 | 53000 |
| RS-03* | Blk 21, lot 1 | 0-4 | F/MW | | | | | | | | | | |
| RS-04 | Blk 14, lot 36-40 | 0-7 | F | 16000 | ND | 26 | 140 | ND | 10 | 19 | 10 | 170 | 32000 |
| RS-05 | Atl. Cable Sub. | 0-2 | NS | 19000 | | ND | 150 | ND | 6 | 21 | 8 | 33 | 25000 |
| RS-05B* | Block 6,lot 39,40 | 0-5 | F | | | | | | | | | | |
| RS-06 | W. of acid plant | 0-2 | Al | 10000 | ND | 22 | 150 | ND | 3 | 11 | 9 | 53 | 28000 |
| RS-07* | Spill Mine | 0-2 | NS | | | | | | | | | | |
| RS-08 | Spill Mine | 0-2 | NS | 8600 | ND | ND | 180 | ND | ND | 8 | ND | 21 | 12000 |
| RS-09* | Acid Mine Drain | 0-2 | AMD | | | | | | | | | | |
| RS-10 | E. of acid plant | 0-2 | NS | 18000 | ND | 20 | 130 | ND | 3 | 23 | 10 | 54 | 37000 |
| RS-11* | Block 2 & 4 | 0-2 | NS | | | | | | | | | | |
| RS-12 | Block 12 & 25 | 0-2 | Al/MW | 11000 | ND | 37 | 100 | ND | 19 | 13 | 8 | 330 | 28000 |
| RS-13 | Homestake cl. | 0-2 | S/MW | 18000 | ND | 47 | 210 | ND | 20 | 22 | 11 | 860 | 47000 |
| RS-15 | Block 21, lot 1 | 0-6 | F | 13,000 | ND | 21 | 160 | ND | 57 | 21 | 9 | 500 | 38,000 |
| RS-16 | Block 2, lots 9-12 | 0-8 | F | 15,000 | ND | ND | 210 | ND | 6 | ND | 8 | 84 | 33,000 |
| RS-17 | Warner K. Patrick | 0-2 | NS | 11,000 | ND | ND | 140 | ND | 7 | 14 | 6 | 66 | 25,000 |
| RS-18 | Block 1, lots 16-2 | 0-5 | F | 16,000 | ND | ND | 200 | ND | 13 | 20 | 10 | 110 | 36,000 |
| RS-19 | RGS Tract | 0-2 | WL | 5,600 | ND | 28 | 160 | ND | 23 | 10 | ND | 260 | 24,000 |
| Soils of the Western U.S. | | | | | <1-2.6 | <0.1-97 | 70-500 | <1-15 | 0.01-10 | 3-2000 | 0.05-65 | 2-300 | — |
| Detection Limit | | | | 100 | 20 | 20 | 50 | 2 | 2 | 5 | 5 | 5 | 5 |

ND = not detected at stated Detection Limit  Values in ( ) are milligram/liter TCLP concentrations

* = sample was not submitted for analysis  Regulatory level for TCLP: Pb = 5 mg/L, Cd = 1 mg/L, Ba = 100 mg/L

# = from Bowen, 1979, all others from Schacklette & Boerngen 1984

shaded values exceed normal metal range for soils of the Western U.S., or, for Pb, the level where EPA guidance suggests further study.

TABLE 5 ETAL CONCENTRATIONS IN SOIL SAMPLES
(continued)

| Sample ID | Location | Depth (in) | Map Unit | Pb mg/kg | Mn mg/kg | Hg mg/kg | Mo mg/kg | Ni mg/kg | Se mg/kg | Ag mg/kg | Tl mg/kg | Tl mg/k | V mg/kg | Zn mg/kg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RS-01 | Group Tract | 0-2 | NS | 100 | 1100 | ND | ND | 21 | ND | ND | ND | 330 | 26 | 190 |
| RS-02 | Blk 1, lot 36-40 | 0-4 | F/MW | 1600 | 1100 | 2.5 | ND | 14 | ND | 11 | ND | 220 | 27 | 990 |
| RS-03* | Blk 21, lot 1 | 0-4 | F/MW | | | | | | | | | | | |
| RS-04 | Blk 14, lot 36-40 | 0-7 | F | 160 | 1500 | 0.8 | ND | 18 | ND | 40 | ND | 270 | 26 | 1500 |
| RS-05 | Atl. Cable Sub. | 0-2 | NS | 280 | 1400 | ND | ND | 16 | ND | ND | ND | 450 | 29 | 880 |
| RS-05B* | Block 6,lot 39,40 | 0-5 | F | | | | | | | | | | | |
| RS-06 | W. of acid plant | 0-2 | Al | 90 | 1100 | 1.7 | ND | 14 | ND | ND | ND | 130 | 22 | 200 |
| RS-07* | Spill Mine | 0-2 | NS | | | | | | | | | | | |
| RS-08 | Spill Mine | 0-2 | NS | 140 | 790 | ND | ND | 9 | ND | ND | ND | 140 | 13 | 220 |
| RS-09* | Acid Mine Drain | 0-2 | AMD | | | | | | | | | | | |
| RS-10 | E. of acid plant | 0-2 | NS | 160 | 1100 | ND | ND | 23 | ND | ND | ND | 240 | 26 | 240 |
| RS-11* | Block 2 & 4 | 0-2 | NS | | | | | | | | | | | |
| RS-12 | Block 12 & 25 | 0-2 | Al/MW | 6200 | 1300 | ND | ND | 13 | ND | 13 | ND | 220 | 21 | 2400 |
| RS-13 | Homestake cl. | 0-2 | S/MW | 4800 | 5600 | 0.6 | ND | 20 | ND | 64 | ND | 360 | 56 | 4000 |
| RS-15 | Block 21, lot 1 | 0-6 | F | 3900 | 3,000 | 0.5 | ND | 15 | ND | 16 | ND | 210 | 28 | 1700 |
| RS-16 | Block 2, lots 9-12 | 0-8 | F | 750 | 1800 | 0.4 | ND | 13 | ND | ND | ND | 230 | 31 | 1,300 |
| RS-17 | Warner K. Patrick | 0-2 | NS | 640 | 740 | ND | ND | 10 | ND | ND | ND | 100 | 22 | 750 |
| RS-18 | Block 1, 16-20 | 0-5 | F | 1,400 | 2,400 | 0.5 | ND | 12 | ND | ND | ND | 230 | 31 | 2,400 |
| RS-19 | RGS Tract | 0-2 | WL | 12,000 | 800 | 0.5 | ND | 5 | ND | 21 | ND | 100 | 15 | 3,700 |
| Soils of the Western US | | | | <10-700 | 30-5000 | <0.01-4. | ---- | <5-700 | 0.01-12# | 0.01-8# | 0.02-2. | ---- | 3-500# | 10-2100 |
| Detection Limit | | | | 20 | 5 | 0.2 | 20 | 5 | 20 | 10 | 50 | 5 | 10 | 5 |

ND = not detected at stated Detection Limit  Values in ( ) are milligram/liter TCLP concentrations

* = sample was not submitted for analysis  Regulatory level for TCLP: Pb = 5 mg/L, Cd = 1 mg/L, Ba = 100 mg/L

# = from Bowen, 1979, all others from Schacklette & Boerngen 1984

shaded values exceed metal range for soils of the Western US, or, for Pb, the level where EPA guidance suggests further study.

TABLE 5 METAL CONCENTRATIONS IN SOIL SAMPLES
(continued)

| Sample ID | Location | Depth (in) | Map Unit | Pb mg/kg | Mn mg/kg | Hg mg/kg | Mo mg/kg | Ni mg/kg | Se mg/kg | Ag mg/kg | Tl mg/kg | Ti mg/k | V mg/kg | Zn mg/kg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RS-20 | Roy Tract | 0-2 | WL | 2,000 | 1,600 | 0.8 | ND | 14 | ND | ND | ND | 130 | 29 | 2,400 |
| RS-21 | Block 20, 21-27 | 0-2 | DS | 3,400 | 2,900 | 0.3 | ND | 22 | ND | 19 | ND | 150 | 27 | 5,300 |
| RS-22 | Block 19, 13-20 | 0-2 | DS | 12,000 | 1,500 | 0.6 | ND | 12 | 13 | ND | ND | 120 | 24 | 4,400 |
| RS-23 | Block 19, 7-9 & 2 | 0-2 | DA | 800 | 2,500 | ND | ND | 15 | ND | ND | ND | 190 | 24 | 2,000 |
| RS-24 | Block 28, lots 6-2 | 0-2 | DS | 1,000 | 1,900 | 0.4 | ND | 18 | ND | ND | ND | 170 | 25 | 1,700 |
| RS-25 | Roy Tract | 0-2 | C/F/A | 1,200 | 1,200 | ND | ND | 11 | ND | 12 | ND | 180 | 28 | 1,100 |
| RS-26 | E of A.E. Arms Tra | 0-6 | DD | 1,600 | 13,000 | 0.9 | 23 | 25 | ND | 141 | ND | 280 | 29 | 4,000 |
| RS-27 | E of A.E. Arms | 0-2 | WL | 500 | 12,000 | ND | ND | 17 | ND | 48 | ND | 130 | 22 | 1,500 |
| RS-28 | Block 25, lots 1-4 | 0-2 | DA | 8,600 | 2,000 | 0.3 | ND | 14 | ND | 14 | ND | 170 | 28 | 2,600 |
| Smuggler | Smug. claim | 0-2 | NS/MW | 420 | | | | | | | | | | 460 |
| Y.Boy | Y.Boy claim | 0-2 | NS/MW | 6,500 | | | | | | | | | | 2,100 |
| Hillside #2 | H.side #2 claim | 0-2 | NS/MW | 9,100 | | | | | | | | | | 2,400 |
| Hillside | H.side claim | 0-2 | NS/MW | 2,800 | | | | | | | | | | 4,400 |
| Home | Home claim | 0-2 | NS/MW | 300 | | | | | | | | | | 780 |
| S.Patch | S. Patch claim | 0-2 | F/MW | 12,000 | | | | | | | | | | 2,900 |
| Ada North | L.Ada.N. claim | 0-2 | NS | 77 | | | | | | | | | | 120 |
| Group | Group tract | 0-2 | NS | 260 | | | | | | | | | | 500 |
| Soils of the Western US | | | | <10-700 | 30-5000 | <0.01-4. | ----- | <5-700 | 0.01-12# | 0.01-8# | 0.02-2. | ----- | 3-500# | 10-2100 |
| Detection Limit | | | | 20 | 5 | 0.2 | 20 | 5 | 20 | 10 | 50 | 5 | 10 | 5 |

ND = not detected at stated Detection Limit  Values in ( ) are milligram/liter TCLP concentrations

* = sample was not submitted for analysis  Regulatory level for TCLP: Pb = 5 mg/L, Cd = 1 mg/L, Ba = 100 mg/L

# = from Bowen, 1979, all others from Schacklette & Boerngen 1984

shaded values exceed metal range for soils of the Western US, or, for Pb, the level where EPA guidance suggests further study.

TABLE 3 TAL CONCENTRATIONS IN SOIL SAMPLES
(continued)

| Sample ID | Location | Depth (in) | Map Unit | Al mg/kg | Sb mg/kg | As mg/kg | Ba mg/kg | Be mg/kg | Cd mg/kg | Cr mg/kg | Co mg/kg | Cu mg/k | Fe mg/kg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RS-20 | Roy Tract | 0-2 | WL | 9,800 | ND | 22 | 190 | ND | 17 | 17 | 10 | 330 | 51,000 |
| RS-21 | Block 20, 21-27 | 0-2 | DS | 15,000 | ND | ND | 86 | ND | 38 | 24 | 11 | 240 | 37,000 |
| RS-22 | Block 19, 13-20 | 0-2 | DS | 12,000 | ND | ND | 120 | ND | 33 | 18 | 12 | 200 | 24,000 |
| RS-23 | Block 19, 7-9 & 2 | 0-2 | DA | 11,000 | ND | 29 | 110 | ND | [illegible] | 19 | 9 | 160 | 29,000 |
| RS-24 | Block 28, 6-20 | 0-2 | DS | 11,000 | ND | 30 | 150 | ND | 11 | 18 | 11 | 190 | 38,000 |
| RS-25 | Roy Tract | 0-2 | C/F/A | 7,700 | ND | 40 | 380 | ND | 4 | 15 | 6 | 200 | 63,000 |
| RS-26 | E of A.E. Arms Tra | 0-6 | DD | 15,000 | ND | 27 | 680 | ND | 9 | 37 | 12 | 310 | 61,000 |
| RS-27 | E of A.E. Arms Ta | 0-2 | WL | 9,900 | ND | 25 | 310 | ND | 14 | 15 | 9 | 150 | 26,000 |
| RS-28 | Block 25, lot 1-4 | 0-2 | DA | 13,000 | ND | ND | 130 | ND | 17 | 21 | 10 | 420 | 37,000 |
| Smuggler | Smug. claim | 0-2 | NS | | | 12 | | | 2.2 | | | | |
| Y.Boy | Y.Boy claim | 0-2 | NS | | | 19 | | | 12 | | | | |
| Hillside #2 | H.side #2 claim | 0-2 | NS | | | 24 | | | 16 | | | | |
| Hillside | H.side claim | 0-2 | NS | | | 26 | | | 23 | | | | |
| Home | Home claim | 0-2 | NS | | | 21 | | | 4.6 | | | | |
| S.Patch | S. Patch claim | 0-2 | NS | | | 26 | | | 17 | | | | |
| Ada North | L.Ada.N. claim | 0-2 | NS | | | 9.8 | | | ND | | | | |
| Group | Group tract | 0-2 | NS | | | 13 | | | 2.1 | | | | |
| Soils of the Western US | | | | | <1-2.6 | <0.1-97 | 70-500 | <1-15 | 0.01-10 | 3-2000 | 0.05-65 | 2-300 | --- |
| Detection Limit | | | | 100 | 20 | 20 | 50 | 2 | 2 | 5 | 5 | 5 | 5 |

ND = not detected at stated Detection Limit  Values in ( ) are milligram/liter TCLP concentrations
* = sample was not submitted for analysis  Regulatory level for TCLP: Pb = 5 mg/L, Cd = 1 mg/L, Ba = 100 mg/L
# = from Bowen, 1979, all others from Schacklette & Boerngen 1984

shaded values exceed normal metal range for soils of the Western US, or, for Pb, the level where EPA guidance suggests further study.

TABLE 5 TAL CONCENTRATIONS IN SOIL SAMPLES
(continued)

| Sample ID | Location | Depth (in) | Map Unit | Al mg/kg | Sb mg/kg | As mg/kg | Ba mg/kg | Be mg/kg | Cd mg/kg | Cr mg/kg | Co mg/kg | Cu mg/k | Fe mg/kg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BK10 | Block 10 | 0-2 | NS | | | ND | | | 1.6 | | | | |
| BK11 | Block 11 | 0-2 | NS | | | ND | | | ND | | | | |
| BK38 | Block 38 | 0-2 | NS | | | ND | | | ND | | | | |
| BK39 | Block 39 | 0-2 | NS | | | 14 | | | ND | | | | |
| Lots 17-20 | L.17-20,Blk.1 | 0-2 | F | | | ND | | | 9.5 | | | | |
| Sch.Lots | L.9-12,Blk.2 | 0-2 | F | | | ND | | | 6.6 | | | | |
| Patrick | Warner K. Patrick | 0-2 | NS | | | 10 | | | 2.1 | | | | |
| RA-01 | Silver Ck | 0-4 | Al/MW | 10000 | ND | 50 | 70 | ND | 10 | 10 | 10 | 190 | 44000 |
| RP-01 | Laura Mine | 0-2 | MW | 5800 | ND | 74 | 130 | ND | 60 | 6 | ND | 590 | 56000 |
| RP-02* | Lex. Mine | 0-2 | MW | | | | | | | | | | |
| RP-03 | Atl. Cable Mine | 0-4 | MW | 12000 | ND | 26 | 90 | ND | 84 | 24 | 13 | 570 | 57000 |
| RP-04 | Shamrock | 0-6 | MW | | | (ND) | (1.1) | | (0.66) | (ND) | | | |
| T-01 | Rico town dump | 6 | L | 19,000 | ND | ND | 110 | 2 | ND | 24 | 10 | 9 | 26,000 |
| T-02 | Rico town dump | 14 | L | 10,000 | ND | 36 | 140 | ND | 4 | 16 | 8 | 74 | 24,000 |
| T-03 | Block1 36-38 | 0-8 | F | 12,000 | ND | 49 | 170 | ND | 6 | 25 | 9 | 230 | 47,000 |
| Trench 1 | L.40,Blk.1 | 0-3ft | F/NS | | | ND | | | 6 | | | | |
| Trench 2 | L.40,Blk.1 | 0-3ft | F/NS | | | ND | | | ND | | | | |
| Soils of the Western US | | | | | <1-2.6 | <0.1-97 | 70-500 | <1-15 | 0.01-10 | 3-2000 | 0.05-65 | 2-300 | ---- |
| Detection Limit | | | | 100 | 20 | 20 | 50 | 2 | 2 | 5 | 5 | 5 | 5 |

ND = not detected at stated Detection Limit  Values in ( ) are milligram/liter TCLP concentrations
* = sample was not submitted for analysis  Regulatory level for TCLP: Pb = 5 mg/L, Cd = 1 mg/L, Ba = 100 mg/L
# = from Bowen, 1979, all others from Schacklette & Boerngen 1984

shaded values exceed normal metal range for soils of the Western US, or, for Pb, the level where EPA guidance suggests further study.

TABLE 3 TAL CONCENTRATIONS IN SOIL SAMPLES

(continued)

| Sample ID | Location | Depth (in) | Map Unit | Pb mg/kg | Mn mg/kg | Hg mg/kg | Mo mg/kg | Ni mg/kg | Se mg/kg | Ag mg/kg | Tl mg/kg | Tl mg/k | V mg/kg | Zn mg/kg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BK10 | Block 10 | 0-2 | NS | 190 | | | | | | | | | | 360 |
| BK11 | Block 11 | 0-2 | NS | 62 | | | | | | | | | | 150 |
| BK38 | Block 38 | 0-2 | NS | 84 | | | | | | | | | | 160 |
| BK39 | Block 39 | 0-2 | NS | 96 | | | | | | | | | | 160 |
| Lots 17-20 | L.17-20,Blk.1 | 0-2 | F | 330 | | | | | | | | | | 2,000 |
| Sch.Lots | L.9-12,Blk.2 | 0-2 | F | 650 | | | | | | | | | | 1,500 |
| Patrick | Warner K. Patrick | 0-2 | NS | 1300 | | | | | | | | | | 970 |
| RA-01 | Silver Ck | 0-4 | Al/MW | 180 | 2300 | ND | ND | 15 | ND | ND | ND | 170 | 15 | 1,400 |
| RP-01 | Laura Mine | 0-2 | MW | (8500) | 1200 | 0.4 | 34 | ND | ND | (220) | ND | 43 | 12 | [illegible] |
| RP-02* | Lex. Mine | 0-2 | MW | | | | | | | | | | | |
| RP-03 | Atl. Cable Mine | 0-4 | MW | 7000 | 5000 | 0.4 | ND | 21 | ND | (63) | ND | 150 | 18 | [illegible] |
| RP-04 | Shamrock | 0-6 | MW | (4.3) | | (ND) | | | (ND) | (ND) | | | | |
| T-01 | Rico town dump | 6 | L | 20 | 500 | ND | ND | 24 | ND | ND | ND | 230 | 29 | 65 |
| T-02 | Rico town dump | 14 | L | 380 | 4,300 | ND | ND | 13 | ND | (11) | ND | 200 | 24 | 640 |
| T-03 | Block 1, 36-38 | 0-8 | F | (21) 770 | 1,200 | 0.4 | ND | 16 | ND | (10) | ND | 150 | 28 | 1,300 |
| Trench 1 | L.40,Blk.1 | 0-3ft. | F/NS | 830 | | | | | | | | | | 1400 |
| Trench 2 | L.40,Blk.1 | 0-3ft. | F/NS | 230 | | | | | | | | | | 410 |
| Soils of the Western US | | | | <10-700 | 30-5000 | <0.01-4. | — | <5-700 | 0.01-12# | 0.01-8# | 0.02-2. | — | 3-500# | 10-2100 |
| Detection Limit | | | | 20 | 5 | 0.2 | 20 | 5 | 20 | 10 | 50 | 5 | 10 | 5 |

ND = not detected at stated Detection Limit  Values in ( ) are milligram/liter TCLP concentrations

* = sample was not submitted for analysis  Regulatory level for TCLP: Pb = 5 mg/L, Cd = 1 mg/L, Ba = 100 mg/L

# = from Bowen, 1979, all others from Schackiette & Boerngen 1984

shaded values exceed metal range for soils of the Western US, or, for Pb, the level where EPA guidance suggests further study.

TAB[illegible]6 METAL CONCENTRATIONS IN WATER SAMPLES

| Sample ID | Location | Al (mg/L) | Sb (mg/L) | As (mg/L) | Ba (mg/L) | Be (mg/L) | Cd (mg/L) | Cr (mg/L) | Co (mg/L) | Cu (mg/L) | Fe (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| RW-01 | Silver Ck, below mill | ND | ND | ND | ND | ND | ND | ND | ND | ND | 0.13 |
| RW-02 | Spill Mine | 180 | ND | ND | ND | ND | 0.33 | ND | 0.13 | 12 | 0.39 |
| RW-03 | Dolores R. - Arg. Discharg | 0.2 | ND | ND | ND | ND | ND | ND | ND | ND | 0.34 |
| RW-04 | Dolores R. down grad. | 0.4 | ND | ND | ND | ND | ND | ND | ND | ND | 0.13 |
| RW-05 | Dolores R. up grad. | 0.4 | ND | ND | ND | ND | ND | ND | ND | ND | 0.09 |
| | Dolores River Standard | | | 0.05 | | | 0.0004 | 0.1 | | 0.014 | 1 |
| | Detection Limit | 0.2 | 0.2 | 0.2 | 0.5 | 0.02 | 0.02 | 0.05 | 0.05 | 0.05 | 0.05 |

ND = not detected at stated Detection Limit

| Sample ID | Location | Pb (mg/L) | Mn (mg/L) | Hg (mg/L) | Mo (mg/L) | Ni (mg/L) | Se (mg/L) | Ag (mg/L) | Tl (mg/L) | Tl (mg/L) | V (mg/L) | Zn (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RW-01 | Silver Ck, below mill | ND | 0.11 | ND | ND | ND | ND | ND | ND | ND | ND | 0.22 |
| RW-02 | Spill Mine | ND | 40 | ND | ND | 0.39 | ND | ND | ND | ND | ND | 40 |
| RW-03 | Dolores R. - Arg. Discharg | ND | 0.76 | ND | ND | ND | ND | ND | ND | ND | ND | 0.39 |
| RW-04 | Dolores R. down grad. | ND | 0.06 | ND | ND | ND | ND | ND | ND | ND | ND | 0.08 |
| RW-05 | Dolores R. up grad. | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| | Dolores River Standard | 0.004 | 1 | 5E-05 | | 0.05 | 0.02 | 0.0001 | | | | |
| | Detection Limit | 0.2 | 0.05 | 0.001 | 0.05 | 0.05 | 0.2 | 0.1 | 0.2 | 0.05 | 0.1 | 0.05 |

ND = not detected at stated Detection Limit

## TABLE 7 SAMPLING LOCATIONS - ASSAY BUILDING

| Sample Number | Depth (bgs) | Location |
|---|---|---|
| SP01 | 5' | Leach line 10' west of NEC of building |
| SP02 | 5' | Leach line 30' west of NEC of building |
| SP03 | 8' | Leach line 10' east of NWC of building |
| SP04 | 6' | Test pit downgradient of tanks about 6' |
| SP05 | 7' | South tank on east side, 3' below top of tank |
| SP06 | 5' | Test pit near southwest corner of property |
| C1 | NA | Composite sample from soil stockpile |

TABLE 8 - ASSAY BUILDING METAL CONCENTRATIONS IN SOIL SAMPLES

| Sample No. | Location | Depth (FT) | Al (mg/kg) | Sb (mg/kg) | As (mg/kg) | Ba (mg/kg) | Be (mg/kg) | Cd (mg/kg) | Cr (mg/kg) | Co (mg/kg) | Cu (mg/kg) | Fe (mg/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SP01 | 10' W NEC | 5 | 16000 | ND | ND | 210 | ND | 9 | 20 | 9 | 150 | 24000 |
| SP02 | West Side Mid | 5 | 13000 | ND | 62 | 170 | ND | 13 | 16 | 8 | 190 | 22000 |
| SP03 | NWC Bldg | 8 | 11000 | ND | 22 | 98 | ND | 7 | 16 | 9 | 180 | 37000 |
| SP04 | SEC by tank | 6 | 16000 | ND | 29 | 120 | ND | 5 | 20 | 10 | 40 | 26000 |
| SP05 | Septic tank pit | 7 | 7000 | ND | ND | 71 | ND | 7 | 12 | 6 | 160 | 20000 |
| SP06 | SWC-Backgrnd | 5 | 16000 | ND | ND | 110 | ND | 3 | 22 | 9 | 45 | 23000 |
| | Soils of Western U.S. | | | <1-2.6 | <0.1-97 | 70-5000 | <1-15 | 0.01-10 | 3-2000 | 0.05-65 | 2-300 | |
| | Detection Level | | 200 | 20 | 20 | 50 | 2 | 2 | 5 | 5 | 5 | 200 |

| Sample No. | Location | Depth (FT) | Pb (mg/kg) | Mn (mg/kg) | Hg (mg/kg) | Mo (mg/kg) | Ni (mg/kg) | Se (mg/kg) | Ag (mg/kg) | Tl (mg/kg) | Ti (mg/kg) | V (mg/kg) | Zn (mg/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SP01 | 10' W NEC | 5 | 880 | 2800 | 16 | ND | 15 | ND | 20 | ND | 200 | 27 | 1800 |
| SP02 | West Side Mid | 5 | 1100 | 8500 | 1.4 | 7 | 12 | ND | 45 | ND | 120 | 22 | 2100 |
| SP03 | NWC Bldg | 8 | 1050 | 1500 | ND | ND | 16 | ND | ND | ND | 120 | 23 | 1100 |
| SP04 | SEC by tank | 6 | 760 | 1200 | ND | ND | 14 | ND | ND | ND | 240 | 30 | 1100 |
| SP05 | Septic tank pit | 7 | 1300 | 1200 | ND | ND | 9 | ND | ND | ND | 150 | 19 | 1300 |
| SP06 | SWC-Backgrnd | 5 | 380 | 900 | ND | ND | 16 | ND | ND | ND | 200 | 29 | 630 |
| | Soils of Western U.S. | | <10-700 | 30-5000 | <0.01-4.6 | | <5-700 | 0.01-12# | 0.01-8# | 0.02-2.8 | --- | 3-500# | 10-2100 |
| | Detection Level | | 20 | 5 | 0.5 | 5 | 5 | 20 | 10 | 50 | 5 | 10 | 5 |

ND=not detected at stated Detection Level

# From Bowen, 1979

*PRIVILEGED AND CONFIDENTIAL*

TABLE 9 FORMER HIGHWAY DEPARTMENT PROPERTY TOXICITY CHARACTERISTIC LEACHING PROCEDURE TRACE METAL CONCENTRATIONS

| SAMPLE I.D. | Arsenic | Barium | Cadmium | Chromium | Lead | Mercury | Selenium | Silver |
|---|---|---|---|---|---|---|---|---|
| DOT 1 | ND | 0.8 | 0.08 | ND | ND | ND | ND | ND |
| DOT 2 | ND | 1.2 | 0.05 | ND | ND | ND | ND | ND |
| DOT 3 | ND | 2 | 0.07 | ND | 1.7 | ND | ND | ND |
| Detection Level | 0.2 | 0.5 | 0.05 | 0.05 | 0.5 | 0.02 | .2 | 0.05 |
| Regulatory Level | 5.0 | 100 | 1.0 | 5.0 | 5.0 | 0.2 | 1.0 | 1.0 |

ND = not detected
All units are milligrams per liter

*PRIVILEGED AND CONFIDENTIAL*

**TABLE 10** **FORMER HIGHWAY DEPARTMENT PROPERTY - AROMATIC VOLATILE COMPOUNDS**

| SAMPLE I.D. | Benzene (mg/kg) | Toluene (mg/kg) | Ethyl-benzene (mg/kg) | Total Xylenes (mg/kg) | | TVH (mg/kg) | TEH (mg/kg) |
|---|---|---|---|---|---|---|---|
| | | | | m,p-xylene | o-xylene | | |
| DOT 1 | ND | ND | ND | ND | ND | 14 | 28 |
| DOT 2 | ND | ND | ND | ND | ND | 13 | ND |
| DOT 3 | ND | 1.1 | ND | 1.3 | 1.2 | 810 | 600 |
| Detection Level | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 10 | 5 |

ND = not detected

# APPENDIX G

# LABORATORY ANALYTICAL DATA

*PRIVILEGED AND CONFIDENTIAL*

# SOIL ANALYTICAL DATA

Inter-Mountain Laboratories, Inc.

1160 Research Drive
Bozeman, Montana 59715

# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | T-01 | Date Reported: | 08/29/94 |
| Project ID: | Rico, Colorado | Date Sampled: | 08/09/94 |
| Laboratory ID: | B947383 | Date Received: | 08/13/94 |
| Sample Matrix: | Soil | Date Digested: | 08/24/94 |
| | | Date Analyzed: | 08/25/94 |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 19000 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | ND | 20 | mg/kg |
| Barium | 110 | 50 | mg/kg |
| Beryllium | 2 | 2 | mg/kg |
| Cadmium | ND | 2 | mg/kg |
| Chromium | 24 | 5 | mg/kg |
| Cobalt | 10 | 5 | mg/kg |
| Copper | 9 | 5 | mg/kg |
| Iron | 26000 | 100 | mg/kg |
| Lead | 20 | 20 | mg/kg |
| Manganese | 500 | 100 | mg/kg |
| Mercury | ND | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 24 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | ND | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 230 | 5 | mg/kg |
| Vanadium | 29 | 10 | mg/kg |
| Zinc | 65 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 59000 | 100 | mg/kg |
| Potassium | 3400 | 100 | mg/kg |
| Magnesium | 14000 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 640 | 200 | mg/kg |
| Silicon | 210 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.
Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor
Technique), SW-846, September 1986.

Analyst

Reviewed

Inter-Mountain Laboratories, Inc.

1140 Research Drive
Bozeman, Montana 59715

# EPA METHOD 8240
# HSL VOLATILE COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | T-02 | Date Reported: | 08/29/94 |
| Project ID: | Rico, Colorado | Date Sampled: | 08/10/94 |
| Laboratory ID: | 8947384 | Date Received: | 08/13/94 |
| Sample Matrix: | Soil | Date Extracted: | 08/16/94 |
| | | Date Analyzed: | 08/17/94 |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| 1,1,1-Trichloroethane | ND | 0.2 | mg/kg |
| 1,1,2,2-Tetrachloroethane | ND | 0.2 | mg/kg |
| 1,1,2-Trichloroethane | ND | 0.2 | mg/kg |
| 1,1-Dichloroethane | ND | 0.2 | mg/kg |
| 1,1-Dichloroethene | ND | 0.2 | mg/kg |
| 1,2-Dichloroethane | ND | 0.2 | mg/kg |
| [illegible]-Dichloropropane | ND | 0.2 | mg/kg |
| [illegible]utanone (MEK) | ND | 1 | mg/kg |
| 2-Hexanone | ND | 0.2 | mg/kg |
| 4-Methyl-2-pentanone (MIBK) | ND | 0.2 | mg/kg |
| Acetone | ND | 1 | mg/kg |
| Benzene | ND | 0.2 | mg/kg |
| Bromodichloromethane | ND | 0.2 | mg/kg |
| Bromoform | ND | 0.2 | mg/kg |
| Bromomethane | ND | 0.2 | mg/kg |
| Carbon Disulfide | ND | 0.2 | mg/kg |
| Carbon Tetrachloride | ND | 0.2 | mg/kg |
| Chlorobenzene | ND | 0.2 | mg/kg |
| Chloroethane | ND | 0.2 | mg/kg |
| Chloroform | ND | 0.2 | mg/kg |
| Chloromethane | ND | 0.2 | mg/kg |
| cis-1,3-Dichloropropene | ND | 0.2 | mg/kg |
| Dibromochloromethane | ND | 0.2 | mg/kg |
| Ethylbenzene | ND | 0.2 | mg/kg |
| m,p-Xylene | ND | 0.2 | mg/kg |
| Methylene chloride | ND | 1 | mg/kg |
| o-Xylene | ND | 0.2 | mg/kg |
| Styrene | ND | 0.2 | mg/kg |

Inter-Mountain Laboratories, Inc.

1160 Research Drive
Bozeman, Montana 59715

# EPA METHOD 8240
# HSL VOLATILE COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | T-02 | Date Reported: | 08/29/94 |
| Laboratory ID: | B947384 | Date Sampled: | 08/10/94 |
| Sample Matrix: | Soil | Date Analyzed: | 08/17/94 |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Tetrachloroethene (PCE) | ND | 0.2 | mg/kg |
| Toluene | ND | 0.2 | mg/kg |
| trans-1,2-Dichloroethene | ND | 0.2 | mg/kg |
| trans-1,3-Dichloropropene | ND | 0.2 | mg/kg |
| Trichloroethene (TCE) | ND | 0.2 | mg/kg |
| Vinyl Chloride | ND | 0.2 | mg/kg |

ND - Compound not detected at stated Detection Limit.
J - Meets identification criteria, below Detection Limit.
B - Compound detected in method blank.

Inter-Mountain Laboratories, Inc.

1160 Research Drive
Bozeman, Montana 59715

# EPA METHOD 8240
# TENTATIVELY IDENTIFIED COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | T-02 | Date Reported: | 08/29/94 |
| Laboratory ID: | B947384 | Date Sampled: | 08/10/94 |
| Sample Matrix: | Soil | Date Analyzed: | 08/17/94 |

| Tentative Identification | Retention Time (min) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable levels.

Unknown concentrations calculated assuming a Relative Response Factor = 1.

## QUALITY CONTROL:

| Surrogate Recovery | % | Soil QC Limits |
|---|---|---|
| 1,2-Dichloroethane-d4 | 107 | 70 - 121 |
| Toluene-d8 | 99 | 81 - 117 |
| Bromofluorobenzene | 102 | 74 - 121 |

References:

Method 8240, Gas Chromatography/Mass Spectrometry for Volatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, Third Edition, November 1986.

Analyst

Reviewed

Inter-Mountain Laboratories, Inc.

1160 Research Drive
Bozeman, Montana 59715

# EPA METHOD 8270
## HSL SEMI-VOLATILE COMPOUNDS
## BASE/NEUTRAL/ACID EXTRACTABLES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | T-02 | Date Reported: | 08/30/94 |
| Project ID: | Rico, Colorado | Date Sampled: | 08/10/94 |
| Laboratory ID: | 8947384 | Date Received: | 08/13/94 |
| Sample Matrix: | Soil | Date Extracted: | 08/18/94 |
| | | Date Analyzed: | 08/30/94 |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| 1,2,4-Trichlorobenzene | ND | 1 | mg/kg |
| 1,2-Dichlorobenzene | ND | 1 | mg/kg |
| 1,3-Dichlorobenzene | ND | 1 | mg/kg |
| 1,4-Dichlorobenzene | ND | 1 | mg/kg |
| 2,4,5-Trichlorophenol | ND | 1 | mg/kg |
| 2,4,6-Trichlorophenol | ND | 1 | mg/kg |
| 2,4-Dichlorophenol | ND | 1 | mg/kg |
| [illegible]-Dimethylphenol | ND | 1 | mg/kg |
| 2,4-Dinitrophenol | ND | 5 | mg/kg |
| 2,4-Dinitrotoluene | ND | 1 | mg/kg |
| 2,6-Dinitrotoluene | ND | 1 | mg/kg |
| 2-Chloronaphthalene | ND | 1 | mg/kg |
| 2-Chlorophenol | ND | 1 | mg/kg |
| 2-Methylnaphthalene | ND | 1 | mg/kg |
| 2-Methylphenol | ND | 1 | mg/kg |
| 2-Nitroaniline | ND | 5 | mg/kg |
| 2-Nitrophenol | ND | 1 | mg/kg |
| 3,3'-Dichlorobenzidine | ND | 2 | mg/kg |
| 3-Methylphenol/4-Methylphenol ** | ND | 1 | mg/kg |
| 3-Nitroaniline | ND | 5 | mg/kg |
| 4,6-Dinitro-2-methylphenol | ND | 5 | mg/kg |
| 4-Bromophenyl-phenylether | ND | 1 | mg/kg |
| 4-Chloro-3-methylphenol | ND | 2 | mg/kg |
| 4-Chloroaniline | ND | 2 | mg/kg |
| 4-Chlorophenyl-phenylether | ND | 1 | mg/kg |
| 4-Nitroaniline | ND | 2 | mg/kg |
| 4-Nitrophenol | ND | 5 | mg/kg |
| Acenaphthene | ND | 1 | mg/kg |
| Acenaphthylene | ND | 1 | mg/kg |
| Anthracene | ND | 1 | mg/kg |
| Benzo(a)anthracene | ND | 1 | mg/kg |
| [illegible]o(a)pyrene | ND | 1 | mg/kg |
| [illegible]zo(b)fluoranthene | ND | 1 | mg/kg |
| Benzo(g,h,i)perylene | ND | 1 | mg/kg |
| Benzo(k)fluoranthene | ND | 1 | mg/kg |
| Benzoic Acid | ND | 5 | mg/kg |

Inter-Mountain Laboratories, Inc.

1160 Research Drive
Bozeman, Montana 59715

# EPA METHOD 8270
# HSL SEMI-VOLATILE COMPOUNDS
# BASE/NEUTRAL/ACID EXTRACTABLES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | T-02 | Date Reported: | 08/30/94 |
| Laboratory ID: | B947384 | Date Sampled: | 08/10/94 |
| Sample Matrix: | Soil | Date Analyzed: | 08/30/94 |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Benzyl Alcohol | ND | 2 | mg/kg |
| bis(2-Chloroethoxy)methane | ND | 1 | mg/kg |
| bis(2-Chloroethyl)ether | ND | 1 | mg/kg |
| bis(2-Chloroisopropyl)ether | ND | 1 | mg/kg |
| bis(2-Ethylhexyl)phthalate | ND | 5 | mg/kg |
| Butylbenzylphthalate | ND | 1 | mg/kg |
| Chrysene | ND | 1 | mg/kg |
| [illegible]Butylphthalate | ND | 5 | mg/kg |
| Di-n-Octylphthalate | ND | 1 | mg/kg |
| Dibenz(a,h)anthracene | ND | 1 | mg/kg |
| Dibenzofuran | ND | 1 | mg/kg |
| Diethylphthalate | ND | 1 | mg/kg |
| Dimethylphthalate | ND | 1 | mg/kg |
| Fluoranthene | ND | 1 | mg/kg |
| Fluorene | ND | 1 | mg/kg |
| Hexachlorobenzene | ND | 1 | mg/kg |
| Hexachlorobutadiene | ND | 2 | mg/kg |
| Hexachlorocyclopentadiene | ND | 1 | mg/kg |
| Hexachloroethane | ND | 2 | mg/kg |
| Indeno(1,2,3-cd)pyrene | ND | 1 | mg/kg |
| Isophorone | ND | 1 | mg/kg |
| N-Nitrosodi-n-propylamine | ND | 1 | mg/kg |
| N-Nitrosodiphenylamine | ND | 1 | mg/kg |
| Naphthalene | ND | 1 | mg/kg |
| Nitrobenzene | ND | 1 | mg/kg |
| Pentachlorophenol | ND | 5 | mg/kg |
| Phenanthrene | ND | 1 | mg/kg |
| Phenol | ND | 1 | mg/kg |
| Pyrene | ND | 1 | mg/kg |

ND - Compound not detected at stated Detection Limit.
J - Meets identification criteria, below Detection Limit.
** - Compounds coelute by GCMS.
B - Compound detected in Method Blank.

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# EPA METHOD 8270
# TENTATIVELY IDENTIFIED COMPOUNDS
# BASE/NEUTRAL/ACID EXTRACTABLES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | T-02 | Date Reported: | 08/30/94 |
| Laboratory ID: | B947384 | Date Sampled: | 08/10/94 |
| Sample Matrix: | Soil | Date Analyzed: | 08/30/94 |

| Tentative Identification | Retention Time (minutes) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable levels.

Unknown concentration calculated assuming Relative Response Factor = 1.

## QUALITY CONTROL:

| Surrogate Recoveries | % | Soil QC Limits |
|---|---|---|
| 2-Fluorophenol | 69 | 25 - 121 |
| Phenol-d6 | 104 | 24 - 113 |
| Nitrobenzene-d5 | 77 | 23 - 120 |
| 2-Fluorobiphenyl | 86 | 30 - 115 |
| 2,4,6-Tribromophenol | 90 | 19 - 122 |
| Terphenyl-d14 | 87 | 18 - 137 |

Reference:

Method 8270, Gas Chromatography/Mass Spectrometry for Semivolatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, Third Edition, [illegible]ember 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | T-02 | Date Reported: | 08/29/94 |
| Project ID: | Rico, Colorado | Date Sampled: | 08/10/94 |
| Laboratory ID: | B947384 | Date Received: | 08/13/94 |
| Sample Matrix: | Soil | Date Digested: | 08/24/94 |
| | | Date Analyzed: | 08/25/94 |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 10000 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | 36 | 20 | mg/kg |
| Barium | 140 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 4 | 2 | mg/kg |
| Chromium | 16 | 5 | mg/kg |
| Cobalt | 8 | 5 | mg/kg |
| Copper | 74 | 5 | mg/kg |
| Iron | 24000 | 100 | mg/kg |
| Lead | 380 | 20 | mg/kg |
| Manganese | 4300 | 100 | mg/kg |
| Mercury | ND | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 13 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | 11 | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 200 | 5 | mg/kg |
| Vanadium | 24 | 10 | mg/kg |
| Zinc | 640 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 9100 | 100 | mg/kg |
| Potassium | 2300 | 100 | mg/kg |
| Magnesium | 8800 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 640 | 200 | mg/kg |
| Silicon | 260 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.
Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor
Technique), SW-846, September 1986.

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# TOXICITY CHARACTERISTIC LEACHING PROCEDURE - TCLP
## TRACE METAL CONCENTRATION

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | T-03 | Date Reported: | 08/26/94 |
| Project ID: | Rico, Colorado | Date Sampled: | 08/09/94 |
| Laboratory ID: | B947385 | Date Received: | 08/13/94 |
| Sample Matrix: | Soil | Date Extracted TCLP: | 08/23/94 |
| | | Date Analyzed: | 08/25/94 |

| Parameter | Analytical Result (mg/L) | Detection Level (mg/L) | Regulatory Level (mg/L) |
|---|---|---|---|
| Arsenic | ND | 0.2 | 5.0 |
| Barium | 0.7 | 0.5 | 100 |
| Cadmium | 0.08 | 0.05 | 1.0 |
| Chromium | ND | 0.05 | 5.0 |
| Lead | 21 | 0.5 | 5.0 |
| Mercury | ND | 0.02 | 0.2 |
| S[illegible]nium | ND | 0.2 | 1.0 |
| [illegible]r | ND | 0.05 | 1.0 |

ND-Parameter not detected at stated detection level.

References:

Toxicity Characteristic Leaching Procedure , Final Rule,
Federal Register, 40 CFR 261-302. Part V, EPA Vol 55, No. 126, June 29, 1990

Method 3010: Acid Digestion of Aqueous Samples and Extracts
for Total Metals, SW-846, Sept. 1986.

Method 6010: Inductively-Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, Sept. 1990.

Method 7470: Mercury in Liquid Waste (Manual Cold-Vapor
Technique), SW-846, Sept. 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | T-03 | Date Reported: | 08/29/94 |
| Project ID: | Rico, Colorado | Date Sampled: | 08/09/94 |
| Laboratory ID: | 8947385 | Date Received: | 08/13/94 |
| Sample Matrix: | Soil | Date Digested: | 08/24/94 |
| | | Date Analyzed: | 08/25/94 |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 12000 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | 49 | 20 | mg/kg |
| Barium | 170 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 6 | 2 | mg/kg |
| Chromium | 25 | 5 | mg/kg |
| Cobalt | 9 | 5 | mg/kg |
| Copper | 230 | 5 | mg/kg |
| Iron | 47000 | 100 | mg/kg |
| Lead | 7700 | 20 | mg/kg |
| Manganese | 1200 | 100 | mg/kg |
| Mercury | 0.4 | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 16 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | 10 | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 150 | 5 | mg/kg |
| Vanadium | 28 | 10 | mg/kg |
| Zinc | 1300 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 1300 | 100 | mg/kg |
| Potassium | 2100 | 100 | mg/kg |
| Magnesium | 9400 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 610 | 200 | mg/kg |
| Silicon | 310 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.
Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor
Technique), SW-846, September 1986.

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# TOXICITY CHARACTERISTIC LEACHING PROCEDURE - TCLP
# TRACE METAL CONCENTRATION

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | RP-01 | Date Reported: | 08/26/94 |
| Project ID: | Rico, Colorado | Date Sampled: | 08/10/94 |
| Laboratory ID: | B947386 | Date Received: | 08/13/94 |
| Sample Matrix: | Soil | Date Extracted TCLP: | 08/23/94 |
| | | Date Analyzed: | 08/25/94 |

| Parameter | Analytical Result (mg/L) | Detection Level (mg/L) | Regulatory Level (mg/L) |
|---|---|---|---|
| Arsenic | ND | 0.2 | 5.0 |
| Barium | 1.1 | 0.5 | 100 |
| Cadmium | 0.66 | 0.05 | 1.0 |
| Chromium | ND | 0.05 | 5.0 |
| Lead | 4.3 | 0.5 | 5.0 |
| Mercury | ND | 0.02 | 0.2 |
| Selenium | ND | 0.2 | 1.0 |
| [illegible]er | ND | 0.05 | 1.0 |

ND-Parameter not detected at stated detection level.

References:

Toxicity Characteristic Leaching Procedure , Final Rule,
Federal Register, 40 CFR 261-302. Part V, EPA Vol 55, No. 126, June 29, 1990

Method 3010: Acid Digestion of Aqueous Samples and Extracts
for Total Metals, SW-846, Sept. 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, Sept. 1990.

Method 7470: Mercury in Liquid Waste (Manual Cold-Vapor
Technique), SW-846, Sept. 1986.

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# QUALITY ASSURANCE / QUALITY CONTROL

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# QA/QC
# VOLATILE COMPOUNDS BY GC/MS
# METHOD BLANK

Date Analyzed: 08/17/94
Laboratory ID: 3MB-229B
Sample Matrix: Water

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Chloromethane | ND | 5 | ug/L |
| Bromomethane | ND | 5 | ug/L |
| Vinyl Chloride | ND | 5 | ug/L |
| Chloroethane | ND | 5 | ug/L |
| Methylene Chloride | ND | 20 | ug/L |
| Acetone | ND | 20 | ug/L |
| Carbon Disulfide | ND | 5 | ug/L |
| 1,1-Dichloroethene | ND | 5 | ug/L |
| 1,1-Dichloroethane | ND | 5 | ug/L |
| 1,2-Dichloroethene | ND | 5 | ug/L |
| Chloroform | ND | 5 | ug/L |
| 1,2-Dichloroethane | ND | 5 | ug/L |
| 2-Butanone | ND | 20 | ug/L |
| 1,1,1-Trichloroethane | ND | 5 | ug/L |
| Cyclohexane | ND | 5 | ug/L |
| Carbon Tetrachloride | ND | 5 | ug/L |
| Bromodichloromethane | ND | 5 | ug/L |
| 1,2-Dichloropropane | ND | 5 | ug/L |
| 1,4-Dioxane | ND | 500 | ug/L |
| cis-1,3-Dichloropropene | ND | 5 | ug/L |
| Trichloroethene | ND | 5 | ug/L |
| Dibromochloromethane | ND | 5 | ug/L |
| 1,1,2-Trichloroethane | ND | 5 | ug/L |
| Benzene | ND | 5 | ug/L |
| trans-1,3-Dichloropropene | ND | 5 | ug/L |
| 1,2-Dibromoethane | ND | 5 | ug/L |
| Bromoform | ND | 5 | ug/L |
| 4-Methyl-2-pentanone | ND | 5 | ug/L |
| 2-Hexanone | ND | 5 | ug/L |
| Tetrachloroethene | ND | 5 | ug/L |
| 1,1,2,2-Tetrachloroethane | ND | 5 | ug/L |

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# LATILE COMPOUNDS BY GC/MS

Date Analyzed: 08/17/94
Laboratory ID: 3MB-229B
Sample Matrix: Water

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Toluene | ND | 5 | ug/L |
| Chlorobenzene | ND | 5 | ug/L |
| Ethylbenzene | ND | 5 | ug/L |
| Styrene | ND | 5 | ug/L |
| m,p-Xylene | ND | 5 | ug/L |
| o-Xylene | ND | 5 | ug/L |

ND - Compound not detected at stated Detection Limit.
J - Meets identification criteria, below Detection Limit.
B - Compound detected in method blank.

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# TENTATIVELY IDENTIFIED COMPOUNDS
# METHOD BLANK ANALYSIS

Date Analyzed: 08/17/94
Laboratory ID: 3MB-229B
Sample Matrix: Water

| Tentative Identification | Retention Time (min) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable levels.

Unknown concentrations calculated assuming a Relative Response Factor = 1.

## QUALITY CONTROL:

| Surrogate Recovery | % | Water QC Limits |
|---|---|---|
| 1,2-Dichloroethane-d4 | 106 | 76 - 114 |
| Toluene-d8 | 100 | 88 - 110 |
| Bromofluorobenzene | 105 | 86 - 115 |

References:

Method 8240, Gas Chromatography/Mass Spectrometry for Volatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, Third Edition, November 1986.

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# B QA/QC
# VOLATILE COMPOUNDS BY GC/MS
# EXTRACTION BLANK

Date Analyzed: 08/17/94
Laboratory ID: 3EB-229A
Sample Matrix: Soil
Date Extracted: 8/17/94

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Dichlorodifluoromethane | ND | 0.2 | mg/kg |
| Chloromethane | ND | 0.2 | mg/kg |
| Bromomethane | ND | 0.2 | mg/kg |
| Vinyl Chloride | ND | 0.2 | mg/kg |
| Chloroethane | ND | 0.2 | mg/kg |
| Trichlorofluoromethane | ND | 0.2 | mg/kg |
| Methylene Chloride | ND | 1 | mg/kg |
| cis-1,2-Dichloroethene | ND | 0.2 | mg/kg |
| 1,1-Dichloroethene | ND | 0.2 | mg/kg |
| 1,1-Dichloroethane | ND | 0.2 | mg/kg |
| 2,2-Dichloropropane | ND | 0.2 | mg/kg |
| cis-1,2-Dichloroethene | ND | 0.2 | mg/kg |
| Chloroform | ND | 0.2 | mg/kg |
| Bromochloromethane | ND | 0.2 | mg/kg |
| 1,2-Dichloroethane | ND | 0.2 | mg/kg |
| 1,1,1-Trichloroethane | ND | 0.2 | mg/kg |
| Carbon Tetrachloride | ND | 0.2 | mg/kg |
| 1,1-Dichloropropene | ND | 0.2 | mg/kg |
| Benzene | ND | 0.2 | mg/kg |
| 1,2-Dichloroethane | ND | 0.2 | mg/kg |
| Trichloroethene | ND | 0.2 | mg/kg |
| 1,2-Dichloropropane | ND | 0.2 | mg/kg |
| Bromodichloromethane | ND | 0.2 | mg/kg |
| Dibromomethane | ND | 0.2 | mg/kg |
| Toluene | ND | 0.2 | mg/kg |
| 1,1,2-Trichloroethane | ND | 0.2 | mg/kg |
| Tetrachloroethene | ND | 0.2 | mg/kg |
| 1,3-Dichloropropane | ND | 0.2 | mg/kg |
| Dibromochloromethane | ND | 0.2 | mg/kg |
| 1,2-Dibromoethane | ND | 0.2 | mg/kg |
| Chlorobenzene | ND | 0.2 | mg/kg |
| 1,2-Tetrachloroethane | ND | 0.2 | mg/kg |

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# VOLATILE COMPOUNDS BY GC/MS

Date Analyzed: 08/17/94
Laboratory ID: 3EB-229A
Sample Matrix: Soil
Date Extracted: 08/17/94

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Ethylbenzene | ND | 0.2 | mg/kg |
| trans-1,3-Dichloropropene | ND | 0.2 | mg/kg |
| Styrene | ND | 0.2 | mg/kg |
| m,p-Xylene | ND | 0.2 | mg/kg |
| o-Xylene | ND | 0.2 | mg/kg |
| cis-1,3-Dichloropropene | ND | 0.2 | mg/kg |
| Bromoform | ND | 0.2 | mg/kg |
| Isopropylbenzene | ND | 0.2 | mg/kg |
| 1,1,2,2-Tetrachloroethane | ND | 0.2 | mg/kg |
| [illegible]mobenzene | ND | 0.2 | mg/kg |
| [illegible],3-Trichloropropane | ND | 0.2 | mg/kg |
| n-Propylbenzene | ND | 0.2 | mg/kg |
| 2-Chlorotoluene | ND | 0.2 | mg/kg |
| 1,3,5-Trimethylbenzene | ND | 0.2 | mg/kg |
| 4-Chlorotoluene | ND | 0.2 | mg/kg |
| tert-Butylbenzene | ND | 0.2 | mg/kg |
| 1,2,4-Trimethylbenzene | ND | 0.2 | mg/kg |
| sec-Butylbenzene | ND | 0.2 | mg/kg |
| 4-Isopropyltoluene | ND | 0.2 | mg/kg |
| 1,3-Dichlorobenzene | ND | 0.2 | mg/kg |
| 1,4-Dichlorobenzene | ND | 0.2 | mg/kg |
| n-Butylbenzene | ND | 0.2 | mg/kg |
| 1,2-Dichlorobenzene | ND | 0.2 | mg/kg |
| 1,2-Dibromo-3-chloropropane | ND | 0.2 | mg/kg |
| 1,2,4-Trichlorobenzene | ND | 0.2 | mg/kg |
| Hexachlorobutadiene | ND | 0.2 | mg/kg |
| Naphthalene | ND | 0.2 | mg/kg |
| 1,2,3-Trichlorobenzene | ND | 0.2 | mg/kg |

ND - Compound not detected at stated Detection Limit.
J - Meets identification criteria, below Detection Limit.
B - Compound detected in Method Blank.

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# TENTATIVELY IDENTIFIED COMPOUNDS
# EXTRACTION BLANK ANALYSIS

Date Analyzed: 08/17/94
Laboratory ID: 3EB-229A
Sample Matrix: Soil
Date Extracted: 08/17/94

| Tentative Identification | Retention Time (min) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable levels.

Unknown concentrations calculated assuming a Relative Response Factor = 1.

## QUALITY CONTROL:

| Surrogate Recovery | % | Soil QC Limits |
|---|---|---|
| Dibromofluoromethane | 108 | 80 - 120 |
| Toluene-d8 | 101 | 81 - 117 |
| Bromofluorobenzene | 103 | 74 - 121 |

**Reference:**

Method 8260, Gas Chromatography/Mass Spectrometry for Volatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, Third Edition, November 1986.

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# B QA/QC
# SEMI-VOLATILE ORGANIC COMPOUNDS BY GC/MS
# METHOD BLANK

Date Analyzed: 08/30/94
Laboratory ID: SMB-230
Sample Matrix: Soil
Date Extracted: 08/18/94

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| 1,2,4-Trichlorobenzene | ND | 1 | mg/kg |
| 1,2-Dichlorobenzene | ND | 1 | mg/kg |
| 1,3-Dichlorobenzene | ND | 1 | mg/kg |
| 1,4-Dichlorobenzene | ND | 1 | mg/kg |
| 1-Methylnaphthalene | ND | 1 | mg/kg |
| 2,4,5-Trichlorophenol | ND | 1 | mg/kg |
| 2,4,6-Trichlorophenol | ND | 1 | mg/kg |
| 2,4-Dichlorophenol | ND | 1 | mg/kg |
| 2,4-Dimethylphenol | ND | 1 | mg/kg |
| 2,4-Dinitrophenol | ND | 5 | mg/kg |
| 2,4-Dinitrotoluene | ND | 1 | mg/kg |
| -Dinitrotoluene | ND | 1 | mg/kg |
| 2-Chloronaphthalene | ND | 1 | mg/kg |
| 2-Chlorophenol | ND | 1 | mg/kg |
| 2-Methylnaphthalene | ND | 1 | mg/kg |
| 2-Methylphenol | ND | 1 | mg/kg |
| 2-Nitroaniline | ND | 5 | mg/kg |
| 2-Nitrophenol | ND | 1 | mg/kg |
| 3,3'-Dichlorobenzidine | ND | 2 | mg/kg |
| 3-Methylphenol/4-Methylphenol * | ND | 1 | mg/kg |
| 3-Nitroaniline | ND | 5 | mg/kg |
| 4,6-Dinitro-2-methylphenol | ND | 5 | mg/kg |
| 4-Bromophenyl-phenylether | ND | 1 | mg/kg |
| 4-Chloro-3-methylphenol | ND | 2 | mg/kg |
| 4-Chloroaniline | ND | 2 | mg/kg |
| 4-Chlorophenyl-phenylether | ND | 1 | mg/kg |
| 4-Nitroaniline | ND | 2 | mg/kg |
| 4-Nitrophenol | ND | 5 | mg/kg |
| 6-Methyl chrysene | ND | 1 | mg/kg |
| 7,12-Dimethylbenz(a)anthracene | ND | 1 | mg/kg |
| Acenaphthene | ND | 1 | mg/kg |
| Acenaphthylene | ND | 1 | mg/kg |
| Anthracene | ND | 1 | mg/kg |
| Benzenethiol | ND | 1 | mg/kg |
| Benzo(a)anthracene | ND | 1 | mg/kg |
| zo(a)pyrene | ND | 1 | mg/kg |
| nzo(b)fluoranthene | ND | 1 | mg/kg |

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# LAB QA/QC
# SEMI-VOLATILE ORGANIC COMPOUNDS BY GC/MS
# METHOD BLANK

Date Analyzed: 08/30/94
Laboratory ID: SMB-230
Sample Matrix: Soil
Date Extracted: 08/18/94

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Benzo(g,h,i)perylene | ND | 1 | mg/kg |
| Benzo(k)fluoranthene | ND | 1 | mg/kg |
| Benzoic Acid | ND | 5 | mg/kg |
| Benzyl Alcohol | ND | 2 | mg/kg |
| bis(2-Chloroethoxy)methane | ND | 1 | mg/kg |
| bis(2-Chloroethyl)ether | ND | 1 | mg/kg |
| bis(2-Chloroisopropyl)ether | ND | 1 | mg/kg |
| bis(2-Ethylhexyl)phthalate | ND | 1 | mg/kg |
| Butylbenzylphthalate | ND | 1 | mg/kg |
| Chrysene | ND | 1 | mg/kg |
| di-n-Butylphthalate | ND | 1 | mg/kg |
| di-n-Octylphthalate | ND | 1 | mg/kg |
| Dibenz(a,h)acridine | ND | 1 | mg/kg |
| Dibenz(a,h)anthracene | ND | 1 | mg/kg |
| Dibenzofuran | ND | 1 | mg/kg |
| Diethylphthalate | ND | 1 | mg/kg |
| Dimethylphthalate | ND | 1 | mg/kg |
| Fluoranthene | ND | 1 | mg/kg |
| Fluorene | ND | 1 | mg/kg |
| Hexachlorobenzene | ND | 1 | mg/kg |
| Hexachlorobutadiene | ND | 2 | mg/kg |
| Hexachlorocyclopentadiene | ND | 1 | mg/kg |
| Hexachloroethane | ND | 2 | mg/kg |
| Indene | ND | 1 | mg/kg |
| Indeno(1,2,3-cd)pyrene | ND | 1 | mg/kg |
| Isophorone | ND | 1 | mg/kg |
| N-Nitrosodi-n-propylamine | ND | 1 | mg/kg |
| N-Nitrosodiphenylamine | ND | 1 | mg/kg |
| Naphthalene | ND | 1 | mg/kg |
| Nitrobenzene | ND | 1 | mg/kg |
| Pentachlorophenol | ND | 5 | mg/kg |
| Phenanthrene | ND | 1 | mg/kg |
| Phenol | ND | 1 | mg/kg |
| Pyrene | ND | 1 | mg/kg |
| Pyridine | ND | 1 | mg/kg |
| Quinoline | ND | 1 | mg/kg |

ND - Compound not detected at stated Detection Limits.
* - Compounds Coelute by GC/MS.

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# LAB QA/QC
## SEMI-VOLATILE ORGANIC COMPOUNDS BY GC/MS
## METHOD BLANK
## TENTATIVELY IDENTIFIED COMPOUNDS

Date Analyzed: 08/30/94
Laboratory ID: SMB-230
Sample Matrix: Soil
Date Extracted: 08/18/94

| Tentitively Identification | Retention Time (min.) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable levels.

*Unknown concentration calculated assuming Relative Response Factor = 1.*

## QUALITY CONTROL:

| Surrogate Recoveries | % | Soil QC Limits |
|---|---|---|
| 2-Fluorophenol | 71 | 25 - 121 |
| Phenol-d6 | 99 | 24 - 113 |
| Nitrobenzene-d5 | 76 | 23 - 120 |
| 2-Fluorobiphenyl | 82 | 30 - 115 |
| 2,4,6-Tribromophenol | 85 | 19 - 122 |
| Terphenyl-d14 | 77 | 18 - 137 |

Reference:

Method 8270, Gas Chromatography/Mass Spectrometry for Semivolatile Organics, Test Methods for Evaluating Solid Wastes, SW846, USEPA, Third Edition, November 1986.

USEPA Contract Lab Program, Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration, OLM01.0, December 1990.

Analyst

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# [illegible]B QA/QC
# TRACE METALS - TCLP
# METHOD BLANK

Date Analyzed: 08/25/94
Laboratory ID: TMB 94-30
Sample Matrix: Extract

| Parameter | Sample Result | PQL | Regulatory Level | Units |
|---|---|---|---|---|
| Arsenic | ND | 0.2 | 5.0 | mg/L |
| Barium | ND | 5 | 100.0 | mg/L |
| Cadmium | ND | 0.05 | 1.0 | mg/L |
| Chromium | ND | 0.05 | 5.0 | mg/L |
| Lead | ND | 0.2 | 5.0 | mg/L |
| Mercury | ND | 0.02 | 0.2 | mg/L |
| [illegible]enium | ND | 0.2 | 1.0 | mg/L |
| [illegible]er | ND | 0.05 | 1.0 | mg/L |

ND-Parameter not detected at stated detection level.

References:
Toxicity Characteristic Leaching Procedure , Final Rule,
Federal Register, 40 CFR 261-302. Part V, EPA Vol 55, No. 126, June 29, 1990

Method 3010: Acid Digestion of Aqueous Samples and Extracts
for Total Metals, SW-846, Sept. 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, Sept. 1990.

Method 7470: Mercury in Liquid Waste (Manual Cold-Vapor
Technique), SW-846, Sept. 1986.

[illegible]
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# LAB QA/QC
## PURGEABLE ORGANIC COMPOUNDS
## MATRIX SPIKE / MATRIX SPIKE DUPLICATE SUMMARY

Date Analyzed: 08/17/94
Laboratory ID: 3MSD7281
Sample Matrix: Water

### ORIGINAL SAMPLE PARAMETERS

| Parameter | Spike Added (ug/L) | Sample Conc. (ug/L) | MS Conc. (ug/L) | MS Recovery (%) | QC Limits (% Rec.) |
|---|---|---|---|---|---|
| 1,1-Dichloroethene | 100 | 0 | 100 | 100 | 61-145 |
| Trichloroethene | 100 | 0 | 100 | 100 | 71-120 |
| Benzene | 100 | 0 | 97 | 97 | 76-127 |
| Toluene | 100 | 0 | 93 | 93 | 71-127 |
| Chlorobenzene | 100 | 0 | 94 | 94 | 75-130 |

### DUPLICATE SAMPLE PARAMETERS

| Parameter | Spike Added (ug/L) | MSD Conc. (ug/L) | MSD Recovery (%) | RPD (%) | QC Limits RPD | QC Limits Rec. |
|---|---|---|---|---|---|---|
| 1,1-Dichloroethene | 100 | 104 | 104 | 4 | 14 | 61-145 |
| Trichloroethene | 100 | 98 | 98 | 2 | 14 | 71-120 |
| Benzene | 100 | 95 | 95 | 2 | 11 | 76-127 |
| Toluene | 100 | 91 | 91 | 2 | 13 | 71-127 |
| Chlorobenzene | 100 | 92 | 92 | 2 | 13 | 75-130 |

Spike Recovery: 0 out of 10 outside QC limits.
RPD: 0 out of 5 outside QC limits.

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# LAB QA/QC
## PURGEABLE ORGANIC COMPOUNDS
## MATRIX SPIKE / MATRIX SPIKE DUPLICATE SUMMARY

Date Analyzed: 08/17/94
Laboratory ID: 3EMSD738
Sample Matrix: Soil
Date Extracted: 8/17/94

ORIGINAL SAMPLE PARAMETERS

| Parameter | Spike Added (mg/kg) | Sample Conc. (mg/kg) | MS Conc. (mg/kg) | MS Recovery (%) | QC Limits (% Rec.) |
|---|---|---|---|---|---|
| 1,1-Dichloroethene | 2 | 0 | 1.5 | 71 | 59-172 |
| Trichloroethene | 2 | 0 | 1.5 | 75 | 62-137 |
| Benzene | 2 | 0 | 1.6 | 80 | 66-142 |
| Toluene | 2 | 0 | 1.5 | 71 | 59-139 |
| Chlorobenzene | 2 | 0 | 1.6 | 80 | 60-133 |

DUPLICATE SAMPLE PARAMETERS

| Parameter | Spike Added (mg/kg) | MSD Conc. (mg/kg) | MSD Recovery (%) | RPD (%) | QC Limits RPD | QC Limits Rec. |
|---|---|---|---|---|---|---|
| 1,1-Dichloroethene | 2 | 1.6 | 76 | 7 | 22 | 59-172 |
| Trichloroethene | 2 | 1.7 | 85 | 13 | 24 | 62-137 |
| Benzene | 2 | 1.7 | 85 | 11 | 21 | 66-142 |
| Toluene | 2 | 1.7 | 81 | 13 | 21 | 59-139 |
| Chlorobenzene | 2 | 1.7 | 85 | 6 | 21 | 60-133 |

Spike Recovery: 0 out of 10 outside QC limits.
RPD: 0 out of 5 outside QC limits.

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# B QA/QC
# SEMI-VOLATILE ORGANIC COMPOUNDS BY GC/MS
# BLANK SPIKE

Date Analyzed: 08/30/94
Laboratory ID: SBS-230
Sample Matrix: Soil
Date Extracted: 08/18/94

| Parameter | Spike Added (mg/kg) | Sample Conc. (mg/kg) | MS Conc. (mg/kg) | MS Recovery (%) | QC Limits (% Rec.) |
|---|---|---|---|---|---|
| Phenol | 200 | 0 | 124 | 125 | 26 - 90 |
| 2-Chlorophenol | 200 | 0 | 120 | 123 | 25 - 102 |
| 1,4-Dichlorobenzene | 100 | 0 | 71 | 73 | 28 - 104 |
| n-Nitroso-di-n-propylamine | 100 | 0 | 80 | 76 | 41-126 |
| 1,2,4-Trichlorobenzene | 100 | 0 | 74 | 82 | 38 - 107 |
| 4-Chloro-3-methylphenol | 200 | 0 | 119 | 136 | 26 - 103 |
| Acenaphthene | 100 | 0 | 70 | 83 | 31 - 137 |
| 4-Nitrophenol | 200 | 0 | 120 | 154 | 11-114 |
| -Dinitrotoluene | 100 | 0 | 71 | 84 | 28 - 89 |
| Pentachlorophenol | 200 | 0 | 187 | 155 | 17 - 109 |
| Pyrene | 100 | 0 | 77 | 75 | 35 - 142 |

## QUALITY CONTROL:

| Surrogate Recoveries | % | Soil QC Limits |
|---|---|---|
| 2-Fluorophenol | 81 | 25 - 121 |
| Phenol-d6 | 101 | 24 - 113 |
| Nitrobenzene-d5 | 79 | 23 - 120 |
| 2-Fluorobiphenyl | 84 | 30 - 115 |
| 2,4,6-Tribromophenol | 92 | 19 - 122 |
| Terphenyl-d14 | 82 | 18 - 137 |

Spike Recovery: 0 out of 11 outside QC limits.

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# B QA/QC
# TRACE METALS - TCLP
# MATRIX SPIKE

Date Analyzed: 08/25/94
Laboratory ID: B947386
Sample Matrix: Soil

| Parameter | Spike Added (mg/L) | Sample Conc. (mg/L) | MS Conc. (mg/L) | MS Recovery (%) | QC Limits (% Rec.) |
|---|---|---|---|---|---|
| Arsenic | 2.5 | ND | 2.6 | 105 | 75 - 125 |
| Barium | 5.0 | 1.1 | 6.0 | 97 | 75 - 125 |
| Cadmium | 0.50 | 0.66 | 1.12 | 92 | 75 - 125 |
| Chromium | 2.0 | ND | 2.0 | 98 | 75 - 125 |
| Lead | 2.0 | 4.3 | 6.1 | 91 | 75 - 125 |
| Mercury | 0.20 | ND | 0.21 | 103 | 75 - 125 |
| Selenium | 2.5 | ND | 2.9 | 114 | 75 - 125 |
| Silver | 0.05 | ND | 0.06 | 121 | 75 - 125 |

ND-Parameter not detected at stated detection level.

References:
Toxicity Characteristic Leaching Procedure , Final Rule,
Federal Register, 40 CFR 261-302. Part V, EPA Vol 55, No. 126, June 29, 1990

Method 3010: Acid Digestion of Aqueous Samples and Extracts
for Total Metals, SW-846, Sept. 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, Sept. 1990.

Method 7470: Mercury in Liquid Waste (Manual Cold-Vapor
Techniquel, SW-846, Sept. 1986.

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# LAB QA/QC
# TRACE METALS - TCLP
# DUPLICATE SUMMARY

Date Analyzed: 08/25/94
Laboratory ID: B947385
Sample Matrix: Soil

| Parameter | Sample Result | Duplicate Sample Result | RPD % | PQL | Units |
|---|---|---|---|---|---|
| Arsenic | ND | ND | 0 | 0.2 | mg/L |
| Barium | 0.7 | 0.7 | 0 | 5 | mg/L |
| Cadmium | 0.08 | 0.08 | 0 | 0.05 | mg/L |
| Chromium | ND | ND | 0 | 0.05 | mg/L |
| Lead | 21 | 22 | 5 | 0.2 | mg/L |
| Mercury | ND | ND | 0 | 0.02 | mg/L |
| Selenium | ND | ND | 0 | 0.2 | mg/L |
| Silver | ND | ND | 0 | 0.05 | mg/L |

ND-Parameter not detected at stated detection level.

References:
Toxicity Characteristic Leaching Procedure , Final Rule,
Federal Register, 40 CFR 261-302. Part V, EPA Vol 55, No. 126, June 29, 1990

Method 3010: Acid Digestion of Aqueous Samples and Extracts
for Total Metals, SW-846, Sept. 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, Sept. 1990.

Method 7470: Mercury in Liquid Waste (Manual Cold-Vapor
Technique), SW-846, Sept. 1986.

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# CHAIN OF CUSTODY RECORD

| Client/Project Name | Project Location |
|---|---|
| Walsh Environmental / Rico | Rico, CO |

| Sampler: (Signature) | Chain of Custody Tape No. |
|---|---|
| David P Bunker | |

ANALYSES / PARAMETERS

| Sample No./ Identification | Date | Time | Lab Number | Matrix | No. of Containers | Metal Scan ICP | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| RS-15 | 8/9 | 11:30 | B947369 | Soil | 1 | ✓ | | | | 1-2oz ea. |
| RS-16 | 8/9 | 10:40 | 7370 | Soil | 1 | ✓ | | | | |
| RS-17 | 8/9 | 12:10 | 7371 | Soil | 1 | ✓ | | | | |
| RS-18 | 8/9 | 16:50 | 7372 | Soil | 1 | ✓ | | | | |
| RS-19 | 8/10 | 8:20 | 7373 | Soil | 1 | ✓ | | | | |
| RS-20 | 8/10 | 8:50 | 7374 | Soil | 1 | ✓ | | | | |
| RS-21 | 8/10 | 13:15 | 7375 | Soil | 1 | ✓ | | | | |
| RS-22 | 8/10 | 13:30 | 7376 | Soil | 1 | ✓ | | | | |
| RS-23 | 8/10 | 13:45 | 7377 | Soil | 1 | ✓ | | | | 16.0°C Cooler |
| RS-24 | 8/10 | 14:15 | 7378 | Soil | 1 | ✓ | | | | |
| RS-25 | 8/10 | 16:00 | 7379 | Soil | 1 | ✓ | | | | |
| RS-26 | 8/10 | 16:30 | 7380 | Soil | 1 | ✓ | | | | |
| RS-27 | 8/10 | 17:00 | 7381 | Soil | 1 | ✓ | | | | |
| RS-28 | 8/10 | 17:15 | 7382 | Soil | 1 | ✓ | | | | |

| Relinquished by: (Signature) | Date | Time | Received by: (Signature) | Date | Time |
|---|---|---|---|---|---|
| David P Bunker | 8/12/94 | | [illegible] | 8/13/94 | 9:50 |
| Relinquished by: (Signature) | Date | Time | Received by: (Signature) | Date | Time |
| | | | | | |
| Relinquished by: (Signature) | Date | Time | Received by laboratory: (Signature) | Date | Time |
| | | | | | |

## Inter-Mountain Laboratories, Inc.

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☐ 1714 Phillips Circle, Gillette, Wyoming 82716, Telephone (307) 682-8945

☐ 2506 West Main Street, Farmington, NM 87401, Telephone (505) 326-4737

☐ 1150 Research Dr., Bozeman, Montana 59715, Telephone (406) 586-8450

☐ 11153 SH 30, College Station, TX 77845, Telephone (409) 776-8945

☐ 3304 Longmire Drive, College Station, TX 77845, Telephone (409) 774-4999

19659

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# CHAIN OF CUSTODY RECORD

Client/Project Name: Walsh Environmental / Rico

Project Location: Rico, CO

Sampler: (Signature): David P Bunker

Chain of Custody Tape No.:

ANALYSES / PARAMETERS

| Sample No./ Identification | Date | Time | Lab Number | Matrix | No. of Containers | Metal scan ICP | VOAs | Semi-VOAs | TCLP metals | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| T-01 | 8/9 | 13:20 | 0947383 | soil | 1 | | ✓ | | | |
| T-01 | 8/9 | 13:21 | ~~73~~/84 | soil | 1 | | | ✓ | | |
| T-01 | 8/9 | 13:22 | ↓ | soil | 1 | ✓ | | | | |
| | | | | | | | | | | |
| T-02 | 8/10 | 10:00 | 7384 | soil | 1 | | ✓ | | | |
| T-02 | 8/10 | 10:01 | ↓ | soil | 1 | | | ✓ | | |
| T-02 | 8/10 | 10:02 | ↓ | soil | 1 | ✓ | | | | |
| | | | | | | | | | | |
| T-03 | 8/9 | 16:10 | 7385 | soil | 1 | | | | ✓ | |
| T-03 | 8/9 | 16:15 | ↓ | soil | 1 | ✓ | | | | |
| | | | | | | | | | | |
| RP-01 | 8/10 | 15:30 | 7386 | soil | 1 | | | | ✓ | Label has ID as RP-04 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| Relinquished by: (Signature) | Date | Time | Received by: (Signature) | Date | Time |
|---|---|---|---|---|---|
| David P Bunker | 8/12/94 | | Fed Ex (carrier) | | |
| Fed Ex (carrier) | | | IML (Bozeman) | 8/13/94 | 950 am |
| Relinquished by: (Signature) | Date | Time | Received by laboratory: (Signature) | Date | Time |
| | | | | | |

Inter-Mountain Laboratories, Inc.

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19660

Inter-Mountain Laboratories, Inc.

1160 Research Drive
Bozeman, Montana 59715

# *CASE NARRATIVE*

On September 8, 1994, seventeen samples were received for analysis at Inter-Mountain Laboratories, Bozeman, Montana. The chain of custody form requested analysis for arsenic, cadmium, lead, and zinc. Client name/Project name was listed as Walsh & Asociates / Rico.

Detectable amounts of targeted compounds were present in some of the samples.

Limits of detection for each instrument/analysis are determined by sample matrix effects, instrument performance under standard conditions, and dilution requirements to maintain chromatography output within calibration ranges.

*Wynn Sudtelgte*
IML-Bozeman

0920wa

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Bozeman, Montana 59715

# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | Smuggler | Date Reported: | 09/09/94 |
| Project ID: | #1897-040 / Rico | Date Sampled: | 09/07/94 |
| Laboratory ID: | B948075 | Date Received: | 09/08/94 |
| Sample Matrix: | Soil | Date Digested: | 09/08/94 |
| | | Date Analyzed: | 09/09/94 |

| Parameter | Analytical Result | Detection Level | Units * |
|---|---|---|---|
| Arsenic | 12 | 10 | mg/kg |
| Cadmium | 2.2 | 1 | mg/kg |
| Lead | 420 | 10 | mg/kg |
| Zinc | 460 | 3 | mg/kg |

* Results are reported on an as received basis (wet wt. mg/kg).
ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.

Analyst

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Bozeman, Montana 59715

# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | Yankee Bay | Date Reported: | 09/09/94 |
| Project ID: | #1897-040 / Rico | Date Sampled: | 09/07/94 |
| Laboratory ID: | B948076 | Date Received: | 09/08/94 |
| Sample Matrix: | Soil | Date Digested: | 09/08/94 |
| | | Date Analyzed: | 09/09/94 |

| Parameter | Analytical Result | Detection Level | Units * |
|---|---|---|---|
| Arsenic | 19 | 10 | mg/kg |
| Cadmium | 12 | 1 | mg/kg |
| Lead | 6500 | 10 | mg/kg |
| Zinc | 2100 | 3 | mg/kg |

* Results are reported on an as received basis (wet wt. mg/kg).
ND - Parameter not detected at stated Detection Limit.

**References:**
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.

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Bozeman, Montana 59715

# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | Hillside #2 | Date Reported: | 09/09/94 |
| Project ID: | #1897-040 / Rico | Date Sampled: | 09/07/94 |
| Laboratory ID: | B948077 | Date Received: | 09/08/94 |
| Sample Matrix: | Soil | Date Digested: | 09/08/94 |
| | | Date Analyzed: | 09/09/94 |

| Parameter | Analytical Result | Detection Level | Units * |
|---|---|---|---|
| Arsenic | 24 | 10 | mg/kg |
| Cadmium | 16 | 1 | mg/kg |
| Lead | 9100 | 10 | mg/kg |
| Zinc | 2400 | 3 | mg/kg |

* Results are reported on an as received basis (wet wt. mg/kg).
ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | Hillside | Date Reported: | 09/09/94 |
| Project ID: | #1897-040 / Rico | Date Sampled: | 09/07/94 |
| Laboratory ID: | B948078 | Date Received: | 09/08/94 |
| Sample Matrix: | Soil | Date Digested: | 09/08/94 |
| | | Date Analyzed: | 09/09/94 |

| Parameter | Analytical Result | Detection Level | Units * |
|---|---|---|---|
| Arsenic | 26 | 10 | mg/kg |
| Cadmium | 23 | 1 | mg/kg |
| Lead | 2800 | 10 | mg/kg |
| Zinc | 3400 | 3 | mg/kg |

* Results are reported on an as received basis (wet wt. mg/kg).
ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | Home | Date Reported: | 09/09/94 |
| Project ID: | #1897-040 / Rico | Date Sampled: | 09/07/94 |
| Laboratory ID: | B948079 | Date Received: | 09/08/94 |
| Sample Matrix: | Soil | Date Digested: | 09/08/94 |
| | | Date Analyzed: | 09/09/94 |

| Parameter | Analytical Result | Detection Level | Units * |
|---|---|---|---|
| Arsenic | 21 | 10 | mg/kg |
| Cadmium | 4.6 | 1 | mg/kg |
| Lead | 300 | 10 | mg/kg |
| Zinc | 780 | 3 | mg/kg |

* Results are reported on an as received basis (wet wt. mg/kg).
ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | Sam Patch | Date Reported: | 09/09/94 |
| Project ID: | #1897-040 / Rico | Date Sampled: | 09/07/94 |
| Laboratory ID: | B948080 | Date Received: | 09/08/94 |
| Sample Matrix: | Soil | Date Digested: | 09/08/94 |
| | | Date Analyzed: | 09/09/94 |

| Parameter | Analytical Result | Detection Level | Units * |
|---|---|---|---|
| Arsenic | 26 | 10 | mg/kg |
| Cadmium | 17 | 1 | mg/kg |
| Lead | 12000 | 10 | mg/kg |
| Zinc | 2900 | 3 | mg/kg |

* Results are reported on an as received basis (wet wt. mg/kg).
ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | Patrick | Date Reported: | 09/09/94 |
| Project ID: | #1897-040 / Rico | Date Sampled: | 09/07/94 |
| Laboratory ID: | 8948081 | Date Received: | 09/08/94 |
| Sample Matrix: | Soil | Date Digested: | 09/08/94 |
| | | Date Analyzed: | 09/09/94 |

| Parameter | Analytical Result | Detection Level | Units * |
|---|---|---|---|
| Arsenic | 10 | 10 | mg/kg |
| Cadmium | 2.1 | 1 | mg/kg |
| Lead | 9300 | 10 | mg/kg |
| Zinc | 970 | 3 | mg/kg |

* Results are reported on an as received basis (wet wt. mg/kg).
ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | Ada North | Date Reported: | 09/09/94 |
| Project ID: | #1897-040 / Rico | Date Sampled: | 09/07/94 |
| Laboratory ID: | B948082 | Date Received: | 09/08/94 |
| Sample Matrix: | Soil | Date Digested: | 09/08/94 |
| | | Date Analyzed: | 09/09/94 |

| Parameter | Analytical Result | Detection Level | Units * |
|---|---|---|---|
| Arsenic | 9.8 | 10 | mg/kg |
| Cadmium | ND | 1 | mg/kg |
| Lead | 77 | 10 | mg/kg |
| Zinc | 120 | 3 | mg/kg |

* Results are reported on an as received basis (wet wt. mg/kg).
ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | Group Tract | Date Reported: | 09/09/94 |
| Project ID: | #1897-040 / Rico | Date Sampled: | 09/07/94 |
| Laboratory ID: | B948083 | Date Received: | 09/08/94 |
| Sample Matrix: | Soil | Date Digested: | 09/08/94 |
| | | Date Analyzed: | 09/09/94 |

| Parameter | Analytical Result | Detection Level | Units * |
|---|---|---|---|
| Arsenic | 13 | 10 | mg/kg |
| Cadmium | 2.1 | 1 | mg/kg |
| Lead | 260 | 10 | mg/kg |
| Zinc | 500 | 3 | mg/kg |

* Results are reported on an as received basis (wet wt. mg/kg).
ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | Trench 1 | Date Reported: | 09/09/94 |
| Project ID: | #1897-040 / Rico | Date Sampled: | 09/07/94 |
| Laboratory ID: | B948084 | Date Received: | 09/08/94 |
| Sample Matrix: | Soil | Date Digested: | 09/08/94 |
| | | Date Analyzed: | 09/09/94 |

| Parameter | Analytical Result | Detection Level | Units * |
|---|---|---|---|
| Arsenic | ND | 10 | mg/kg |
| Cadmium | 6 | 1 | mg/kg |
| Lead | 830 | 10 | mg/kg |
| Zinc | 1400 | 3 | mg/kg |

* Results are reported on an as received basis (wet wt. mg/kg).
ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | Trench 2 | Date Reported: | 09/09/94 |
| Project ID: | #1897-040 / Rico | Date Sampled: | 09/07/94 |
| Laboratory ID: | B948085 | Date Received: | 09/08/94 |
| Sample Matrix: | Soil | Date Digested: | 09/08/94 |
| | | Date Analyzed: | 09/09/94 |

| Parameter | Analytical Result | Detection Level | Units * |
|---|---|---|---|
| Arsenic | ND | 10 | mg/kg |
| Cadmium | ND | 1 | mg/kg |
| Lead | 230 | 10 | mg/kg |
| Zinc | 410 | 3 | mg/kg |

* Results are reported on an as received basis (wet wt. mg/kg).
ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.

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Bozeman, Montana 59715

# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | BK 10 | Date Reported: | 09/09/94 |
| Project ID: | #1897-040 / Rico | Date Sampled: | 09/07/94 |
| Laboratory ID: | B948086 | Date Received: | 09/08/94 |
| Sample Matrix: | Soil | Date Digested: | 09/08/94 |
| | | Date Analyzed: | 09/09/94 |

| Parameter | Analytical Result | Detection Level | Units * |
|---|---|---|---|
| Arsenic | ND | 10 | mg/kg |
| Cadmium | 1.6 | 1 | mg/kg |
| Lead | 190 | 10 | mg/kg |
| Zinc | 360 | 3 | mg/kg |

* Results are reported on an as received basis (wet wt. mg/kg).
ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | BK 11 | Date Reported: | 09/09/94 |
| Project ID: | #1897-040 / Rico | Date Sampled: | 09/07/94 |
| Laboratory ID: | B948087 | Date Received: | 09/08/94 |
| Sample Matrix: | Soil | Date Digested: | 09/08/94 |
| | | Date Analyzed: | 09/09/94 |

| Parameter | Analytical Result | Detection Level | Units * |
|---|---|---|---|
| Arsenic | ND | 10 | mg/kg |
| Cadmium | ND | 1 | mg/kg |
| Lead | 62 | 10 | mg/kg |
| Zinc | 150 | 3 | mg/kg |

* Results are reported on an as received basis (wet wt. mg/kg).
ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | BK 38 | Date Reported: | 09/09/94 |
| Project ID: | #1897-040 / Rico | Date Sampled: | 09/07/94 |
| Laboratory ID: | B948088 | Date Received: | 09/08/94 |
| Sample Matrix: | Soil | Date Digested: | 09/08/94 |
| | | Date Analyzed: | 09/09/94 |

| Parameter | Analytical Result | Detection Level | Units * |
|---|---|---|---|
| Arsenic | ND | 10 | mg/kg |
| Cadmium | ND | 1 | mg/kg |
| Lead | 84 | 10 | mg/kg |
| Zinc | 160 | 3 | mg/kg |

* Results are reported on an as received basis (wet wt. mg/kg).
ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | BK 39 | Date Reported: | 09/09/94 |
| Project ID: | #1897-040 / Rico | Date Sampled: | 09/07/94 |
| Laboratory ID: | B948089 | Date Received: | 09/08/94 |
| Sample Matrix: | Soil | Date Digested: | 09/08/94 |
| | | Date Analyzed: | 09/09/94 |

| Parameter | Analytical Result | Detection Level | Units * |
|---|---|---|---|
| Arsenic | 14 | 10 | mg/kg |
| Cadmium | ND | 1 | mg/kg |
| Lead | 96 | 10 | mg/kg |
| Zinc | 160 | 3 | mg/kg |

* Results are reported on an as received basis (wet wt. mg/kg).
ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | Lots 17-20 | Date Reported: | 09/09/94 |
| Project ID: | #1897-040 / Rico | Date Sampled: | 09/07/94 |
| Laboratory ID: | B948090 | Date Received: | 09/08/94 |
| Sample Matrix: | Soil | Date Digested: | 09/08/94 |
| | | Date Analyzed: | 09/09/94 |

| Parameter | Analytical Result | Detection Level | Units * |
|---|---|---|---|
| Arsenic | ND | 10 | mg/kg |
| Cadmium | 9.5 | 1 | mg/kg |
| Lead | 830 | 10 | mg/kg |
| Zinc | 2000 | 3 | mg/kg |

* Results are reported on an as received basis (wet wt. mg/kg).
ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | School Lots | Date Reported: | 09/09/94 |
| Project ID: | #1897-040 / Rico | Date Sampled: | 09/07/94 |
| Laboratory ID: | B948091 | Date Received: | 09/08/94 |
| Sample Matrix: | Soil | Date Digested: | 09/08/94 |
| | | Date Analyzed: | 09/09/94 |

| Parameter | Analytical Result | Detection Level | Units * |
|---|---|---|---|
| Arsenic | ND | 10 | mg/kg |
| Cadmium | 6.6 | 1 | mg/kg |
| Lead | 650 | 10 | mg/kg |
| Zinc | 1500 | 3 | mg/kg |

* Results are reported on an as received basis (wet wt. mg/kg).
ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.

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# QUALITY ASSURANCE / QUALITY CONTROL

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# LAB QA/QC
# TOTAL METALS ANALYSIS
# MATRIX SPIKE

Date Analyzed: 09/08/94
Laboratory ID: B948083
Sample Matrix: Soil

| Parameter | Spike Added (mg/L) | Sample Conc. (mg/L) | MS Conc. (mg/L) | MS Recovery (%) | QC Limits (% Rec.) |
|---|---|---|---|---|---|
| Arsenic | 2.5 | 0.57 | 2.7 | 85 | 75 - 125 |
| Cadmium | 0.50 | 0.04 | 0.49 | 91 | 75 - 125 |
| Lead | 1.5 | 5.2 | 6.6 | 95 | 75 - 125 |
| Zinc | 1.0 | 10.2 | 11.2 | 106 | 75 - 125 |

ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.

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# LAB QA/QC
# TOTAL METALS ANALYSIS
# DUPLICATE ANALYSIS

Date Analyzed: 09/08/94
Laboratory ID: B948083
Sample Matrix: Soil

| Parameter | Analytical Result (mg/kg) | Duplicate Result (mg/kg) | Percent RPD ( % ) | QC Limits ( % ) |
|---|---|---|---|---|
| Arsenic | 13 | 14 | 7 | 25 |
| Cadmium | 2.1 | 2.6 | 21 | 25 |
| Lead | 260 | 300 | 14 | 25 |
| Zinc | 500 | 550 | 10 | 25 |

* Results are reported on an as received basis (wet wt. mg/kg).
ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges. SW-846, September 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission Spectroscopy, SW-846, September 1986.

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Walsh & Associates, Inc.
Environmental Scientists and Engineers

CHAIN OF CUSTODY RECORD

№ 2845

4888 Pearl East Avenue, Suite 108
Boulder Colorado 80301

TO: Deb Anderson

Proj. No. 1897-040 Project Name RICO

SAMPLERS: (Signature) [signature]

| Sta No | Date | Time | Station Location | Sample Tag No. | As, Cd, Pb, Zn | No. of Containers | Remarks |
|---|---|---|---|---|---|---|---|
| 8946075 | 9/7/94 | 1030 | Smuggler | 39321 | ✓ | 1 | 1-4oz ea. |
| 8076 | 9/7/94 | 1045 | Yankee Boy | 39322 | ✓ | 1 | |
| 8077 | 9/7/94 | 1102 | Hillside #2 | 39323 | ✓ | 1 | |
| 8078 | 9/7/94 | 1115 | Hillside | 39324 | ✓ | 1 | |
| 8079 | 9/7/94 | 1125 | Home | 39325 | ✓ | 1 | |
| 8060 | 9/7/94 | 1140 | Sam Patch | 39326 | ✓ | 1 | |
| 8061 | 9/7/94 | 1225 | Patrick | 39327 | ✓ | 1 | |
| 8062 | 9/7/94 | 1310 | Ada North | 39328 | ✓ | 1 | |
| 8063 | 9/7/94 | 1320 | Group tract | 39329 | ✓ | 1 | |
| 8084 | 9/7/94 | 14:29 | Trench 1 | 39330, 39340 | ✓ | 2 | 2-4oz. |
| 8065 | 9/7/94 | 14:43 | Trench 2 | 39331, 39341 | ✓ | 2 | " |
| 8066 | 9/7/94 | 1505 | ~~Trench 3~~ BK 10 | 39332-333 | ✓ | 2 | 2-2oz |
| 8087 | 9/7/94 | 15:20 | BK 11 | 39334-335 | ✓ | 2 | " |
| 8088 | 9/7/94 | 15:21 | BK 38 | 39336 | ✓ | 1 | |
| 8089 | 9/7/94 | 15:25 | BK 39 | 39337 | ✓ | 1 | |

| Relinquished by: (Sign.) | Date/Time | Received by: (Sign.) | Relinquished by: (Sign.) | Date/Time | Received by: (Sign.) |
|---|---|---|---|---|---|
| [signature] | 17:05 9/7 | Fed Ex | Fed Ex. (carrier) | 9/8/94 9400 | [signature] |
| Relinquished by: (Sign.) | Date/Time | Received by: (Sign.) | Relinquished by: (Sign.) | Date/Time | Received by: (Sign.) |
| | | | | | |
| Relinquished by: (Sign.) | Date/Time | Received for Laboratory by: (Sign.) | Date/Time | Remarks: "cooler" temp. 20.1 (bag w/blue ice) | |

Distribution: Original accompanies shipment.

WALSH & ASSOCIATES, INC

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# *CASE NARRATIVE*

On June 18, 1994, twelve soil samples were received for analysis at Inter-Mountain Laboratories, Bozeman, Montana. The chain of custody form requested analysis for ICP scan for metals and mercury. Client name/Project name was listed as Walsh & Associates / 1897-010 / Rico Co.

Detectable amounts of targeted compounds were present in all of the samples.

Limits of detection for each instrument/analysis are determined by sample matrix effects, instrument performance under standard conditions, and dilution requirements to maintain chromatography output within calibration ranges.

*Wynn Sudtelgte*
IML-Bozeman

0714wa2

Inter-Mountain Laboratories, Inc.

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# GENERAL PARAMETERS
# PERCENT SOLIDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | Inclusive | Date Reported: | 07/14/94 |
| Project ID: | 1897-010 / Rico Co | Date Sampled: | 06/13/94 |
| Laboratory ID: | B945766-5777 | Date Received: | 06/18/94 |
| Sample Matrix: | Soil | | |
| Preservation: | cool | | |
| Condition: | intact | | |

| Sample ID | Lab ID | Analytical Result | Units |
|---|---|---|---|
| RS-01 | B945766 | 91 | % |
| RS-02 | B945767 | 95 | % |
| RS-04 | B945768 | 95 | % |
| RS-05 | B945769 | 97 | % |
| RS-06 | B945770 | 97 | % |
| RS-08 | B945771 | 84 | % |
| [illegible]10 | B945772 | 97 | % |
| RS-12 | B945773 | 98 | % |
| RS-13 | B945774 | 98 | % |
| RP-01 | B945775 | 98 | % |
| RP-03 | B945776 | 88 | % |
| RA-01 | B945777 | 96 | % |

Reference: Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, Third Edition, November 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | RS-01 | Date Reported: | 07/12/94 |
| Project ID: | 1897-010 / Rico Co | Date Sampled: | 06/13/94 |
| Laboratory ID: | B945766 | Date Received: | 06/18/94 |
| Sample Matrix: | Soil | Date Extracted : | 07/05/94 |
| Preservation: | Cool | Date Analyzed: | 07/06/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 17000 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | ND | 20 | mg/kg |
| Barium | 110 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | ND | 2 | mg/kg |
| Chromium | 19 | 5 | mg/kg |
| Cobalt | 10 | 5 | mg/kg |
| Copper | 27 | 5 | mg/kg |
| Iron | 23000 | 100 | mg/kg |
| Lead | 100 | 20 | mg/kg |
| Manganese | 1100 | 100 | mg/kg |
| Mercury | ND | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 21 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | ND | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 330 | 5 | mg/kg |
| Vanadium | 26 | 10 | mg/kg |
| Zinc | 190 | 5 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 6000 | 100 | mg/kg |
| Potassium | 3000 | 100 | mg/kg |
| Magnesium | 11000 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 9500 | 200 | mg/kg |
| Silicon | 450 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND- Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.
Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor
Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | RS-02 | Date Reported: | 07/12/94 |
| Project ID: | 1897-010 / Rico Co | Date Sampled: | 06/13/94 |
| Laboratory ID: | B945767 | Date Received: | 06/18/94 |
| Sample Matrix: | Soil | Date Extracted : | 07/05/94 |
| Preservation: | Cool | Date Analyzed: | 07/06/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 15000 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | 62 | 20 | mg/kg |
| Barium | 170 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 7 | 2 | mg/kg |
| Chromium | 21 | 5 | mg/kg |
| Cobalt | 7 | 5 | mg/kg |
| Copper | 190 | 5 | mg/kg |
| Iron | 53000 | 100 | mg/kg |
| Lead | 1500 | 20 | mg/kg |
| Manganese | 1100 | 100 | mg/kg |
| Mercury | 2.5 | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 14 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | 11 | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 220 | 5 | mg/kg |
| Vanadium | 27 | 10 | mg/kg |
| Zinc | 990 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 1300 | 100 | mg/kg |
| Potassium | 2200 | 100 | mg/kg |
| Magnesium | 10000 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 1300 | 200 | mg/kg |
| Silicon | 560 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND-Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.
Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor
Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | RS-04 | Date Reported: | 07/12/94 |
| Project ID: | 1897-010 / Rico Co | Date Sampled: | 06/13/94 |
| Laboratory ID: | B945768 | Date Received: | 06/18/94 |
| Sample Matrix: | Soil | Date Extracted : | 07/05/94 |
| Preservation: | Cool | Date Analyzed: | 07/06/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 16000 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | 26 | 20 | mg/kg |
| Barium | 140 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 10 | 2 | mg/kg |
| Chromium | 19 | 5 | mg/kg |
| Cobalt | 10 | 5 | mg/kg |
| Copper | 170 | 5 | mg/kg |
| Iron | 32000 | 100 | mg/kg |
| Lead | 160 | 20 | mg/kg |
| Manganese | 1500 | 100 | mg/kg |
| Mercury | 0.8 | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 18 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | 10 | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 270 | 5 | mg/kg |
| Vanadium | 26 | 10 | mg/kg |
| Zinc | 1500 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 5500 | 100 | mg/kg |
| Potassium | 2300 | 100 | mg/kg |
| Magnesium | 8700 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 1000 | 200 | mg/kg |
| Silicon | 730 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND-Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.
Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor
Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | RS-05 | Date Reported: | 07/12/94 |
| Project ID: | 1897-010 / Rico Co | Date Sampled: | 06/13/94 |
| Laboratory ID: | 8945769 | Date Received: | 06/18/94 |
| Sample Matrix: | Soil | Date Extracted : | 07/05/94 |
| Preservation: | Cool | Date Analyzed: | 07/06/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 19000 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | ND | 20 | mg/kg |
| Barium | 150 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 6 | 2 | mg/kg |
| Chromium | 21 | 5 | mg/kg |
| Cobalt | 8 | 5 | mg/kg |
| Copper | 33 | 5 | mg/kg |
| Iron | 25000 | 100 | mg/kg |
| Lead | 280 | 20 | mg/kg |
| Manganese | 1400 | 100 | mg/kg |
| Mercury | ND | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 16 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | ND | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 450 | 5 | mg/kg |
| Vanadium | 29 | 10 | mg/kg |
| Zinc | 880 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 4600 | 100 | mg/kg |
| Potassium | 2900 | 100 | mg/kg |
| Magnesium | 7000 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 670 | 200 | mg/kg |
| Silicon | 560 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND-Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.
Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor
Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | RS-06 | Date Reported: | 07/12/94 |
| Project ID: | 1897-010 / Rico Co | Date Sampled: | 06/13/94 |
| Laboratory ID: | B945770 | Date Received: | 06/18/94 |
| Sample Matrix: | Soil | Date Extracted : | 07/05/94 |
| Preservation: | Cool | Date Analyzed: | 07/06/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 10000 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | 22 | 20 | mg/kg |
| Barium | 150 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 3 | 2 | mg/kg |
| Chromium | 11 | 5 | mg/kg |
| Cobalt | 9 | 5 | mg/kg |
| Copper | 53 | 5 | mg/kg |
| Iron | 28000 | 100 | mg/kg |
| Lead | 90 | 20 | mg/kg |
| Manganese | 1100 | 100 | mg/kg |
| Mercury | 1.7 | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 14 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | ND | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 130 | 5 | mg/kg |
| Vanadium | 22 | 10 | mg/kg |
| Zinc | 200 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 4300 | 100 | mg/kg |
| Potassium | 2100 | 100 | mg/kg |
| Magnesium | 4400 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 840 | 200 | mg/kg |
| Silicon | 730 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND-Parameter not detected at stated Detection Limit.

References:

Method 3050: Acid digestion of Soils, Sediments, and Sludges. SW-846, September 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission Spectroscopy, SW-846, September 1986.

Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | RS-08 | Date Reported: | 07/12/94 |
| Project ID: | 1897-010 / Rico Co | Date Sampled: | 06/13/94 |
| Laboratory ID: | B945771 | Date Received: | 06/18/94 |
| Sample Matrix: | Soil | Date Extracted : | 07/05/94 |
| Preservation: | Cool | Date Analyzed: | 07/06/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 8600 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | ND | 20 | mg/kg |
| Barium | 180 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | ND | 2 | mg/kg |
| Chromium | 8 | 5 | mg/kg |
| Cobalt | ND | 5 | mg/kg |
| Copper | 21 | 5 | mg/kg |
| Iron | 12000 | 100 | mg/kg |
| Lead | 140 | 20 | mg/kg |
| Manganese | 790 | 100 | mg/kg |
| Mercury | ND | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 9 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | ND | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 140 | 5 | mg/kg |
| Vanadium | 13 | 10 | mg/kg |
| Zinc | 220 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 8500 | 100 | mg/kg |
| Potassium | 2000 | 100 | mg/kg |
| Magnesium | 3300 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 670 | 200 | mg/kg |
| Silicon | 730 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND-Parameter not detected at stated Detection Limit.

References:

Method 3050: *Acid digestion of Soils, Sediments, and Sludges.* SW-846, September 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission Spectroscopy, SW-846, September 1986.

Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | RS-10 | Date Reported: | 07/12/94 |
| Project ID: | 1897-010 / Rico Co | Date Sampled: | 06/13/94 |
| Laboratory ID: | B945772 | Date Received: | 06/18/94 |
| Sample Matrix: | Soil | Date Extracted : | 07/05/94 |
| Preservation: | Cool | Date Analyzed: | 07/06/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 18000 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | 20 | 20 | mg/kg |
| Barium | 130 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 3 | 2 | mg/kg |
| Chromium | 23 | 5 | mg/kg |
| Cobalt | 10 | 5 | mg/kg |
| Copper | 54 | 5 | mg/kg |
| Iron | 37000 | 100 | mg/kg |
| Lead | 160 | 20 | mg/kg |
| Manganese | 1100 | 100 | mg/kg |
| Mercury | ND | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 23 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | ND | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 240 | 5 | mg/kg |
| Vanadium | 26 | 10 | mg/kg |
| Zinc | 240 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 3700 | 100 | mg/kg |
| Potassium | 3200 | 100 | mg/kg |
| Magnesium | 11000 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 1000 | 200 | mg/kg |
| Silicon | 500 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND-Parameter not detected at stated Detection Limit.

References:

Method 3050: Acid digestion of Soils, Sediments, and Sludges. SW-846, September 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission Spectroscopy, SW-846, September 1986.

Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | RS-12 | Date Reported: | 07/12/94 |
| Project ID: | 1897-010 / Rico Co | Date Sampled: | 06/13/94 |
| Laboratory ID: | B945773 | Date Received: | 06/18/94 |
| Sample Matrix: | Soil | Date Extracted : | 07/05/94 |
| Preservation: | Cool | Date Analyzed: | 07/06/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 11000 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | 37 | 20 | mg/kg |
| Barium | 100 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 19 | 2 | mg/kg |
| Chromium | 13 | 5 | mg/kg |
| Cobalt | 8 | 5 | mg/kg |
| Copper | 330 | 5 | mg/kg |
| Iron | 28000 | 100 | mg/kg |
| Lead | 5200 | 20 | mg/kg |
| Manganese | 1300 | 100 | mg/kg |
| Mercury | ND | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 13 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | 13 | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 220 | 5 | mg/kg |
| Vanadium | 21 | 10 | mg/kg |
| Zinc | 2400 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 3700 | 100 | mg/kg |
| Potassium | 1500 | 100 | mg/kg |
| Magnesium | 5800 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 790 | 200 | mg/kg |
| Silicon | 410 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND-Parameter not detected at stated Detection Limit.

References:

Method 3050: Acid digestion of Soils, Sediments, and Sludges. SW-846, September 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission Spectroscopy, SW-846, September 1986.

Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | RS-13 | Date Reported: | 07/12/94 |
| Project ID: | 1897-010 / Rico Co | Date Sampled: | 06/13/94 |
| Laboratory ID: | B945774 | Date Received: | 06/18/94 |
| Sample Matrix: | Soil | Date Extracted : | 07/05/94 |
| Preservation: | Cool | Date Analyzed: | 07/06/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 18000 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | 47 | 20 | mg/kg |
| Barium | 210 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 20 | 2 | mg/kg |
| Chromium | 22 | 5 | mg/kg |
| Cobalt | 11 | 5 | mg/kg |
| Copper | 660 | 5 | mg/kg |
| Iron | 47000 | 100 | mg/kg |
| Lead | 4800 | 20 | mg/kg |
| Manganese | 5600 | 100 | mg/kg |
| Mercury | 0.6 | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 20 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | 64 | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 360 | 5 | mg/kg |
| Vanadium | 56 | 10 | mg/kg |
| Zinc | 4000 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 12000 | 100 | mg/kg |
| Potassium | 2900 | 100 | mg/kg |
| Magnesium | 8700 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 8200 | 200 | mg/kg |
| Silicon | 630 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND-Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.
Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor
Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | RP-01 | Date Reported: | 07/12/94 |
| Project ID: | 1897-010 / Rico Co | Date Sampled: | 06/13/94 |
| Laboratory ID: | B945775 | Date Received: | 06/18/94 |
| Sample Matrix: | Soil | Date Extracted : | 07/05/94 |
| Preservation: | Cool | Date Analyzed: | 07/06/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 5800 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | 74 | 20 | mg/kg |
| Barium | 130 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 60 | 2 | mg/kg |
| Chromium | 6 | 5 | mg/kg |
| Cobalt | ND | 5 | mg/kg |
| Copper | 590 | 5 | mg/kg |
| Iron | 56000 | 100 | mg/kg |
| Lead | 8500 | 20 | mg/kg |
| Manganese | 1200 | 100 | mg/kg |
| Mercury | 0.4 | 0.2 | mg/kg |
| Molybdenum | 34 | 20 | mg/kg |
| Nickel | ND | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | 220 | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 43 | 5 | mg/kg |
| Vanadium | 12 | 10 | mg/kg |
| Zinc | 9000 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 3100 | 100 | mg/kg |
| Potassium | 1800 | 100 | mg/kg |
| Magnesium | 4100 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 720 | 200 | mg/kg |
| Silicon | 240 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND-Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.
Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor
Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | RP-03 | Date Reported: | 07/12/94 |
| Project ID: | 1897-010 / Rico Co | Date Sampled: | 06/13/94 |
| Laboratory ID: | 8945776 | Date Received: | 06/18/94 |
| Sample Matrix: | Soil | Date Extracted : | 07/05/94 |
| Preservation: | Cool | Date Analyzed: | 07/06/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 12000 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | 26 | 20 | mg/kg |
| Barium | 90 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 84 | 2 | mg/kg |
| Chromium | 24 | 5 | mg/kg |
| Cobalt | 13 | 5 | mg/kg |
| Copper | 570 | 5 | mg/kg |
| Iron | 57000 | 5 | mg/kg |
| Lead | 7000 | 20 | mg/kg |
| Manganese | 5000 | 5 | mg/kg |
| Mercury | 0.4 | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 21 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | 68 | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 150 | 5 | mg/kg |
| Vanadium | 18 | 10 | mg/kg |
| Zinc | 13000 | 5 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 25000 | 100 | mg/kg |
| Potassium | 1300 | 100 | mg/kg |
| Magnesium | 11000 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 520 | 200 | mg/kg |
| Silicon | 580 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND-Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission Spectroscopy, SW-846, September 1986.
Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | RA-01 | Date Reported: | 07/12/94 |
| Project ID: | 1897-010 / Rico Co | Date Sampled: | 06/13/94 |
| Laboratory ID: | B945777 | Date Received: | 06/18/94 |
| Sample Matrix: | Soil | Date Extracted : | 07/05/94 |
| Preservation: | Cool | Date Analyzed: | 07/06/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 10000 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | 50 | 20 | mg/kg |
| Barium | 70 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 10 | 2 | mg/kg |
| Chromium | 10 | 5 | mg/kg |
| Cobalt | 10 | 5 | mg/kg |
| Copper | 190 | 5 | mg/kg |
| Iron | 44000 | 5 | mg/kg |
| Lead | 180 | 20 | mg/kg |
| Manganese | 2300 | 5 | mg/kg |
| Mercury | ND | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 15 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | ND | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 170 | 5 | mg/kg |
| Vanadium | 15 | 10 | mg/kg |
| Zinc | 1400 | 5 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 8800 | 100 | mg/kg |
| Potassium | 1600 | 100 | mg/kg |
| Magnesium | 7400 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 660 | 200 | mg/kg |
| Silicon | 380 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND-Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.
Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor
Technique), SW-846, September 1986.

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# CHAIN OF CUSTODY RECORD

| Client/Project Name | Project Location |
|---|---|
| Walsh Environmental / 1897-010 | Rico CO |

Sampler: (Signature) [signature]

Chain of Custody Tape No.

ANALYSES / PARAMETERS

| Sample No./ Identification | Date | Time | Lab Number | Matrix | No. of Containers | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| RS-01 (Jar 10) | 6/13/94 | | B945766 | Soil | 1 | | | | | 1-2oz. ea. |
| RS-02 (Jar 15) | | | 5767 | | 1 | | | | | |
| RS-04 (Jar 11) | | | 5768 | | 1 | | | | | |
| RS-05 (Jar 8) | | | 5769 | | 1 | | | | | |
| RS-06 (Jar 9) | | | 5770 | | 1 | | | | | |
| RS-08 (Jar 5) | | | 5771 | | 1 | | | | | |
| RS-10 (Jar 1) | | | 5772 | | 1 | | | | | |
| RS-12 (Jar 2) | | | 5773 | | 1 | | | | | |
| RS-13 (Jar 4) | | | 5774 | | 1 | | | | | |
| RP-01 (Jar 14) | | | 5775 | | 1 | | | | | |
| RP-03 (Jar 17) | | | 5776 | | 1 | | | | | |
| RA-01 (Jar 12) | | | 5777 | | 1 | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

| Relinquished by: (Signature) | Date | Time | Received by: (Signature) | Date | Time |
|---|---|---|---|---|---|
| [signature] | 6/14/94 | 1545 | Fed Ex. (carrier) | | |
| Relinquished by: (Signature) | Date | Time | Received by: (Signature) | Date | Time |
| Fed Ex. (carrier) | | | I. ML via Fed Ex. | 6/18/94 | 1030 AM |
| Relinquished by: (Signature) | Date | Time | Received by laboratory: (Signature) | Date | Time |
| | | | | | |

## Inter-Mountain Laboratories, Inc.

| | | | | | |
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# *CASE NARRATIVE*

On August 13, 1994, eighteen samples were received for analysis at Inter-Mountain Laboratories, Bozeman, Montana. The chain of custody form requested analysis for Toxicity Characteristic Leaching Procedure Parameters, metals only, volatile organic compounds, semivolatile organic compounds, and ICP metals scans. Client name / Project name was listed as Walsh Environmental / Rico / Rico, CO.

Detectable amounts of targeted compounds were present in the samples. Sample T-03 was above the regulatory limit for lead in a TCLP.

The Toxicity Characteristic Leaching Procedure methodology used is outlined in the Federal Register, 40 CFR 261, Vol. 55, No. 126, June 29, 1990. Results are reported in mass per unit volume of leachate (mg/L).

Limits of detection for each instrument/analysis are determined by sample matrix effects, instrument performance under standard conditions, and dilution requirements to maintain chromatography output within calibration ranges.

*Wynn Sudtelgte*
IML-Bozeman

0830wa

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | RS-15 | Date Reported: | 08/29/94 |
| Project ID: | Rico, Colorado | Date Sampled: | 08/09/94 |
| Laboratory ID: | B947369 | Date Received: | 08/13/94 |
| Sample Matrix: | Soil | Date Digested: | 08/24/94 |
| | | Date Analyzed: | 08/25/94 |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 13000 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | 21 | 20 | mg/kg |
| Barium | 160 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 57 | 2 | mg/kg |
| Chromium | 21 | 5 | mg/kg |
| Cobalt | 9 | 5 | mg/kg |
| Copper | 500 | 5 | mg/kg |
| Iron | 38000 | 100 | mg/kg |
| Lead | 3900 | 20 | mg/kg |
| Manganese | 3000 | 100 | mg/kg |
| Mercury | 0.5 | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 15 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | 16 | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 210 | 5 | mg/kg |
| Vanadium | 28 | 10 | mg/kg |
| Zinc | 7700 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 12000 | 100 | mg/kg |
| Potassium | 2100 | 100 | mg/kg |
| Magnesium | 8400 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 620 | 200 | mg/kg |
| Silicon | 870 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.
Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor
Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | RS-16 | Date Reported: | 08/29/94 |
| Project ID: | Rico, Colorado | Date Sampled: | 08/09/94 |
| Laboratory ID: | B947370 | Date Received: | 08/13/94 |
| Sample Matrix: | Soil | Date Digested: | 08/24/94 |
| | | Date Analyzed: | 08/25/94 |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 15000 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | ND | 20 | mg/kg |
| Barium | 210 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 6 | 2 | mg/kg |
| Chromium | ND | 5 | mg/kg |
| Cobalt | 8 | 5 | mg/kg |
| Copper | 84 | 5 | mg/kg |
| Iron | 33000 | 100 | mg/kg |
| Lead | 750 | 20 | mg/kg |
| Manganese | 1800 | 100 | mg/kg |
| Mercury | 0.4 | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 13 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | ND | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 230 | 5 | mg/kg |
| Vanadium | 31 | 10 | mg/kg |
| Zinc | 1300 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 4800 | 100 | mg/kg |
| Potassium | 2900 | 100 | mg/kg |
| Magnesium | 6300 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 900 | 200 | mg/kg |
| Silicon | 390 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.
Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor
Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | RS-17 | Date Reported: | 08/29/94 |
| Project ID: | Rico, Colorado | Date Sampled: | 08/09/94 |
| Laboratory ID: | B947371 | Date Received: | 08/13/94 |
| Sample Matrix: | Soil | Date Digested: | 08/24/94 |
| | | Date Analyzed: | 08/25/94 |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 11000 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | ND | 20 | mg/kg |
| Barium | 140 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 7 | 2 | mg/kg |
| Chromium | 14 | 5 | mg/kg |
| Cobalt | 6 | 5 | mg/kg |
| Copper | 66 | 5 | mg/kg |
| Iron | 25000 | 100 | mg/kg |
| Lead | 540 | 20 | mg/kg |
| Manganese | 740 | 100 | mg/kg |
| Mercury | ND | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 10 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | ND | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 100 | 5 | mg/kg |
| Vanadium | 22 | 10 | mg/kg |
| Zinc | 750 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 5800 | 100 | mg/kg |
| Potassium | 1900 | 100 | mg/kg |
| Magnesium | 4900 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 580 | 200 | mg/kg |
| Silicon | 220 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.
Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor
Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | RS-18 | Date Reported: | 08/29/94 |
| Project ID: | Rico, Colorado | Date Sampled: | 08/09/94 |
| Laboratory ID: | B947372 | Date Received: | 08/13/94 |
| Sample Matrix: | Soil | Date Digested: | 08/24/94 |
| | | Date Analyzed: | 08/25/94 |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 16000 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | ND | 20 | mg/kg |
| Barium | 200 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 13 | 2 | mg/kg |
| Chromium | 20 | 5 | mg/kg |
| Cobalt | 10 | 5 | mg/kg |
| Copper | 110 | 5 | mg/kg |
| Iron | 36000 | 100 | mg/kg |
| Lead | 1400 | 20 | mg/kg |
| Manganese | 2400 | 100 | mg/kg |
| Mercury | 0.5 | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 12 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | ND | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 230 | 5 | mg/kg |
| Vanadium | 31 | 10 | mg/kg |
| Zinc | 2400 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 11000 | 100 | mg/kg |
| Potassium | 2900 | 100 | mg/kg |
| Magnesium | 9400 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 660 | 200 | mg/kg |
| Silicon | 950 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission Spectroscopy, SW-846, September 1986.
Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | RS-19 | Date Reported: | 08/29/94 |
| Project ID: | Rico, Colorado | Date Sampled: | 08/10/94 |
| Laboratory ID: | B947373 | Date Received: | 08/13/94 |
| Sample Matrix: | Soil | Date Digested: | 08/24/94 |
| | | Date Analyzed: | 08/25/94 |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 5600 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | 28 | 20 | mg/kg |
| Barium | 160 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 23 | 2 | mg/kg |
| Chromium | 10 | 5 | mg/kg |
| Cobalt | ND | 5 | mg/kg |
| Copper | 260 | 5 | mg/kg |
| Iron | 24000 | 100 | mg/kg |
| Lead | 12000 | 20 | mg/kg |
| Manganese | 800 | 100 | mg/kg |
| Mercury | 0.5 | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 5 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | 21 | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 100 | 5 | mg/kg |
| Vanadium | 15 | 10 | mg/kg |
| Zinc | 3700 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 5800 | 100 | mg/kg |
| Potassium | 1900 | 100 | mg/kg |
| Magnesium | 3100 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 320 | 200 | mg/kg |
| Silicon | 420 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.
Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor
Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | RS-20 | Date Reported: | 08/29/94 |
| Project ID: | Rico, Colorado | Date Sampled: | 08/10/94 |
| Laboratory ID: | B947374 | Date Received: | 08/13/94 |
| Sample Matrix: | Soil | Date Digested: | 08/24/94 |
| | | Date Analyzed: | 08/25/94 |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 9800 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | 22 | 20 | mg/kg |
| Barium | 190 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 17 | 2 | mg/kg |
| Chromium | 17 | 5 | mg/kg |
| Cobalt | 10 | 5 | mg/kg |
| Copper | 330 | 5 | mg/kg |
| Iron | 51000 | 100 | mg/kg |
| Lead | 2000 | 20 | mg/kg |
| Manganese | 1800 | 100 | mg/kg |
| Mercury | 0.8 | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 14 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | ND | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 130 | 5 | mg/kg |
| Vanadium | 29 | 10 | mg/kg |
| Zinc | 2400 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 3800 | 100 | mg/kg |
| Potassium | 2000 | 100 | mg/kg |
| Magnesium | 4200 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 840 | 200 | mg/kg |
| Silicon | 430 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.
Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor
Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | RS-21 | Date Reported: | 08/29/94 |
| Project ID: | Rico, Colorado | Date Sampled: | 08/10/94 |
| Laboratory ID: | B947375 | Date Received: | 08/13/94 |
| Sample Matrix: | Soil | Date Digested: | 08/24/94 |
| | | Date Analyzed: | 08/25/94 |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 15000 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | ND | 20 | mg/kg |
| Barium | 86 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 38 | 2 | mg/kg |
| Chromium | 24 | 5 | mg/kg |
| Cobalt | 11 | 5 | mg/kg |
| Copper | 240 | 5 | mg/kg |
| Iron | 37000 | 100 | mg/kg |
| Lead | 3400 | 20 | mg/kg |
| Manganese | 2900 | 100 | mg/kg |
| Mercury | 0.3 | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 22 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | 18 | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 150 | 5 | mg/kg |
| Vanadium | 27 | 10 | mg/kg |
| Zinc | 5300 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 41000 | 100 | mg/kg |
| Potassium | 1800 | 100 | mg/kg |
| Magnesium | 19000 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 530 | 200 | mg/kg |
| Silicon | 270 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.
Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor
Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | RS-22 | Date Reported: | 08/29/94 |
| Project ID: | Rico, Colorado | Date Sampled: | 08/10/94 |
| Laboratory ID: | B947376 | Date Received: | 08/13/94 |
| Sample Matrix: | Soil | Date Digested: | 08/24/94 |
| | | Date Analyzed: | 08/25/94 |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 12000 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | ND | 20 | mg/kg |
| Barium | 120 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 33 | 2 | mg/kg |
| Chromium | 18 | 5 | mg/kg |
| Cobalt | 12 | 5 | mg/kg |
| Copper | 200 | 5 | mg/kg |
| Iron | 24000 | 100 | mg/kg |
| Lead | 2000 | 20 | mg/kg |
| Manganese | 1500 | 100 | mg/kg |
| Mercury | 0.6 | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 12 | 5 | mg/kg |
| Selenium | 13 | 20 | mg/kg |
| Silver | ND | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 120 | 5 | mg/kg |
| Vanadium | 24 | 10 | mg/kg |
| Zinc | 4400 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 22000 | 100 | mg/kg |
| Potassium | 2300 | 100 | mg/kg |
| Magnesium | 6600 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 620 | 200 | mg/kg |
| Silicon | 180 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.
Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor
Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | RS-23 | Date Reported: | 08/29/94 |
| Project ID: | Rico, Colorado | Date Sampled: | 08/10/94 |
| Laboratory ID: | B947377 | Date Received: | 08/13/94 |
| Sample Matrix: | Soil | Date Digested: | 08/24/94 |
| | | Date Analyzed: | 08/25/94 |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 11000 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | 29 | 20 | mg/kg |
| Barium | 110 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 11 | 2 | mg/kg |
| Chromium | 19 | 5 | mg/kg |
| Cobalt | 9 | 5 | mg/kg |
| Copper | 160 | 5 | mg/kg |
| Iron | 29000 | 100 | mg/kg |
| Lead | 800 | 20 | mg/kg |
| Manganese | 2500 | 100 | mg/kg |
| Mercury | ND | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 15 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | ND | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 190 | 5 | mg/kg |
| Vanadium | 24 | 10 | mg/kg |
| Zinc | 2000 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 5300 | 100 | mg/kg |
| Potassium | 2000 | 100 | mg/kg |
| Magnesium | 7400 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 580 | 200 | mg/kg |
| Silicon | 630 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.
Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor
Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | RS-24 | Date Reported: | 08/29/94 |
| Project ID: | Rico, Colorado | Date Sampled: | 08/10/94 |
| Laboratory ID: | 8947378 | Date Received: | 08/13/94 |
| Sample Matrix: | Soil | Date Digested: | 08/24/94 |
| | | Date Analyzed: | 08/25/94 |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 11000 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | 30 | 20 | mg/kg |
| Barium | 150 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 11 | 2 | mg/kg |
| Chromium | 18 | 5 | mg/kg |
| Cobalt | 11 | 5 | mg/kg |
| Copper | 190 | 5 | mg/kg |
| Iron | 38000 | 100 | mg/kg |
| Lead | 1000 | 20 | mg/kg |
| Manganese | 1900 | 100 | mg/kg |
| Mercury | 0.4 | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 18 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | ND | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 170 | 5 | mg/kg |
| Vanadium | 25 | 10 | mg/kg |
| Zinc | 1700 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 7300 | 100 | mg/kg |
| Potassium | 1900 | 100 | mg/kg |
| Magnesium | 8000 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 740 | 200 | mg/kg |
| Silicon | 390 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.
Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor
Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | RS-26 | Date Reported: | 08/29/94 |
| Project ID: | Rico, Colorado | Date Sampled: | 08/10/94 |
| Laboratory ID: | B947380 | Date Received: | 08/13/94 |
| Sample Matrix: | Soil | Date Digested: | 08/24/94 |
| | | Date Analyzed: | 08/25/94 |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 15000 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | 27 | 20 | mg/kg |
| Barium | 680 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 9 | 2 | mg/kg |
| Chromium | 37 | 5 | mg/kg |
| Cobalt | 12 | 5 | mg/kg |
| Copper | 310 | 5 | mg/kg |
| Iron | 61000 | 100 | mg/kg |
| Lead | 1600 | 20 | mg/kg |
| Manganese | 13000 | 100 | mg/kg |
| Mercury | 0.9 | 0.2 | mg/kg |
| Molybdenum | 23 | 20 | mg/kg |
| Nickel | 25 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | 41 | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 280 | 5 | mg/kg |
| Vanadium | 29 | 10 | mg/kg |
| Zinc | 4000 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | 26 | 50 | mg/kg |
| Calcium | 28000 | 100 | mg/kg |
| Potassium | 2600 | 100 | mg/kg |
| Magnesium | 12000 | 100 | mg/kg |
| Sodium | 340 | 200 | mg/kg |
| Phosphorous | 1100 | 200 | mg/kg |
| Silicon | 210 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.
Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor
Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | RS-25 | Date Reported: | 08/29/94 |
| Project ID: | Rico, Colorado | Date Sampled: | 08/10/94 |
| Laboratory ID: | B947379 | Date Received: | 08/13/94 |
| Sample Matrix: | Soil | Date Digested: | 08/24/94 |
| | | Date Analyzed: | 08/25/94 |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 7700 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | 40 | 20 | mg/kg |
| Barium | 380 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 4 | 2 | mg/kg |
| Chromium | 15 | 5 | mg/kg |
| Cobalt | 6 | 5 | mg/kg |
| Copper | 200 | 5 | mg/kg |
| Iron | 63000 | 100 | mg/kg |
| Lead | 1200 | 20 | mg/kg |
| Manganese | 1200 | 100 | mg/kg |
| Mercury | ND | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 11 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | 12 | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 180 | 5 | mg/kg |
| Vanadium | 28 | 10 | mg/kg |
| Zinc | 1100 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 5700 | 100 | mg/kg |
| Potassium | 1900 | 100 | mg/kg |
| Magnesium | 3600 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 490 | 200 | mg/kg |
| Silicon | 1300 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.
Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor
Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | RS-26 | Date Reported: | 08/29/94 |
| Project ID: | Rico, Colorado | Date Sampled: | 08/10/94 |
| Laboratory ID: | 8947380 | Date Received: | 08/13/94 |
| Sample Matrix: | Soil | Date Digested: | 08/24/94 |
| | | Date Analyzed: | 08/25/94 |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 15000 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | 27 | 20 | mg/kg |
| Barium | 680 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 9 | 2 | mg/kg |
| Chromium | 37 | 5 | mg/kg |
| Cobalt | 12 | 5 | mg/kg |
| Copper | 310 | 5 | mg/kg |
| Iron | 61000 | 100 | mg/kg |
| Lead | 1600 | 20 | mg/kg |
| Manganese | 13000 | 100 | mg/kg |
| Mercury | 0.9 | 0.2 | mg/kg |
| Molybdenum | 23 | 20 | mg/kg |
| Nickel | 25 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | 41 | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 280 | 5 | mg/kg |
| Vanadium | 29 | 10 | mg/kg |
| Zinc | 4000 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | 26 | 50 | mg/kg |
| Calcium | 28000 | 100 | mg/kg |
| Potassium | 2600 | 100 | mg/kg |
| Magnesium | 12000 | 100 | mg/kg |
| Sodium | 340 | 200 | mg/kg |
| Phosphorous | 1100 | 200 | mg/kg |
| Silicon | 210 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.
Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor
Technique), SW-846, September 1986.

Analyst

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Inter-Mountain Laboratories, Inc.

1160 Research Drive
Bozeman, Montana 59715

# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | RS-27 | Date Reported: | 08/29/94 |
| Project ID: | Rico, Colorado | Date Sampled: | 08/10/94 |
| Laboratory ID: | B947381 | Date Received: | 08/13/94 |
| Sample Matrix: | Soil | Date Digested: | 08/24/94 |
| | | Date Analyzed: | 08/25/94 |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 9900 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | 25 | 20 | mg/kg |
| Barium | 310 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 14 | 2 | mg/kg |
| Chromium | 15 | 5 | mg/kg |
| Cobalt | 9 | 5 | mg/kg |
| Copper | 150 | 5 | mg/kg |
| Iron | 26000 | 100 | mg/kg |
| Lead | 500 | 20 | mg/kg |
| Manganese | 12000 | 100 | mg/kg |
| Mercury | ND | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 17 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | 48 | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 130 | 5 | mg/kg |
| Vanadium | 22 | 10 | mg/kg |
| Zinc | 1500 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 23000 | 100 | mg/kg |
| Potassium | 2100 | 100 | mg/kg |
| Magnesium | 16000 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 830 | 200 | mg/kg |
| Silicon | 620 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.
Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor
Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | RS-28 | Date Reported: | 08/29/94 |
| Project ID: | Rico, Colorado | Date Sampled: | 08/10/94 |
| Laboratory ID: | B947382 | Date Received: | 08/13/94 |
| Sample Matrix: | Soil | Date Digested: | 08/24/94 |
| | | Date Analyzed: | 08/25/94 |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 13000 | 100 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | ND | 20 | mg/kg |
| Barium | 130 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 17 | 2 | mg/kg |
| Chromium | 21 | 5 | mg/kg |
| Cobalt | 10 | 5 | mg/kg |
| Copper | 420 | 5 | mg/kg |
| Iron | 37000 | 100 | mg/kg |
| Lead | 3500 | 20 | mg/kg |
| Manganese | 2000 | 100 | mg/kg |
| Mercury | 0.3 | 0.2 | mg/kg |
| Molybdenum | ND | 20 | mg/kg |
| Nickel | 14 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | 14 | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 170 | 5 | mg/kg |
| Vanadium | 28 | 10 | mg/kg |
| Zinc | 2600 | 20 | mg/kg |
| Gold | ND | 100 | mg/kg |
| Boron | ND | 50 | mg/kg |
| Calcium | 8700 | 100 | mg/kg |
| Potassium | 1600 | 100 | mg/kg |
| Magnesium | 7900 | 100 | mg/kg |
| Sodium | ND | 200 | mg/kg |
| Phosphorous | 590 | 200 | mg/kg |
| Silicon | 430 | 100 | mg/kg |
| Yttrium | ND | 50 | mg/kg |

ND - Parameter not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.
Method 7471: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor
Technique), SW-846, September 1986.

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Bozeman, Montana 59715

# EPA METHOD 8240
# HSL VOLATILE COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | T-01 | Date Reported: | 08/29/94 |
| Project ID: | Rico, Colorado | Date Sampled: | 08/09/94 |
| Laboratory ID: | B947383 | Date Received: | 08/13/94 |
| Sample Matrix: | Soil | Date Extracted: | 08/16/94 |
| | | Date Analyzed: | 08/17/94 |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| 1,1,1-Trichloroethane | ND | 0.2 | mg/kg |
| 1,1,2,2-Tetrachloroethane | ND | 0.2 | mg/kg |
| 1,1,2-Trichloroethane | ND | 0.2 | mg/kg |
| 1,1-Dichloroethane | ND | 0.2 | mg/kg |
| 1,1-Dichloroethene | ND | 0.2 | mg/kg |
| 1,2-Dichloroethane | ND | 0.2 | mg/kg |
| 1,2-Dichloropropane | ND | 0.2 | mg/kg |
| 2-Butanone (MEK) | ND | 1 | mg/kg |
| 2-Hexanone | ND | 0.2 | mg/kg |
| 4-Methyl-2-pentanone (MIBK) | ND | 0.2 | mg/kg |
| Acetone | ND | 1 | mg/kg |
| Benzene | ND | 0.2 | mg/kg |
| Bromodichloromethane | ND | 0.2 | mg/kg |
| Bromoform | ND | 0.2 | mg/kg |
| Bromomethane | ND | 0.2 | mg/kg |
| Carbon Disulfide | ND | 0.2 | mg/kg |
| Carbon Tetrachloride | ND | 0.2 | mg/kg |
| Chlorobenzene | ND | 0.2 | mg/kg |
| Chloroethane | ND | 0.2 | mg/kg |
| Chloroform | ND | 0.2 | mg/kg |
| Chloromethane | ND | 0.2 | mg/kg |
| cis-1,3-Dichloropropene | ND | 0.2 | mg/kg |
| Dibromochloromethane | ND | 0.2 | mg/kg |
| Ethylbenzene | ND | 0.2 | mg/kg |
| m,p-Xylene | ND | 0.2 | mg/kg |
| Methylene chloride | ND | 1 | mg/kg |
| o-Xylene | ND | 0.2 | mg/kg |
| Styrene | ND | 0.2 | mg/kg |

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# EPA METHOD 8240
# HSL VOLATILE COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | T-01 | Date Reported: | 08/29/94 |
| Laboratory ID: | B947383 | Date Sampled: | 08/09/94 |
| Sample Matrix: | Soil | Date Analyzed: | 08/17/94 |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Tetrachloroethene (PCE) | ND | 0.2 | mg/kg |
| Toluene | ND | 0.2 | mg/kg |
| trans-1,2-Dichloroethene | ND | 0.2 | mg/kg |
| trans-1,3-Dichloropropene | ND | 0.2 | mg/kg |
| Trichloroethene (TCE) | ND | 0.2 | mg/kg |
| Vinyl Chloride | ND | 0.2 | mg/kg |

ND - Compound not detected at stated Detection Limit.
J - Meets identification criteria, below Detection Limit.
B - Compound detected in method blank.

Inter-Mountain Laboratories, Inc.

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# EPA METHOD 8240
# TENTATIVELY IDENTIFIED COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | T-01 | Date Reported: | 08/29/94 |
| Laboratory ID: | B947383 | Date Sampled: | 08/09/94 |
| Sample Matrix: | Soil | Date Analyzed: | 08/17/94 |

| Tentative Identification | Retention Time (min) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable levels.

Unknown concentrations calculated assuming a Relative Response Factor = 1.

## QUALITY CONTROL:

| Surrogate Recovery | % | Soil QC Limits |
|---|---|---|
| 1,2-Dichloroethane-d4 | 107 | 70 - 121 |
| Toluene-d8 | 99 | 81 - 117 |
| Bromofluorobenzene | 102 | 74 - 121 |

**References:**

Method 8240, Gas Chromatography/Mass Spectrometry for Volatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, Third Edition, November 1986.

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# EPA METHOD 8270
# HSL SEMI-VOLATILE COMPOUNDS
# BASE/NEUTRAL/ACID EXTRACTABLES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | T-01 | Date Reported: | 08/30/94 |
| Project ID: | Rico, Colorado | Date Sampled: | 08/09/94 |
| Laboratory ID: | B947383 | Date Received: | 08/13/94 |
| Sample Matrix: | Soil | Date Extracted: | 08/18/94 |
| | | Date Analyzed: | 08/30/94 |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| 1,2,4-Trichlorobenzene | ND | 1 | mg/kg |
| 1,2-Dichlorobenzene | ND | 1 | mg/kg |
| 1,3-Dichlorobenzene | ND | 1 | mg/kg |
| 1,4-Dichlorobenzene | ND | 1 | mg/kg |
| 2,4,5-Trichlorophenol | ND | 1 | mg/kg |
| 2,4,6-Trichlorophenol | ND | 1 | mg/kg |
| 2,4-Dichlorophenol | ND | 1 | mg/kg |
| [illegible]-Dimethylphenol | ND | 1 | mg/kg |
| 2,4-Dinitrophenol | ND | 5 | mg/kg |
| 2,4-Dinitrotoluene | ND | 1 | mg/kg |
| 2,6-Dinitrotoluene | ND | 1 | mg/kg |
| 2-Chloronaphthalene | ND | 1 | mg/kg |
| 2-Chlorophenol | ND | 1 | mg/kg |
| 2-Methylnaphthalene | ND | 1 | mg/kg |
| 2-Methylphenol | ND | 1 | mg/kg |
| 2-Nitroaniline | ND | 5 | mg/kg |
| 2-Nitrophenol | ND | 1 | mg/kg |
| 3,3'-Dichlorobenzidine | ND | 2 | mg/kg |
| 3-Methylphenol/4-Methylphenol ** | ND | 1 | mg/kg |
| 3-Nitroaniline | ND | 5 | mg/kg |
| 4,6-Dinitro-2-methylphenol | ND | 5 | mg/kg |
| 4-Bromophenyl-phenylether | ND | 1 | mg/kg |
| 4-Chloro-3-methylphenol | ND | 2 | mg/kg |
| 4-Chloroaniline | ND | 2 | mg/kg |
| 4-Chlorophenyl-phenylether | ND | 1 | mg/kg |
| 4-Nitroaniline | ND | 2 | mg/kg |
| 4-Nitrophenol | ND | 5 | mg/kg |
| Acenaphthene | ND | 1 | mg/kg |
| Acenaphthylene | ND | 1 | mg/kg |
| Anthracene | ND | 1 | mg/kg |
| Benzo(a)anthracene | ND | 1 | mg/kg |
| [illegible]zo(a)pyrene | ND | 1 | mg/kg |
| [illegible]zo(b)fluoranthene | ND | 1 | mg/kg |
| Benzo(g,h,i)perylene | ND | 1 | mg/kg |
| Benzo(k)fluoranthene | ND | 1 | mg/kg |
| Benzoic Acid | ND | 5 | mg/kg |

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# EPA METHOD 8270
# HSL SEMI-VOLATILE COMPOUNDS
# BASE/NEUTRAL/ACID EXTRACTABLES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | T-01 | Date Reported: | 08/30/94 |
| Laboratory ID: | B947383 | Date Sampled: | 08/09/94 |
| Sample Matrix: | Soil | Date Analyzed: | 08/30/94 |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Benzyl Alcohol | ND | 2 | mg/kg |
| bis(2-Chloroethoxy)methane | ND | 1 | mg/kg |
| bis(2-Chloroethyl)ether | ND | 1 | mg/kg |
| bis(2-Chloroisopropyl)ether | ND | 1 | mg/kg |
| bis(2-Ethylhexyl)phthalate | ND | 5 | mg/kg |
| Butylbenzylphthalate | ND | 1 | mg/kg |
| Chrysene | ND | 1 | mg/kg |
| [illegible]-Butylphthalate | ND | 5 | mg/kg |
| Di-n-Octylphthalate | ND | 1 | mg/kg |
| Dibenz(a,h)anthracene | ND | 1 | mg/kg |
| Dibenzofuran | ND | 1 | mg/kg |
| Diethylphthalate | ND | 1 | mg/kg |
| Dimethylphthalate | ND | 1 | mg/kg |
| Fluoranthene | ND | 1 | mg/kg |
| Fluorene | ND | 1 | mg/kg |
| Hexachlorobenzene | ND | 1 | mg/kg |
| Hexachlorobutadiene | ND | 2 | mg/kg |
| Hexachlorocyclopentadiene | ND | 1 | mg/kg |
| Hexachloroethane | ND | 2 | mg/kg |
| Indeno(1,2,3-cd)pyrene | ND | 1 | mg/kg |
| Isophorone | ND | 1 | mg/kg |
| N-Nitrosodi-n-propylamine | ND | 1 | mg/kg |
| N-Nitrosodiphenylamine | ND | 1 | mg/kg |
| Naphthalene | ND | 1 | mg/kg |
| Nitrobenzene | ND | 1 | mg/kg |
| Pentachlorophenol | ND | 5 | mg/kg |
| Phenanthrene | ND | 1 | mg/kg |
| Phenol | ND | 1 | mg/kg |
| Pyrene | ND | 1 | mg/kg |

ND - Compound not detected at stated Detection Limit.
J - Meets identification criteria, below Detection Limit.
** - Compounds coelute by GCMS.
B - Compound detected in Method Blank.

Walsh & Associates, Inc.
Environmental Scientists and Engineers

CHAIN OF CUSTODY RECORD

№ 2847

4888 Pearl East Circle, Suite 108
Boulder Colorado 80301

Proj. No. 1897-040 Project Name RICO

SAMPLERS: (Signature) [signature]

| Sta No | Date | Time | | | Station Location | Sample Tag No. | As Cd Zn Pb | | | | | | | | | | No. of Containers | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3948090 | 9/7/94 | 15:00 | | | LOT 9 17-20 | 39338 | | | | | | | | | | | | |
| 8091 | 9/7/94 | 15:05 | | | SCHOOL LOTS | 39339 | | | | | | | | | | | | |

| Relinquished by: (Sign.) | Date/Time | Received by: (Sign.) | Relinquished by: (Sign.) | Date/Time | Received by: (Sign.) |
|---|---|---|---|---|---|
| [signature] | 1725 9/7/94 | Fed Ex. (carrier) | Fed Ex (carrier) | 9/8/94 940am | [signature] |
| Relinquished by: (Sign.) | Date/Time | Received by: (Sign.) | Relinquished by: (Sign.) | Date/Time | Received by: (Sign.) |
| | | | | | |
| Relinquished by: (Sign.) | Date/Time | Received for Laboratory by: (Sign.) | Date/Time | Remarks: | |
| | | | | | |

Distribution: Original accompanies shipment.

WALSH & ASSOCIATES, INC

*PRIVILEGED AND CONFIDENTIAL*

# WATER ANALYTICAL DATA

Inter-Mountain Laboratories, Inc.

1160 Research Drive
Bozeman, Montana 59715

# *CASE NARRATIVE*

On June 18, 1994, five water samples were received for analysis at Inter-Mountain Laboratories, Bozeman, Montana. The chain of custody form requested analysis for ICP scan for metals and mercury. Client name/Project name was listed as Walsh & Associates / 1897-010 / Rico Co.

Detectable amounts of targeted compounds were present in some of the samples.

Limits of detection for each instrument/analysis are determined by sample matrix effects, instrument performance under standard conditions, and dilution requirements to maintain chromatography output within calibration ranges.

*Wynn Sudtelgte*
IML-Bozeman

0714wa

Inter-Mountain Laboratories, Inc.

1160 Research Drive
Bozeman, Montana 59715

# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | RW-01 | Date Reported: | 07/12/94 |
| Project ID: | 1897-010 / Rico Co | Date Sampled: | 06/15/94 |
| Laboratory ID: | 8945778 | Date Received: | 06/18/94 |
| Sample Matrix: | Water | Date Extracted : | 07/05/94 |
| Preservation: | Cool; HNO3 | Date Analyzed: | 07/06/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | ND | 0.2 | mg/L |
| Antimony | ND | 0.2 | mg/L |
| Arsenic | ND | 0.2 | mg/L |
| Barium | ND | 0.5 | mg/L |
| Beryllium | ND | 0.02 | mg/L |
| Cadmium | ND | 0.02 | mg/L |
| Chromium | ND | 0.05 | mg/L |
| Cobalt | ND | 0.05 | mg/L |
| Copper | ND | 0.05 | mg/L |
| Iron | 0.13 | 0.05 | mg/L |
| Lead | ND | 0.2 | mg/L |
| Manganese | 0.11 | 0.05 | mg/L |
| Mercury | ND | 0.001 | mg/L |
| Molybdenum | ND | 0.05 | mg/L |
| Nickel | ND | 0.05 | mg/L |
| Selenium | ND | 0.2 | mg/L |
| Silver | ND | 0.1 | mg/L |
| Thallium | ND | 0.2 | mg/L |
| Titanium | ND | 0.05 | mg/L |
| Vanadium | ND | 0.1 | mg/L |
| Zinc | 0.22 | 0.05 | mg/L |
| Gold | ND | 2 | mg/L |
| Boron | ND | 1 | mg/L |
| Calcium | 24 | 1 | mg/L |
| Potassium | ND | 1 | mg/L |
| Magnesium | 2.6 | 1 | mg/L |
| Sodium | ND | 2 | mg/L |
| Phosphorous | ND | 2 | mg/L |
| Silicon | 1.7 | 1 | mg/L |
| Yttrium | ND | 0.5 | mg/L |

ND - Compound not detected at stated Detection Limit.

References:
Method 3010: Acid Digestion of Aqueous Samples and Extracts for Total Metals, SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission Spectroscopy, SW-846, September 1986.
Method 7470: Mercury in Liquid Waste (Manual Cold-Vapor Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | RW-02 | Date Reported: | 07/12/94 |
| Project ID: | 1897-010 / Rico Co | Date Sampled: | 06/16/94 |
| Laboratory ID: | B945779 | Date Received: | 06/18/94 |
| Sample Matrix: | Water | Date Extracted : | 07/05/94 |
| Preservation: | Cool; HNO3 | Date Analyzed: | 07/06/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 180 | 0.2 | mg/L |
| Antimony | ND | 0.2 | mg/L |
| Arsenic | ND | 0.2 | mg/L |
| Barium | ND | 0.5 | mg/L |
| Beryllium | ND | 0.02 | mg/L |
| Cadmium | 0.33 | 0.02 | mg/L |
| Chromium | ND | 0.05 | mg/L |
| Cobalt | 0.13 | 0.05 | mg/L |
| Copper | 12 | 0.05 | mg/L |
| Iron | 0.39 | 0.05 | mg/L |
| Lead | ND | 0.2 | mg/L |
| Manganese | 40 | 0.05 | mg/L |
| Mercury | ND | 0.001 | mg/L |
| Molybdenum | ND | 0.05 | mg/L |
| Nickel | 0.39 | 0.05 | mg/L |
| Selenium | ND | 0.2 | mg/L |
| Silver | ND | 0.1 | mg/L |
| Thallium | ND | 0.2 | mg/L |
| Titanium | ND | 0.05 | mg/L |
| Vanadium | ND | 0.1 | mg/L |
| Zinc | 40 | 0.05 | mg/L |
| Gold | ND | 2 | mg/L |
| Boron | ND | 1 | mg/L |
| Calcium | 270 | 1 | mg/L |
| Potassium | 2.5 | 1 | mg/L |
| Magnesium | 170 | 1 | mg/L |
| Sodium | 2.1 | 2 | mg/L |
| Phosphorous | ND | 2 | mg/L |
| Silicon | 38 | 1 | mg/L |
| Yttrium | 0.6 | 0.5 | mg/L |

ND - Compound not detected at stated Detection Limit.

References:
Method 3010: Acid Digestion of Aqueous Samples and Extracts for Total Metals, SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission Spectroscopy, SW-846, September 1986.
Method 7470: Mercury in Liquid Waste (Manual Cold-Vapor Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | RW-03 | Date Reported: | 07/12/94 |
| Project ID: | 1897-010 / Rico Co | Date Sampled: | 06/16/94 |
| Laboratory ID: | B945780 | Date Received: | 06/18/94 |
| Sample Matrix: | Water | Date Extracted : | 07/05/94 |
| Preservation: | Cool; HNO3 | Date Analyzed: | 07/06/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 0.2 | 0.2 | mg/L |
| Antimony | ND | 0.2 | mg/L |
| Arsenic | ND | 0.2 | mg/L |
| Barium | ND | 0.5 | mg/L |
| Beryllium | ND | 0.02 | mg/L |
| Cadmium | ND | 0.02 | mg/L |
| Chromium | ND | 0.05 | mg/L |
| Cobalt | ND | 0.05 | mg/L |
| Copper | ND | 0.05 | mg/L |
| Iron | 0.34 | 0.05 | mg/L |
| Lead | ND | 0.2 | mg/L |
| Manganese | 0.76 | 0.05 | mg/L |
| Mercury | ND | 0.001 | mg/L |
| Molybdenum | ND | 0.05 | mg/L |
| Nickel | ND | 0.05 | mg/L |
| Selenium | ND | 0.2 | mg/L |
| Silver | ND | 0.1 | mg/L |
| Thallium | ND | 0.2 | mg/L |
| Titanium | ND | 0.05 | mg/L |
| Vanadium | ND | 0.1 | mg/L |
| Zinc | 0.39 | 0.05 | mg/L |
| Gold | ND | 2 | mg/L |
| Boron | ND | 1 | mg/L |
| Calcium | 310 | 1 | mg/L |
| Potassium | 2.9 | 1 | mg/L |
| Magnesium | 24 | 1 | mg/L |
| Sodium | 14 | 2 | mg/L |
| Phosphorous | ND | 2 | mg/L |
| Silicon | 5.9 | 1 | mg/L |
| Yttrium | ND | 0.5 | mg/L |

ND - Compound not detected at stated Detection Limit.

References:
Method 3010: Acid Digestion of Aqueous Samples and Extracts for Total Metals, SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission Spectroscopy, SW-846, September 1986.
Method 7470: Mercury in Liquid Waste (Manual Cold-Vapor Technique), SW-846, September 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | RW-04 | Date Reported: | 07/12/94 |
| Project ID: | 1897-010 / Rico Co | Date Sampled: | 06/16/94 |
| Laboratory ID: | B945781 | Date Received: | 06/18/94 |
| Sample Matrix: | Water | Date Extracted : | 07/05/94 |
| Preservation: | Cool; HNO3 | Date Analyzed: | 07/06/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 0.4 | 0.2 | mg/L |
| Antimony | ND | 0.2 | mg/L |
| Arsenic | ND | 0.2 | mg/L |
| Barium | ND | 0.5 | mg/L |
| Beryllium | ND | 0.02 | mg/L |
| Cadmium | ND | 0.02 | mg/L |
| Chromium | ND | 0.05 | mg/L |
| Cobalt | ND | 0.05 | mg/L |
| Copper | ND | 0.05 | mg/L |
| Iron | 0.13 | 0.05 | mg/L |
| Lead | ND | 0.2 | mg/L |
| Manganese | 0.06 | 0.05 | mg/L |
| Mercury | ND | 0.001 | mg/L |
| Molybdenum | ND | 0.05 | mg/L |
| Nickel | ND | 0.05 | mg/L |
| Selenium | ND | 0.2 | mg/L |
| Silver | ND | 0.1 | mg/L |
| Thallium | ND | 0.2 | mg/L |
| Titanium | ND | 0.05 | mg/L |
| Vanadium | ND | 0.1 | mg/L |
| Zinc | 0.08 | 0.05 | mg/L |
| Gold | ND | 2 | mg/L |
| Boron | ND | 1 | mg/L |
| Calcium | 36 | 1 | mg/L |
| Potassium | ND | 1 | mg/L |
| Magnesium | 4.7 | 1 | mg/L |
| Sodium | ND | 2 | mg/L |
| Phosphorous | ND | 2 | mg/L |
| Silicon | 3.3 | 1 | mg/L |
| Yttrium | ND | 0.5 | mg/L |

ND - Compound not detected at stated Detection Limit.

References:
Method 3010: Acid Digestion of Aqueous Samples and Extracts for Total Metals, SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission Spectroscopy, SW-846, September 1986.
Method 7470: Mercury in Liquid Waste (Manual Cold-Vapor Technique), SW-846, September 1986.

SR
Analyst

WB
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Inter-Mountain Laboratories, Inc.

1160 Research Drive
Bozeman, Montana 59715

# EPA METHOD 8270
# TENTATIVELY IDENTIFIED COMPOUNDS
# BASE/NEUTRAL/ACID EXTRACTABLES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | T-01 | Date Reported: | 08/30/94 |
| Laboratory ID: | B947383 | Date Sampled: | 08/09/94 |
| Sample Matrix: | Soil | Date Analyzed: | 08/30/94 |

| Tentative Identification | Retention Time (minutes) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable levels.

Unknown concentration calculated assuming Relative Response Factor = 1.

## QUALITY CONTROL:

| Surrogate Recoveries | % | Soil QC Limits |
|---|---|---|
| 2-Fluorophenol | 71 | 25 - 121 |
| Phenol-d6 | 101 | 24 - 113 |
| Nitrobenzene-d5 | 77 | 23 - 120 |
| 2-Fluorobiphenyl | 85 | 30 - 115 |
| 2,4,6-Tribromophenol | 86 | 19 - 122 |
| Terphenyl-d14 | 87 | 18 - 137 |

Reference:

Method 8270, Gas Chromatography/Mass Spectrometry for Semivolatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, Third Edition, November 1986.

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Bozeman, Montana 59715

# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | RW-05 | Date Reported: | 07/12/94 |
| Project ID: | 1897-010 / Rico Co | Date Sampled: | 06/16/94 |
| Laboratory ID: | B945782 | Date Received: | 06/18/94 |
| Sample Matrix: | Water | Date Extracted : | 07/05/94 |
| Preservation: | Cool; HNO3 | Date Analyzed: | 07/06/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 0.4 | 0.2 | mg/L |
| Antimony | ND | 0.2 | mg/L |
| Arsenic | ND | 0.2 | mg/L |
| Barium | ND | 0.5 | mg/L |
| Beryllium | ND | 0.02 | mg/L |
| Cadmium | ND | 0.02 | mg/L |
| Chromium | ND | 0.05 | mg/L |
| Cobalt | ND | 0.05 | mg/L |
| Copper | ND | 0.05 | mg/L |
| Iron | 0.09 | 0.05 | mg/L |
| Lead | ND | 0.2 | mg/L |
| Manganese | ND | 0.05 | mg/L |
| Mercury | ND | 0.001 | mg/L |
| Molybdenum | ND | 0.05 | mg/L |
| Nickel | ND | 0.05 | mg/L |
| Selenium | ND | 0.2 | mg/L |
| Silver | ND | 0.1 | mg/L |
| Thallium | ND | 0.2 | mg/L |
| Titanium | ND | 0.05 | mg/L |
| Vanadium | ND | 0.1 | mg/L |
| Zinc | ND | 0.05 | mg/L |
| Gold | ND | 2 | mg/L |
| Boron | ND | 1 | mg/L |
| Calcium | 21 | 1 | mg/L |
| Potassium | ND | 1 | mg/L |
| Magnesium | 3.1 | 1 | mg/L |
| Sodium | ND | 2 | mg/L |
| Phosphorous | ND | 2 | mg/L |
| Silicon | 2.9 | 1 | mg/L |
| Yttrium | ND | 0.5 | mg/L |

ND - Compound not detected at stated Detection Limit.

References:
Method 3010: Acid Digestion of Aqueous Samples and Extracts for Total Metals, SW-846, September 1986.
Method 6010: Inductively Coupled Plasma-Atomic Emission Spectroscopy, SW-846, September 1986.
Method 7470: Mercury in Liquid Waste (Manual Cold-Vapor Technique), SW-846, September 1986.

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# CHAIN OF CUSTODY RECORD

| Client/Project Name | Project Location |
|---|---|
| Walsh Environmental / 1897-010 | Rico Co |

Sampler: (Signature)

Chain of Custody Tape No.

ANALYSES / PARAMETERS

| Sample No./ Identification | Date | Time | Lab Number | Matrix | No. of Containers | ICP Scan 27 metals | Hg | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| RW-01 | 6/15/94 | 1650 | B945778 | Water | 1 | ✓ | ✓ | | | |
| RW-02 | 6/16/94 | 0908 | 5779 | | 1 | ✓ | ✓ | | | pH 3.9 |
| RW-03 | 6/16/94 | 1140 | 5780 | | 1 | ✓ | ✓ | | | |
| RW-04 | 6/16/94 | 1300 | 5781 | | 1 | ✓ | ✓ | | | |
| RW-05 | 6/16/94 | 1446 | 5782 | | 1 | ✓ | ✓ | | | |

| Relinquished by: (Signature) | Date | Time | Received by: (Signature) | Date | Time |
|---|---|---|---|---|---|
| | 6/17/94 | 1545 | Tom W. Fraker via Fed Ex. 18.3°C | 6/18 | 10:30 Am |
| Relinquished by: (Signature) | Date | Time | Received by: (Signature) | Date | Time |
| | | | | | |
| Relinquished by: (Signature) | Date | Time | Received by laboratory: (Signature) | Date | Time |
| | | | | | |

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22133

*PRIVILEGED AND CONFIDENTIAL*

# ASSAY BUILDING ANALYTICAL DATA

Inter-Mountain Laboratories, Inc.

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# *CASE NARRATIVE*

On July 2, 1994, seven samples were received for analysis at Inter-Mountain Laboratories, Bozeman, Montana. The chain of custody form requested analysis for Toxicity Characteristic Leaching Procedure Parameters on one sample, with volatile organic compounds, semivolatile organic compounds, sulfates, cyanide, and metals requested on the others. Client name / Project name was listed as Walsh & Associates / Rico Assay Bldg / 1897-010 / Rico, CO.

Detectable amounts of targeted compounds were present in some of the samples.

The Toxicity Characteristic Leaching Procedure methodology used is outlined in the Federal Register, 40 CFR 261, Vol. 55, No. 126, June 29, 1990. Results are reported in mass per unit volume of leachate (mg/L).

Limits of detection for each instrument/analysis are determined by sample matrix effects, instrument performance under standard conditions, and dilution requirements to maintain chromatography output within calibration ranges.

*Wynn Sudtelgte*
IML-Bozeman

0729wa

Inter-Mountain Laboratories, Inc.

1160 Research Drive
Bozeman, Montana 59715

# EPA METHOD 8240
# HSL VOLATILE COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP01 | Date Reported: | 07/22/94 |
| Project ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | B946403 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | Date Extracted: | 07/06/94 |
| Preservation: | Cool | Date Analyzed: | 07/06/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| 1,1,1-Trichloroethane | ND | 0.2 | mg/kg |
| 1,1,2,2-Tetrachloroethane | ND | 0.2 | mg/kg |
| 1,1,2-Trichloroethane | ND | 0.2 | mg/kg |
| 1,1-Dichloroethane | ND | 0.2 | mg/kg |
| 1,1-Dichloroethene | ND | 0.2 | mg/kg |
| 1,2-Dichloroethane | ND | 0.2 | mg/kg |
| 1,2-Dichloropropane | ND | 0.2 | mg/kg |
| [illegible]tanone (MEK) | ND | 1 | mg/kg |
| 2-Hexanone | ND | 0.2 | mg/kg |
| 4-Methyl-2-pentanone (MIBK) | ND | 0.2 | mg/kg |
| Acetone | ND | 1 | mg/kg |
| Benzene | ND | 0.2 | mg/kg |
| Bromodichloromethane | ND | 0.2 | mg/kg |
| Bromoform | ND | 0.2 | mg/kg |
| Bromomethane | ND | 0.2 | mg/kg |
| Carbon Disulfide | ND | 0.2 | mg/kg |
| Carbon Tetrachloride | ND | 0.2 | mg/kg |
| Chlorobenzene | ND | 0.2 | mg/kg |
| Chloroethane | ND | 0.2 | mg/kg |
| Chloroform | ND | 0.2 | mg/kg |
| Chloromethane | ND | 0.2 | mg/kg |
| cis-1,3-Dichloropropene | ND | 0.2 | mg/kg |
| Dibromochloromethane | ND | 0.2 | mg/kg |
| Ethylbenzene | ND | 0.2 | mg/kg |
| m,p-Xylene | ND | 0.2 | mg/kg |
| Methylene chloride | ND | 1 | mg/kg |
| o-Xylene | ND | 0.2 | mg/kg |
| Styrene | ND | 0.2 | mg/kg |

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# EPA METHOD 8240
# HSL VOLATILE COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP01 | Date Reported: | 07/22/94 |
| Laboratory ID: | B946403 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/06/94 |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Tetrachloroethene (PCE) | ND | 0.2 | mg/kg |
| Toluene | ND | 0.2 | mg/kg |
| trans-1,2-Dichloroethene | ND | 0.2 | mg/kg |
| trans-1,3-Dichloropropene | ND | 0.2 | mg/kg |
| Trichloroethene (TCE) | ND | 0.2 | mg/kg |
| Vinyl Chloride | ND | 0.2 | mg/kg |

ND - Compound not detected at stated Detection Limit.
J - Meets identification criteria, below Detection Limit.
B - Compound detected in method blank.

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# EPA METHOD 8240
# TENTATIVELY IDENTIFIED COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP01 | Date Reported: | 07/22/94 |
| Laboratory ID: | B946403 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/06/94 |

| Tentative Identification | Retention Time (min) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable levels.

Unknown concentrations calculated assuming a Relative Response Factor = 1.

## QUALITY CONTROL:

| Surrogate Recovery | % | Soil QC Limits |
|---|---|---|
| 1,2-Dichloroethane-d4 | 93 | 70 - 121 |
| Toluene-d8 | 100 | 81 - 117 |
| Bromofluorobenzene | 99 | 74 - 121 |

References:

Method 8240, Gas Chromatography/Mass Spectrometry for Volatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, Third Edition, November 1986.

Analyst

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# EPA METHOD 8270
# HSL SEMI-VOLATILE COMPOUNDS
# BASE/NEUTRAL/ACID EXTRACTABLES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP01 | Date Reported: | 07/25/94 |
| Project ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | B946403 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | Date Extracted: | 07/07/94 |
| Preservation: | Cool | Date Analyzed: | 07/18/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | | Detection Limit | Units |
|---|---|---|---|---|
| 1,2,4-Trichlorobenzene | ND | | 1 | mg/kg |
| 1,2-Dichlorobenzene | ND | | 1 | mg/kg |
| 1,3-Dichlorobenzene | ND | | 1 | mg/kg |
| 1,4-Dichlorobenzene | ND | | 1 | mg/kg |
| 2,4,5-Trichlorophenol | ND | | 1 | mg/kg |
| 2,4,6-Trichlorophenol | ND | | 1 | mg/kg |
| 2,4-Dichlorophenol | ND | | 1 | mg/kg |
| 2,4-Dimethylphenol | ND | | 1 | mg/kg |
| 2,4-Dinitrophenol | ND | | 5 | mg/kg |
| 2,4-Dinitrotoluene | ND | | 1 | mg/kg |
| 2,6-Dinitrotoluene | ND | | 1 | mg/kg |
| 2-Chloronaphthalene | ND | | 1 | mg/kg |
| 2-Chlorophenol | ND | | 1 | mg/kg |
| 2-Methylnaphthalene | ND | | 1 | mg/kg |
| 2-Methylphenol | ND | | 1 | mg/kg |
| 2-Nitroaniline | ND | | 5 | mg/kg |
| 2-Nitrophenol | ND | | 1 | mg/kg |
| 3,3'-Dichlorobenzidine | ND | | 2 | mg/kg |
| 3-Methylphenol/4-Methylphenol ** | ND | | 1 | mg/kg |
| 3-Nitroaniline | ND | | 5 | mg/kg |
| 4,6-Dinitro-2-methylphenol | ND | | 5 | mg/kg |
| 4-Bromophenyl-phenylether | ND | | 1 | mg/kg |
| 4-Chloro-3-methylphenol | ND | | 2 | mg/kg |
| 4-Chloroaniline | ND | | 2 | mg/kg |
| 4-Chlorophenyl-phenylether | ND | | 1 | mg/kg |
| 4-Nitroaniline | ND | | 2 | mg/kg |
| 4-Nitrophenol | ND | | 5 | mg/kg |
| Acenaphthene | ND | | 1 | mg/kg |
| Acenaphthylene | ND | | 1 | mg/kg |
| Anthracene | ND | | 1 | mg/kg |
| Benzo(a)anthracene | ND | | 1 | mg/kg |
| Benzo(a)pyrene | ND | | 1 | mg/kg |
| Benzo(b)fluoranthene | 0.7 | J | 1 | mg/kg |
| Benzo(g,h,i)perylene | ND | | 1 | mg/kg |
| Benzo(k)fluoranthene | ND | | 1 | mg/kg |
| Benzoic Acid | ND | | 5 | mg/kg |

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# EPA METHOD 8270
# HSL SEMI-VOLATILE COMPOUNDS
# BASE/NEUTRAL/ACID EXTRACTABLES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP01 | Date Reported: | 07/25/94 |
| Laboratory ID: | 8946403 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/18/94 |

| Parameter | Analytical Result | | Detection Limit | Units |
|---|---|---|---|---|
| Benzyl Alcohol | ND | | 2 | mg/kg |
| bis(2-Chloroethoxy)methane | ND | | 1 | mg/kg |
| bis(2-Chloroethyl)ether | ND | | 1 | mg/kg |
| bis(2-Chloroisopropyl)ether | ND | | 1 | mg/kg |
| bis(2-Ethylhexyl)phthalate | ND | | 5 | mg/kg |
| Butylbenzylphthalate | ND | | 1 | mg/kg |
| Chrysene | ND | | 1 | mg/kg |
| [illegible]-Butylphthalate | ND | | 5 | mg/kg |
| Di-n-Octylphthalate | ND | | 1 | mg/kg |
| Dibenz(a,h)anthracene | ND | | 1 | mg/kg |
| Dibenzofuran | ND | | 1 | mg/kg |
| Diethylphthalate | ND | | 1 | mg/kg |
| Dimethylphthalate | ND | | 1 | mg/kg |
| Fluoranthene | 0.9 | J | 1 | mg/kg |
| Fluorene | ND | | 1 | mg/kg |
| Hexachlorobenzene | ND | | 1 | mg/kg |
| Hexachlorobutadiene | ND | | 2 | mg/kg |
| Hexachlorocyclopentadiene | ND | | 1 | mg/kg |
| Hexachloroethane | ND | | 2 | mg/kg |
| Indeno(1,2,3-cd)pyrene | ND | | 1 | mg/kg |
| Isophorone | ND | | 1 | mg/kg |
| N-Nitrosodi-n-propylamine | ND | | 1 | mg/kg |
| N-Nitrosodiphenylamine | ND | | 1 | mg/kg |
| Naphthalene | ND | | 1 | mg/kg |
| Nitrobenzene | ND | | 1 | mg/kg |
| Pentachlorophenol | ND | | 5 | mg/kg |
| Phenanthrene | ND | | 1 | mg/kg |
| Phenol | ND | | 1 | mg/kg |
| Pyrene | 0.7 | J | 1 | mg/kg |

ND - Compound not detected at stated Detection Limit.
J - Meets identification criteria, below Detection Limit.
** - Compounds coelute by GCMS.
B - Compound detected in Method Blank.

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# EPA METHOD 8270
# TENTATIVELY IDENTIFIED COMPOUNDS
# BASE/NEUTRAL/ACID EXTRACTABLES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP01 | Date Reported: | 07/25/94 |
| Laboratory ID: | 8946403 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/18/94 |

| Tentative Identification | Retention Time (minutes) | Concentration | Units |
|---|---|---|---|
| Unknown hydrocarbon | 21.66 | 4 | mg/kg |
| Unknown hydrocarbon | 30.50 | 2 | mg/kg |
| Unknown hydrocarbon | 32.52 | 3 | mg/kg |
| Unknown hydrocarbon | 35.23 | 3 | mg/kg |
| [illegible]wn hydrocarbon | 39.10 | 3 | mg/kg |

Unknown concentration calculated assuming Relative Response Factor = 1.

## QUALITY CONTROL:

| Surrogate Recoveries | % | Soil QC Limits |
|---|---|---|
| 2-Fluorophenol | 59 | 25 - 121 |
| Phenol-d6 | 79 | 24 - 113 |
| Nitrobenzene-d5 | 74 | 23 - 120 |
| 2-Fluorobiphenyl | 76 | 30 - 115 |
| 2,4,6-Tribromophenol | 83 | 19 - 122 |
| Terphenyl-d14 | 54 | 18 - 137 |

Reference:

Method 8270, Gas Chromatography/Mass Spectrometry for Semivolatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, Third Edition, [illegible]ber 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP01 | Date Reported: | 07/26/94 |
| Project ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | B946403 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | Date Extracted : | 07/11/94 |
| Preservation: | Cool | Date Analyzed: | 07/20/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 16000 | 200 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | ND | 20 | mg/kg |
| Barium | 210 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 9 | 2 | mg/kg |
| Chromium | 20 | 5 | mg/kg |
| Cobalt | 9 | 5 | mg/kg |
| Copper | 150 | 5 | mg/kg |
| Iron | 24000 | 200 | mg/kg |
| Lead | 880 | 20 | mg/kg |
| [illegible]ry | 16 | 0.5 | mg/kg |
| [illegible]nese | 2800 | 5 | mg/kg |
| Molybdenum | ND | 5 | mg/kg |
| Nickel | 15 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | 20 | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 200 | 5 | mg/kg |
| Vanadium | 27 | 10 | mg/kg |
| Zinc | 1800 | 5 | mg/kg |
| Gold | ND | 200 | mg/kg |
| Boron | ND | 100 | mg/kg |
| Calcium | 9000 | 100 | mg/kg |
| Potassium | 2300 | 100 | mg/kg |
| Magnesium | 7700 | 100 | mg/kg |
| Sodium | 340 | 200 | mg/kg |
| Phosphorous | 850 | 200 | mg/kg |
| Silicon | 210 | 100 | mg/kg |
| Yttrium | 16 | 5 | mg/kg |

ND - Compound not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.

[illegible]d 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.

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# GENERAL PARAMETERS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP01 | Date Reported: | 07/27/94 |
| Program ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | B946403 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | | |
| Preservation: | Cool | | |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Cyanide, Total | ND | 0.5 | mg/kg |
| Sulfate | 150 | 10 | mg/kg |

*Note result is suspect. Barium sulfate precipitation had dark flakes in the filtrate.

Reference: SW-846, United States Environmental Protection Agency, Nov. 1986
Appendix 9010A : Cyanide Extraction Procedure for Solids and Oils
Method 9010 : Total and Amenable Cyanide
Methods of Soil Analysis, No 9, American Society of Agronomy, 1965

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# EPA METHOD 8240
# HSL VOLATILE COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP02 | Date Reported: | 07/22/94 |
| Project ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | B946404 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | Date Extracted: | 07/06/94 |
| Preservation: | Cool | Date Analyzed: | 07/06/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| 1,1,1-Trichloroethane | ND | 0.2 | mg/kg |
| 1,1,2,2-Tetrachloroethane | ND | 0.2 | mg/kg |
| 1,1,2-Trichloroethane | ND | 0.2 | mg/kg |
| 1,1-Dichloroethane | ND | 0.2 | mg/kg |
| 1,1-Dichloroethene | ND | 0.2 | mg/kg |
| 1,2-Dichloroethane | ND | 0.2 | mg/kg |
| [illegible]-Dichloropropane | ND | 0.2 | mg/kg |
| 2-Butanone (MEK) | ND | 1 | mg/kg |
| 2-Hexanone | ND | 0.2 | mg/kg |
| 4-Methyl-2-pentanone (MIBK) | ND | 0.2 | mg/kg |
| Acetone | ND | 1 | mg/kg |
| Benzene | ND | 0.2 | mg/kg |
| Bromodichloromethane | ND | 0.2 | mg/kg |
| Bromoform | ND | 0.2 | mg/kg |
| Bromomethane | ND | 0.2 | mg/kg |
| Carbon Disulfide | ND | 0.2 | mg/kg |
| Carbon Tetrachloride | ND | 0.2 | mg/kg |
| Chlorobenzene | ND | 0.2 | mg/kg |
| Chloroethane | ND | 0.2 | mg/kg |
| Chloroform | ND | 0.2 | mg/kg |
| Chloromethane | ND | 0.2 | mg/kg |
| cis-1,3-Dichloropropene | ND | 0.2 | mg/kg |
| Dibromochloromethane | ND | 0.2 | mg/kg |
| Ethylbenzene | ND | 0.2 | mg/kg |
| m,p-Xylene | ND | 0.2 | mg/kg |
| Methylene chloride | ND | 1 | mg/kg |
| o-Xylene | ND | 0.2 | mg/kg |
| Styrene | ND | 0.2 | mg/kg |

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# EPA METHOD 8240
# HSL VOLATILE COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP02 | Date Reported: | 07/22/94 |
| Laboratory ID: | B946404 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/06/94 |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Tetrachloroethene (PCE) | ND | 0.2 | mg/kg |
| Toluene | ND | 0.2 | mg/kg |
| trans-1,2-Dichloroethene | ND | 0.2 | mg/kg |
| trans-1,3-Dichloropropene | ND | 0.2 | mg/kg |
| Trichloroethene (TCE) | ND | 0.2 | mg/kg |
| Vinyl Chloride | ND | 0.2 | mg/kg |

ND - Compound not detected at stated Detection Limit.
J - Meets identification criteria, below Detection Limit.
B - Compound detected in method blank.

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# EPA METHOD 8240
# TENTATIVELY IDENTIFIED COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP02 | Date Reported: | 07/22/94 |
| Laboratory ID: | 8946404 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/06/94 |

| Tentative Identification | Retention Time (min) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable levels.

Unknown concentrations calculated assuming a Relative Response Factor = 1.

## QUALITY CONTROL:

| Surrogate Recovery | % | Soil QC Limits |
|---|---|---|
| 1,2-Dichloroethane-d4 | 93 | 70 - 121 |
| Toluene-d8 | 100 | 81 - 117 |
| Bromofluorobenzene | 99 | 74 - 121 |

References:

Method 8240, Gas Chromatography/Mass Spectrometry for Volatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, Third Edition, November 1986.

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# EPA METHOD 8270
# HSL SEMI-VOLATILE COMPOUNDS
# BASE/NEUTRAL/ACID EXTRACTABLES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP02 | Date Reported: | 07/25/94 |
| Project ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | B946404 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | Date Extracted: | 07/07/94 |
| Preservation: | Cool | Date Analyzed: | 07/18/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| 1,2,4-Trichlorobenzene | ND | 1 | mg/kg |
| 1,2-Dichlorobenzene | ND | 1 | mg/kg |
| 1,3-Dichlorobenzene | ND | 1 | mg/kg |
| 1,4-Dichlorobenzene | ND | 1 | mg/kg |
| 2,4,5-Trichlorophenol | ND | 1 | mg/kg |
| 2,4,6-Trichlorophenol | ND | 1 | mg/kg |
| 2,4-Dichlorophenol | ND | 1 | mg/kg |
| 2,4-Dimethylphenol | ND | 1 | mg/kg |
| 2,4-Dinitrophenol | ND | 5 | mg/kg |
| 2,4-Dinitrotoluene | ND | 1 | mg/kg |
| 2,6-Dinitrotoluene | ND | 1 | mg/kg |
| 2-Chloronaphthalene | ND | 1 | mg/kg |
| 2-Chlorophenol | ND | 1 | mg/kg |
| 2-Methylnaphthalene | ND | 1 | mg/kg |
| 2-Methylphenol | ND | 1 | mg/kg |
| 2-Nitroaniline | ND | 5 | mg/kg |
| 2-Nitrophenol | ND | 1 | mg/kg |
| 3,3'-Dichlorobenzidine | ND | 2 | mg/kg |
| 3-Methylphenol/4-Methylphenol ** | ND | 1 | mg/kg |
| 3-Nitroaniline | ND | 5 | mg/kg |
| 4,6-Dinitro-2-methylphenol | ND | 5 | mg/kg |
| 4-Bromophenyl-phenylether | ND | 1 | mg/kg |
| 4-Chloro-3-methylphenol | ND | 2 | mg/kg |
| 4-Chloroaniline | ND | 2 | mg/kg |
| 4-Chlorophenyl-phenylether | ND | 1 | mg/kg |
| 4-Nitroaniline | ND | 2 | mg/kg |
| 4-Nitrophenol | ND | 5 | mg/kg |
| Acenaphthene | ND | 1 | mg/kg |
| Acenaphthylene | ND | 1 | mg/kg |
| Anthracene | ND | 1 | mg/kg |
| Benzo(a)anthracene | ND | 1 | mg/kg |
| Benzo(a)pyrene | ND | 1 | mg/kg |
| Benzo(b)fluoranthene | ND | 1 | mg/kg |
| Benzo(g,h,i)perylene | ND | 1 | mg/kg |
| Benzo(k)fluoranthene | ND | 1 | mg/kg |
| Benzoic Acid | ND | 5 | mg/kg |

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# EPA METHOD 8270
## HSL SEMI-VOLATILE COMPOUNDS
## BASE/NEUTRAL/ACID EXTRACTABLES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP02 | Date Reported: | 07/25/94 |
| Laboratory ID: | 8946404 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/18/94 |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Benzyl Alcohol | ND | 2 | mg/kg |
| bis(2-Chloroethoxy)methane | ND | 1 | mg/kg |
| bis(2-Chloroethyl)ether | ND | 1 | mg/kg |
| bis(2-Chloroisopropyl)ether | ND | 1 | mg/kg |
| bis(2-Ethylhexyl)phthalate | ND | 5 | mg/kg |
| Butylbenzylphthalate | ND | 1 | mg/kg |
| [illegible]ene | ND | 1 | mg/kg |
| Di-n-Butylphthalate | ND | 5 | mg/kg |
| Di-n-Octylphthalate | ND | 1 | mg/kg |
| Dibenz(a,h)anthracene | ND | 1 | mg/kg |
| Dibenzofuran | ND | 1 | mg/kg |
| Diethylphthalate | ND | 1 | mg/kg |
| Dimethylphthalate | ND | 1 | mg/kg |
| Fluoranthene | ND | 1 | mg/kg |
| Fluorene | ND | 1 | mg/kg |
| Hexachlorobenzene | ND | 1 | mg/kg |
| Hexachlorobutadiene | ND | 2 | mg/kg |
| Hexachlorocyclopentadiene | ND | 1 | mg/kg |
| Hexachloroethane | ND | 2 | mg/kg |
| Indeno(1,2,3-cd)pyrene | ND | 1 | mg/kg |
| Isophorone | ND | 1 | mg/kg |
| N-Nitrosodi-n-propylamine | ND | 1 | mg/kg |
| N-Nitrosodiphenylamine | ND | 1 | mg/kg |
| Naphthalene | ND | 1 | mg/kg |
| Nitrobenzene | ND | 1 | mg/kg |
| Pentachlorophenol | ND | 5 | mg/kg |
| Phenanthrene | ND | 1 | mg/kg |
| Phenol | ND | 1 | mg/kg |
| Pyrene | ND | 1 | mg/kg |

ND - Compound not detected at stated Detection Limit.
J - Meets identification criteria, below Detection Limit.
** - Compounds coelute by GCMS.
B - Compound detected in Method Blank.

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# EPA METHOD 8270
# TENTATIVELY IDENTIFIED COMPOUNDS
# BASE/NEUTRAL/ACID EXTRACTABLES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP02 | Date Reported: | 07/25/94 |
| Laboratory ID: | 8946404 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/18/94 |

| Tentative Identification | Retention Time (minutes) | Concentration | Units |
|---|---|---|---|
| Unknown hydrocarbon | 21.66 | 1 | mg/kg |
| Unknown hydrocarbon | 30.49 | 1 | mg/kg |
| Unknown hydrocarbon | 32.53 | 1 | mg/kg |
| Unknown hydrocarbon | 35.21 | 1 | mg/kg |
| Unknown hydrocarbon | 39.08 | 1 | mg/kg |

Unknown concentration calculated assuming Relative Response Factor = 1.

## QUALITY CONTROL:

| Surrogate Recoveries | % | Soil QC Limits |
|---|---|---|
| 2-Fluorophenol | 57 | 25 - 121 |
| Phenol-d6 | 76 | 24 - 113 |
| Nitrobenzene-d5 | 71 | 23 - 120 |
| 2-Fluorobiphenyl | 74 | 30 - 115 |
| 2,4,6-Tribromophenol | 84 | 19 - 122 |
| Terphenyl-d14 | 51 | 18 - 137 |

Reference:

Method 8270, Gas Chromatography/Mass Spectrometry for Semivolatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, Third Edition, November 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP02 | Date Reported: | 07/26/94 |
| Project ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | B946404 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | Date Extracted : | 07/11/94 |
| Preservation: | Cool | Date Analyzed: | 07/20/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 13000 | 200 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | ND | 20 | mg/kg |
| Barium | 170 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 13 | 2 | mg/kg |
| Chromium | 16 | 5 | mg/kg |
| Cobalt | 8 | 5 | mg/kg |
| Copper | 190 | 5 | mg/kg |
| Iron | 22000 | 200 | mg/kg |
| Lead | 1100 | 20 | mg/kg |
| Mercury | 1.4 | 0.5 | mg/kg |
| Manganese | 8500 | 5 | mg/kg |
| Molybdenum | 7 | 5 | mg/kg |
| Nickel | 12 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | 45 | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 120 | 5 | mg/kg |
| Vanadium | 22 | 10 | mg/kg |
| Zinc | 2100 | 5 | mg/kg |
| Gold | ND | 200 | mg/kg |
| Boron | ND | 100 | mg/kg |
| Calcium | 21000 | 100 | mg/kg |
| Potassium | 1700 | 100 | mg/kg |
| Magnesium | 7800 | 100 | mg/kg |
| Sodium | 300 | 200 | mg/kg |
| Phosphorous | 670 | 200 | mg/kg |
| Silicon | 320 | 100 | mg/kg |
| Yttrium | 13 | 5 | mg/kg |

ND - Compound not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.

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# GENERAL PARAMETERS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP02 | Date Reported: | 07/27/94 |
| Program ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | 8946404 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | | |
| Preservation: | Cool | | |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Cyanide, Total | ND | 0.5 | mg/kg |
| Sulfate | 97 | 10 | mg/kg |

Reference: SW-846, United States Environmental Protection Agency, Nov. 1986
Appendix 9010A : Cyanide Extraction Procedure for Solids and Oils
Method 9010 : Total and Amenable Cyanide
Methods of Soil Analysis, No 9, American Society of Agronomy, 1965

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# EPA METHOD 8240
# HSL VOLATILE COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP03 | Date Reported: | 07/22/94 |
| Project ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | B946405 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | Date Extracted: | 07/06/94 |
| Preservation: | Cool | Date Analyzed: | 07/06/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| 1,1,1-Trichloroethane | ND | 0.2 | mg/kg |
| 1,1,2,2-Tetrachloroethane | ND | 0.2 | mg/kg |
| 1,1,2-Trichloroethane | ND | 0.2 | mg/kg |
| 1,1-Dichloroethane | ND | 0.2 | mg/kg |
| 1,1-Dichloroethene | ND | 0.2 | mg/kg |
| 1,2-Dichloroethane | ND | 0.2 | mg/kg |
| [illegible]Dichloropropane | ND | 0.2 | mg/kg |
| 2-Butanone (MEK) | ND | 1 | mg/kg |
| 2-Hexanone | ND | 0.2 | mg/kg |
| 4-Methyl-2-pentanone (MIBK) | ND | 0.2 | mg/kg |
| Acetone | ND | 1 | mg/kg |
| Benzene | ND | 0.2 | mg/kg |
| Bromodichloromethane | ND | 0.2 | mg/kg |
| Bromoform | ND | 0.2 | mg/kg |
| Bromomethane | ND | 0.2 | mg/kg |
| Carbon Disulfide | ND | 0.2 | mg/kg |
| Carbon Tetrachloride | ND | 0.2 | mg/kg |
| Chlorobenzene | ND | 0.2 | mg/kg |
| Chloroethane | ND | 0.2 | mg/kg |
| Chloroform | ND | 0.2 | mg/kg |
| Chloromethane | ND | 0.2 | mg/kg |
| cis-1,3-Dichloropropene | ND | 0.2 | mg/kg |
| Dibromochloromethane | ND | 0.2 | mg/kg |
| Ethylbenzene | ND | 0.2 | mg/kg |
| m,p-Xylene | ND | 0.2 | mg/kg |
| Methylene chloride | ND | 1 | mg/kg |
| o-Xylene | ND | 0.2 | mg/kg |
| Styrene | ND | 0.2 | mg/kg |

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# EPA METHOD 8240
# HSL VOLATILE COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP03 | Date Reported: | 07/22/94 |
| Laboratory ID: | B946405 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/06/94 |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Tetrachloroethene (PCE) | ND | 0.2 | mg/kg |
| Toluene | ND | 0.2 | mg/kg |
| trans-1,2-Dichloroethene | ND | 0.2 | mg/kg |
| trans-1,3-Dichloropropene | ND | 0.2 | mg/kg |
| Trichloroethene (TCE) | ND | 0.2 | mg/kg |
| Vinyl Chloride | ND | 0.2 | mg/kg |

ND - Compound not detected at stated Detection Limit.
J - Meets identification criteria, below Detection Limit.
B - Compound detected in method blank.

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# EPA METHOD 8240
# TENTATIVELY IDENTIFIED COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP03 | Date Reported: | 07/22/94 |
| Laboratory ID: | B946405 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/06/94 |

| Tentative Identification | Retention Time (min) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable levels.

Known concentrations calculated assuming a Relative Response Factor = 1.

## QUALITY CONTROL:

| Surrogate Recovery | % | Soil QC Limits |
|---|---|---|
| 1,2-Dichloroethane-d4 | 93 | 70 - 121 |
| Toluene-d8 | 99 | 81 - 117 |
| Bromofluorobenzene | 100 | 74 - 121 |

References:

Method 8240, Gas Chromatography/Mass Spectrometry for Volatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, Third Edition, November 1986.

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# EPA METHOD 8270
## HSL SEMI-VOLATILE COMPOUNDS
## BASE/NEUTRAL/ACID EXTRACTABLES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP03 | Date Reported: | 07/25/94 |
| Project ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | B946405 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | Date Extracted: | 07/07/94 |
| Preservation: | Cool | Date Analyzed: | 07/18/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| 1,2,4-Trichlorobenzene | ND | 1 | mg/kg |
| 1,2-Dichlorobenzene | ND | 1 | mg/kg |
| 1,3-Dichlorobenzene | ND | 1 | mg/kg |
| 1,4-Dichlorobenzene | ND | 1 | mg/kg |
| 2,4,5-Trichlorophenol | ND | 1 | mg/kg |
| 2,4,6-Trichlorophenol | ND | 1 | mg/kg |
| 2,4-Dichlorophenol | ND | 1 | mg/kg |
| 2,4-Dimethylphenol | ND | 1 | mg/kg |
| 2,4-Dinitrophenol | ND | 5 | mg/kg |
| 2,4-Dinitrotoluene | ND | 1 | mg/kg |
| 2,6-Dinitrotoluene | ND | 1 | mg/kg |
| 2-Chloronaphthalene | ND | 1 | mg/kg |
| 2-Chlorophenol | ND | 1 | mg/kg |
| 2-Methylnaphthalene | ND | 1 | mg/kg |
| 2-Methylphenol | ND | 1 | mg/kg |
| 2-Nitroaniline | ND | 5 | mg/kg |
| 2-Nitrophenol | ND | 1 | mg/kg |
| 3,3'-Dichlorobenzidine | ND | 2 | mg/kg |
| 3-Methylphenol/4-Methylphenol ** | ND | 1 | mg/kg |
| 3-Nitroaniline | ND | 5 | mg/kg |
| 4,6-Dinitro-2-methylphenol | ND | 5 | mg/kg |
| 4-Bromophenyl-phenylether | ND | 1 | mg/kg |
| 4-Chloro-3-methylphenol | ND | 2 | mg/kg |
| 4-Chloroaniline | ND | 2 | mg/kg |
| 4-Chlorophenyl-phenylether | ND | 1 | mg/kg |
| 4-Nitroaniline | ND | 2 | mg/kg |
| 4-Nitrophenol | ND | 5 | mg/kg |
| Acenaphthene | ND | 1 | mg/kg |
| Acenaphthylene | ND | 1 | mg/kg |
| Anthracene | ND | 1 | mg/kg |
| Benzo(a)anthracene | ND | 1 | mg/kg |
| Benzo(a)pyrene | ND | 1 | mg/kg |
| Benzo(b)fluoranthene | ND | 1 | mg/kg |
| Benzo(g,h,i)perylene | ND | 1 | mg/kg |
| Benzo(k)fluoranthene | ND | 1 | mg/kg |
| Benzoic Acid | ND | 5 | mg/kg |

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# EPA METHOD 8270
# HSL SEMI-VOLATILE COMPOUNDS
# BASE/NEUTRAL/ACID EXTRACTABLES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP03 | Date Reported: | 07/25/94 |
| Laboratory ID: | 8946405 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/18/94 |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Benzyl Alcohol | ND | 2 | mg/kg |
| bis(2-Chloroethoxy)methane | ND | 1 | mg/kg |
| bis(2-Chloroethyl)ether | ND | 1 | mg/kg |
| bis(2-Chloroisopropyl)ether | ND | 1 | mg/kg |
| bis(2-Ethylhexyl)phthalate | ND | 5 | mg/kg |
| [illegible]lbenzylphthalate | ND | 1 | mg/kg |
| [illegible]ysene | ND | 1 | mg/kg |
| Di-n-Butylphthalate | ND | 5 | mg/kg |
| Di-n-Octylphthalate | ND | 1 | mg/kg |
| Dibenz(a,h)anthracene | ND | 1 | mg/kg |
| Dibenzofuran | ND | 1 | mg/kg |
| Diethylphthalate | ND | 1 | mg/kg |
| Dimethylphthalate | ND | 1 | mg/kg |
| Fluoranthene | ND | 1 | mg/kg |
| Fluorene | ND | 1 | mg/kg |
| Hexachlorobenzene | ND | 1 | mg/kg |
| Hexachlorobutadiene | ND | 2 | mg/kg |
| Hexachlorocyclopentadiene | ND | 1 | mg/kg |
| Hexachloroethane | ND | 2 | mg/kg |
| Indeno(1,2,3-cd)pyrene | ND | 1 | mg/kg |
| Isophorone | ND | 1 | mg/kg |
| N-Nitrosodi-n-propylamine | ND | 1 | mg/kg |
| N-Nitrosodiphenylamine | ND | 1 | mg/kg |
| Naphthalene | ND | 1 | mg/kg |
| Nitrobenzene | ND | 1 | mg/kg |
| Pentachlorophenol | ND | 5 | mg/kg |
| Phenanthrene | ND | 1 | mg/kg |
| Phenol | ND | 1 | mg/kg |
| Pyrene | ND | 1 | mg/kg |

ND - Compound not detected at stated Detection Limit.
J - Meets identification criteria, below Detection Limit.
** - Compounds coelute by GCMS.
B - Compound detected in Method Blank.

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# EPA METHOD 8270
# TENTATIVELY IDENTIFIED COMPOUNDS
# BASE/NEUTRAL/ACID EXTRACTABLES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP03 | Date Reported: | 07/25/94 |
| Laboratory ID: | B946405 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/18/94 |

| Tentative Identification | Retention Time (minutes) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable levels.

Unknown concentration calculated assuming Relative Response Factor = 1.

## QUALITY CONTROL:

| Surrogate Recoveries | % | Soil QC Limits |
|---|---|---|
| 2-Fluorophenol | 54 | 25 - 121 |
| Phenol-d6 | 83 | 24 - 113 |
| Nitrobenzene-d5 | 75 | 23 - 120 |
| 2-Fluorobiphenyl | 76 | 30 - 115 |
| 2,4,6-Tribromophenol | 72 | 19 - 122 |
| Terphenyl-d14 | 60 | 18 - 137 |

Reference:

Method 8270, Gas Chromatography/Mass Spectrometry for Semivolatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, Third Edition, November 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP03 | Date Reported: | 07/26/94 |
| Project ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | B946405 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | Date Extracted : | 07/11/94 |
| Preservation: | Cool | Date Analyzed: | 07/20/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 11000 | 200 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | 22 | 20 | mg/kg |
| Barium | 98 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 7 | 2 | mg/kg |
| Chromium | 16 | 5 | mg/kg |
| Cobalt | 9 | 5 | mg/kg |
| Copper | 180 | 5 | mg/kg |
| Iron | 37000 | 200 | mg/kg |
| [illegible] | 1050 | 20 | mg/kg |
| [illegible]cury | ND | 0.5 | mg/kg |
| Manganese | 1500 | 5 | mg/kg |
| Molybdenum | ND | 5 | mg/kg |
| Nickel | 16 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | ND | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 120 | 5 | mg/kg |
| Vanadium | 23 | 10 | mg/kg |
| Zinc | 1100 | 5 | mg/kg |
| Gold | ND | 200 | mg/kg |
| Boron | ND | 100 | mg/kg |
| Calcium | 2700 | 100 | mg/kg |
| Potassium | 1800 | 100 | mg/kg |
| Magnesium | 8100 | 100 | mg/kg |
| Sodium | 240 | 200 | mg/kg |
| Phosphorous | 690 | 200 | mg/kg |
| Silicon | 230 | 100 | mg/kg |
| Yttrium | 22 | 5 | mg/kg |

ND - Compound not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.

...ethod 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.

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# GENERAL PARAMETERS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP03 | Date Reported: | 07/27/94 |
| Program ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | B946405 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | | |
| Preservation: | Cool | | |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Cyanide, Total | ND | 0.5 | mg/kg |
| Sulfate | 120 | 10 | mg/kg |

Sulfate result is suspect. Barium sulfate precipitation was tan, not white as expected.

Reference: SW-846, United States Environmental Protection Agency, Nov. 1986
Appendix 9010A : Cyanide Extraction Procedure for Solids and Oils
Method 9010 : Total and Amenable Cyanide
Methods of Soil Analysis, No 9, American Society of Agronomy, 1965

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# EPA METHOD 8240
# HSL VOLATILE COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP04 | Date Reported: | 07/22/94 |
| Project ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | 8946406 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | Date Extracted: | 07/06/94 |
| Preservation: | Cool | Date Analyzed: | 07/06/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| 1,1,1-Trichloroethane | ND | 0.2 | mg/kg |
| 1,1,2,2-Tetrachloroethane | ND | 0.2 | mg/kg |
| 1,1,2-Trichloroethane | ND | 0.2 | mg/kg |
| 1,1-Dichloroethane | ND | 0.2 | mg/kg |
| 1,1-Dichloroethene | ND | 0.2 | mg/kg |
| 1,[illegible]-Dichloroethane | ND | 0.2 | mg/kg |
| [illegible]-Dichloropropane | ND | 0.2 | mg/kg |
| 2-Butanone (MEK) | ND | 1 | mg/kg |
| 2-Hexanone | ND | 0.2 | mg/kg |
| 4-Methyl-2-pentanone (MIBK) | ND | 0.2 | mg/kg |
| Acetone | ND | 1 | mg/kg |
| Benzene | ND | 0.2 | mg/kg |
| Bromodichloromethane | ND | 0.2 | mg/kg |
| Bromoform | ND | 0.2 | mg/kg |
| Bromomethane | ND | 0.2 | mg/kg |
| Carbon Disulfide | ND | 0.2 | mg/kg |
| Carbon Tetrachloride | ND | 0.2 | mg/kg |
| Chlorobenzene | ND | 0.2 | mg/kg |
| Chloroethane | ND | 0.2 | mg/kg |
| Chloroform | ND | 0.2 | mg/kg |
| Chloromethane | ND | 0.2 | mg/kg |
| cis-1,3-Dichloropropene | ND | 0.2 | mg/kg |
| Dibromochloromethane | ND | 0.2 | mg/kg |
| Ethylbenzene | ND | 0.2 | mg/kg |
| m,p-Xylene | ND | 0.2 | mg/kg |
| Methylene chloride | ND | 1 | mg/kg |
| o-Xylene | ND | 0.2 | mg/kg |
| Styrene | ND | 0.2 | mg/kg |

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# EPA METHOD 8240
# HSL VOLATILE COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP04 | Date Reported: | 07/22/94 |
| Laboratory ID: | B946406 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/06/94 |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Tetrachloroethene (PCE) | ND | 0.2 | mg/kg |
| Toluene | ND | 0.2 | mg/kg |
| trans-1,2-Dichloroethene | ND | 0.2 | mg/kg |
| trans-1,3-Dichloropropene | ND | 0.2 | mg/kg |
| Trichloroethene (TCE) | ND | 0.2 | mg/kg |
| Vinyl Chloride | ND | 0.2 | mg/kg |

ND - Compound not detected at stated Detection Limit.
J - Meets identification criteria, below Detection Limit.
B - Compound detected in method blank.

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# EPA METHOD 8240
# TENTATIVELY IDENTIFIED COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP04 | Date Reported: | 07/22/94 |
| Laboratory ID: | B946406 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/06/94 |

| Tentative Identification | Retention Time (min) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable levels.

Unknown concentrations calculated assuming a Relative Response Factor = 1.

## QUALITY CONTROL:

| Surrogate Recovery | % | Soil QC Limits |
|---|---|---|
| 1,2-Dichloroethane-d4 | 90 | 70 - 121 |
| Toluene-d8 | 105 | 81 - 117 |
| Bromofluorobenzene | 96 | 74 - 121 |

References:

Method 8240, Gas Chromatography/Mass Spectrometry for Volatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, Third Edition, November 1986.

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# EPA METHOD 8270
# HSL SEMI-VOLATILE COMPOUNDS
# BASE/NEUTRAL/ACID EXTRACTABLES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP04 | Date Reported: | 07/25/94 |
| Project ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | B946406 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | Date Extracted: | 07/07/94 |
| Preservation: | Cool | Date Analyzed: | 07/18/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| 1,2,4-Trichlorobenzene | ND | 1 | mg/kg |
| 1,2-Dichlorobenzene | ND | 1 | mg/kg |
| 1,3-Dichlorobenzene | ND | 1 | mg/kg |
| 1,4-Dichlorobenzene | ND | 1 | mg/kg |
| 2,4,5-Trichlorophenol | ND | 1 | mg/kg |
| 2,4,6-Trichlorophenol | ND | 1 | mg/kg |
| 2,4-Dichlorophenol | ND | 1 | mg/kg |
| 2,4-Dimethylphenol | ND | 1 | mg/kg |
| 2,4-Dinitrophenol | ND | 5 | mg/kg |
| 2,4-Dinitrotoluene | ND | 1 | mg/kg |
| 2,6-Dinitrotoluene | ND | 1 | mg/kg |
| 2-Chloronaphthalene | ND | 1 | mg/kg |
| 2-Chlorophenol | ND | 1 | mg/kg |
| 2-Methylnaphthalene | ND | 1 | mg/kg |
| 2-Methylphenol | ND | 1 | mg/kg |
| 2-Nitroaniline | ND | 5 | mg/kg |
| 2-Nitrophenol | ND | 1 | mg/kg |
| 3,3'-Dichlorobenzidine | ND | 2 | mg/kg |
| 3-Methylphenol/4-Methylphenol ** | ND | 1 | mg/kg |
| 3-Nitroaniline | ND | 5 | mg/kg |
| 4,6-Dinitro-2-methylphenol | ND | 5 | mg/kg |
| 4-Bromophenyl-phenylether | ND | 1 | mg/kg |
| 4-Chloro-3-methylphenol | ND | 2 | mg/kg |
| 4-Chloroaniline | ND | 2 | mg/kg |
| 4-Chlorophenyl-phenylether | ND | 1 | mg/kg |
| 4-Nitroaniline | ND | 2 | mg/kg |
| 4-Nitrophenol | ND | 5 | mg/kg |
| Acenaphthene | ND | 1 | mg/kg |
| Acenaphthylene | ND | 1 | mg/kg |
| Anthracene | ND | 1 | mg/kg |
| Benzo(a)anthracene | ND | 1 | mg/kg |
| Benzo(a)pyrene | ND | 1 | mg/kg |
| Benzo(b)fluoranthene | ND | 1 | mg/kg |
| Benzo(g,h,i)perylene | ND | 1 | mg/kg |
| Benzo(k)fluoranthene | ND | 1 | mg/kg |
| Benzoic Acid | ND | 5 | mg/kg |

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# EPA METHOD 8270
# HSL SEMI-VOLATILE COMPOUNDS
# BASE/NEUTRAL/ACID EXTRACTABLES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP04 | Date Reported: | 07/25/94 |
| Laboratory ID: | B946406 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/18/94 |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Benzyl Alcohol | ND | 2 | mg/kg |
| bis(2-Chloroethoxy)methane | ND | 1 | mg/kg |
| bis(2-Chloroethyl)ether | ND | 1 | mg/kg |
| bis(2-Chloroisopropyl)ether | ND | 1 | mg/kg |
| bis(2-Ethylhexyl)phthalate | ND | 5 | mg/kg |
| [illegible]benzylphthalate | ND | 1 | mg/kg |
| [illegible]rysene | ND | 1 | mg/kg |
| Di-n-Butylphthalate | ND | 5 | mg/kg |
| Di-n-Octylphthalate | ND | 1 | mg/kg |
| Dibenz(a,h)anthracene | ND | 1 | mg/kg |
| Dibenzofuran | ND | 1 | mg/kg |
| Diethylphthalate | ND | 1 | mg/kg |
| Dimethylphthalate | ND | 1 | mg/kg |
| Fluoranthene | ND | 1 | mg/kg |
| Fluorene | ND | 1 | mg/kg |
| Hexachlorobenzene | ND | 1 | mg/kg |
| Hexachlorobutadiene | ND | 2 | mg/kg |
| Hexachlorocyclopentadiene | ND | 1 | mg/kg |
| Hexachloroethane | ND | 2 | mg/kg |
| Indeno(1,2,3-cd)pyrene | ND | 1 | mg/kg |
| Isophorone | ND | 1 | mg/kg |
| N-Nitrosodi-n-propylamine | ND | 1 | mg/kg |
| N-Nitrosodiphenylamine | ND | 1 | mg/kg |
| Naphthalene | ND | 1 | mg/kg |
| Nitrobenzene | ND | 1 | mg/kg |
| Pentachlorophenol | ND | 5 | mg/kg |
| Phenanthrene | ND | 1 | mg/kg |
| Phenol | ND | 1 | mg/kg |
| Pyrene | ND | 1 | mg/kg |

ND - Compound not detected at stated Detection Limit.
J - Meets identification criteria, below Detection Limit.
** - Compounds coelute by GCMS.
B - Compound detected in Method Blank.

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# EPA METHOD 8270
# TENTATIVELY IDENTIFIED COMPOUNDS
# BASE/NEUTRAL/ACID EXTRACTABLES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP04 | Date Reported: | 07/25/94 |
| Laboratory ID: | 8946406 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/18/94 |

| Tentative Identification | Retention Time (minutes) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable levels.

Unknown concentration calculated assuming Relative Response Factor = 1.

## QUALITY CONTROL:

| Surrogate Recoveries | % | Soil QC Limits |
|---|---|---|
| 2-Fluorophenol | 58 | 25 - 121 |
| Phenol-d6 | 86 | 24 - 113 |
| Nitrobenzene-d5 | 75 | 23 - 120 |
| 2-Fluorobiphenyl | 76 | 30 - 115 |
| 2,4,6-Tribromophenol | 75 | 19 - 122 |
| Terphenyl-d14 | 57 | 18 - 137 |

**Reference:**

Method 8270, Gas Chromatography/Mass Spectrometry for Semivolatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, Third Edition, November 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP04 | Date Reported: | 07/26/94 |
| Project ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | 8946406 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | Date Extracted : | 07/11/94 |
| Preservation: | Cool | Date Analyzed: | 07/20/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 16000 | 200 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | 29 | 20 | mg/kg |
| Barium | 120 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 5 | 2 | mg/kg |
| Chromium | 20 | 5 | mg/kg |
| Cobalt | 10 | 5 | mg/kg |
| Copper | 40 | 5 | mg/kg |
| Iron | 26000 | 200 | mg/kg |
| [illegible] | 760 | 20 | mg/kg |
| Mercury | ND | 0.5 | mg/kg |
| Manganese | 1200 | 5 | mg/kg |
| Molybdenum | ND | 5 | mg/kg |
| Nickel | 14 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | ND | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 240 | 5 | mg/kg |
| Vanadium | 30 | 10 | mg/kg |
| Zinc | 1100 | 5 | mg/kg |
| Gold | ND | 200 | mg/kg |
| Boron | ND | 100 | mg/kg |
| Calcium | 3800 | 100 | mg/kg |
| Potassium | 2300 | 100 | mg/kg |
| Magnesium | 7800 | 100 | mg/kg |
| Sodium | 230 | 200 | mg/kg |
| Phosphorous | 650 | 200 | mg/kg |
| Silicon | 360 | 100 | mg/kg |
| Yttrium | 14 | 5 | mg/kg |

ND - Compound not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission Spectroscopy, SW-846, September 1986.

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# GENERAL PARAMETERS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP04 | Date Reported: | 07/27/94 |
| Program ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | B946406 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | | |
| Preservation: | Cool | | |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Cyanide, Total | ND | 0.5 | mg/kg |
| Sulfate | 280 | 10 | mg/kg |

*The result is suspect. Sample had a colloidal suspension that could not be filtered out. When acidified, the suspension precipitated. Filtration was performed; however, all precipitation was not filterable before addition of barium chloride.*

Reference: SW-846, United States Environmental Protection Agency, Nov. 1986
Appendix 9010A : Cyanide Extraction Procedure for Solids and Oils
Method 9010 : Total and Amenable Cyanide
Methods of Soil Analysis, No 9, American Society of Agronomy, 1965

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# EPA METHOD 8240
# HSL VOLATILE COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP05 | Date Reported: | 07/22/94 |
| Project ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | B946407 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | Date Extracted: | 07/06/94 |
| Preservation: | Cool | Date Analyzed: | 07/06/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| 1,1,1-Trichloroethane | ND | 0.2 | mg/kg |
| 1,1,2,2-Tetrachloroethane | ND | 0.2 | mg/kg |
| 1,1,2-Trichloroethane | ND | 0.2 | mg/kg |
| 1,1-Dichloroethane | ND | 0.2 | mg/kg |
| 1,[illegible]-Dichloroethene | ND | 0.2 | mg/kg |
| [illegible]-Dichloroethane | ND | 0.2 | mg/kg |
| ,,2-Dichloropropane | ND | 0.2 | mg/kg |
| 2-Butanone (MEK) | ND | 1 | mg/kg |
| 2-Hexanone | ND | 0.2 | mg/kg |
| 4-Methyl-2-pentanone (MIBK) | ND | 0.2 | mg/kg |
| Acetone | ND | 1 | mg/kg |
| Benzene | ND | 0.2 | mg/kg |
| Bromodichloromethane | ND | 0.2 | mg/kg |
| Bromoform | ND | 0.2 | mg/kg |
| Bromomethane | ND | 0.2 | mg/kg |
| Carbon Disulfide | ND | 0.2 | mg/kg |
| Carbon Tetrachloride | ND | 0.2 | mg/kg |
| Chlorobenzene | ND | 0.2 | mg/kg |
| Chloroethane | ND | 0.2 | mg/kg |
| Chloroform | ND | 0.2 | mg/kg |
| Chloromethane | ND | 0.2 | mg/kg |
| cis-1,3-Dichloropropene | ND | 0.2 | mg/kg |
| Dibromochloromethane | ND | 0.2 | mg/kg |
| Ethylbenzene | ND | 0.2 | mg/kg |
| m,p-Xylene | ND | 0.2 | mg/kg |
| Methylene chloride | ND | 1 | mg/kg |
| o-Xylene | ND | 0.2 | mg/kg |
| Styrene | ND | 0.2 | mg/kg |

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# EPA METHOD 8240
# HSL VOLATILE COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP05 | Date Reported: | 07/22/94 |
| Laboratory ID: | B946407 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/06/94 |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Tetrachloroethene (PCE) | ND | 0.2 | mg/kg |
| Toluene | ND | 0.2 | mg/kg |
| trans-1,2-Dichloroethene | ND | 0.2 | mg/kg |
| trans-1,3-Dichloropropene | ND | 0.2 | mg/kg |
| Trichloroethene (TCE) | ND | 0.2 | mg/kg |
| [illegible] Chloride | ND | 0.2 | mg/kg |

ND - Compound not detected at stated Detection Limit.
J - Meets identification criteria, below Detection Limit.
B - Compound detected in method blank.

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# EPA METHOD 8240
# TENTATIVELY IDENTIFIED COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP05 | Date Reported: | 07/22/94 |
| Laboratory ID: | 8946407 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/06/94 |

| Tentative Identification | Retention Time (min) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable levels.

Known concentrations calculated assuming a Relative Response Factor = 1.

## QUALITY CONTROL:

| Surrogate Recovery | % | Soil QC Limits |
|---|---|---|
| 1,2-Dichloroethane-d4 | 89 | 70 - 121 |
| Toluene-d8 | 105 | 81 - 117 |
| Bromofluorobenzene | 96 | 74 - 121 |

References:

Method 8240, Gas Chromatography/Mass Spectrometry for Volatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, Third Edition, November 1986.

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# EPA METHOD 8270
## HSL SEMI-VOLATILE COMPOUNDS
## BASE/NEUTRAL/ACID EXTRACTABLES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP05 | Date Reported: | 07/25/94 |
| Project ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | B946407 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | Date Extracted: | 07/07/94 |
| Preservation: | Cool | Date Analyzed: | 07/19/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| 1,2,4-Trichlorobenzene | ND | 1 | mg/kg |
| 1,2-Dichlorobenzene | ND | 1 | mg/kg |
| 1,3-Dichlorobenzene | ND | 1 | mg/kg |
| 1,4-Dichlorobenzene | ND | 1 | mg/kg |
| 2,4,5-Trichlorophenol | ND | 1 | mg/kg |
| 2,[illegible]-Trichlorophenol | ND | 1 | mg/kg |
| [illegible]Dichlorophenol | ND | 1 | mg/kg |
| 2,4-Dimethylphenol | ND | 1 | mg/kg |
| 2,4-Dinitrophenol | ND | 5 | mg/kg |
| 2,4-Dinitrotoluene | ND | 1 | mg/kg |
| 2,6-Dinitrotoluene | ND | 1 | mg/kg |
| 2-Chloronaphthalene | ND | 1 | mg/kg |
| 2-Chlorophenol | ND | 1 | mg/kg |
| 2-Methylnaphthalene | ND | 1 | mg/kg |
| 2-Methylphenol | ND | 1 | mg/kg |
| 2-Nitroaniline | ND | 5 | mg/kg |
| 2-Nitrophenol | ND | 1 | mg/kg |
| 3,3'-Dichlorobenzidine | ND | 2 | mg/kg |
| 3-Methylphenol/4-Methylphenol ** | ND | 1 | mg/kg |
| 3-Nitroaniline | ND | 5 | mg/kg |
| 4,6-Dinitro-2-methylphenol | ND | 5 | mg/kg |
| 4-Bromophenyl-phenylether | ND | 1 | mg/kg |
| 4-Chloro-3-methylphenol | ND | 2 | mg/kg |
| 4-Chloroaniline | ND | 2 | mg/kg |
| 4-Chlorophenyl-phenylether | ND | 1 | mg/kg |
| 4-Nitroaniline | ND | 2 | mg/kg |
| 4-Nitrophenol | ND | 5 | mg/kg |
| Acenaphthene | ND | 1 | mg/kg |
| Acenaphthylene | ND | 1 | mg/kg |
| Anthracene | ND | 1 | mg/kg |
| [illegible]a)anthracene | ND | 1 | mg/kg |
| [illegible]nzo(a)pyrene | ND | 1 | mg/kg |
| Benzo(b)fluoranthene | ND | 1 | mg/kg |
| Benzo(g,h,i)perylene | ND | 1 | mg/kg |
| Benzo(k)fluoranthene | ND | 1 | mg/kg |
| Benzoic Acid | ND | 5 | mg/kg |

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# EPA METHOD 8270
# TENTATIVELY IDENTIFIED COMPOUNDS
# BASE/NEUTRAL/ACID EXTRACTABLES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP05 | Date Reported: | 07/25/94 |
| Laboratory ID: | B946407 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/19/94 |

| Tentative Identification | Retention Time (minutes) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable levels.

Unknown concentration calculated assuming Relative Response Factor = 1.

## QUALITY CONTROL:

| Surrogate Recoveries | % | Soil QC Limits |
|---|---|---|
| 2-Fluorophenol | 59 | 25 - 121 |
| Phenol-d6 | 80 | 24 - 113 |
| Nitrobenzene-d5 | 68 | 23 - 120 |
| 2-Fluorobiphenyl | 77 | 30 - 115 |
| 2,4,6-Tribromophenol | 81 | 19 - 122 |
| Terphenyl-d14 | 55 | 18 - 137 |

Reference:

Method 8270, Gas Chromatography/Mass Spectrometry for Semivolatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, Third Edition, November 1986.

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# EPA METHOD 8270
# TENTATIVELY IDENTIFIED COMPOUNDS
# BASE/NEUTRAL/ACID EXTRACTABLES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP05 | Date Reported: | 07/25/94 |
| Laboratory ID: | B946407 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/19/94 |

| Tentative Identification | Retention Time (minutes) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable levels.

Unknown concentration calculated assuming Relative Response Factor = 1.

## QUALITY CONTROL:

| Surrogate Recoveries | % | Soil QC Limits |
|---|---|---|
| 2-Fluorophenol | 59 | 25 - 121 |
| Phenol-d6 | 80 | 24 - 113 |
| Nitrobenzene-d5 | 68 | 23 - 120 |
| 2-Fluorobiphenyl | 77 | 30 - 115 |
| 2,4,6-Tribromophenol | 81 | 19 - 122 |
| Terphenyl-d14 | 55 | 18 - 137 |

*Reference:*

Method 8270, Gas Chromatography/Mass Spectrometry for Semivolatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, Third Edition, November 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP05 | Date Reported: | 07/26/94 |
| Project ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | 8946407 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | Date Extracted : | 07/11/94 |
| Preservation: | Cool | Date Analyzed: | 07/20/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 7000 | 200 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | ND | 20 | mg/kg |
| Barium | 71 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 7 | 2 | mg/kg |
| Chromium | 12 | 5 | mg/kg |
| Cobalt | 6 | 5 | mg/kg |
| Copper | 160 | 5 | mg/kg |
| Iron | 20000 | 200 | mg/kg |
| [illegible] | 1300 | 20 | mg/kg |
| [illegible]rcury | ND | 0.5 | mg/kg |
| Manganese | 1200 | 5 | mg/kg |
| Molybdenum | ND | 5 | mg/kg |
| Nickel | 9 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | ND | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 150 | 5 | mg/kg |
| Vanadium | 19 | 10 | mg/kg |
| Zinc | 1300 | 5 | mg/kg |
| Gold | ND | 200 | mg/kg |
| Boron | ND | 100 | mg/kg |
| Calcium | 2900 | 100 | mg/kg |
| Potassium | 1050 | 100 | mg/kg |
| Magnesium | 4900 | 100 | mg/kg |
| Sodium | 240 | 200 | mg/kg |
| Phosphorous | 390 | 200 | mg/kg |
| Silicon | 340 | 100 | mg/kg |
| Yttrium | 7 | 5 | mg/kg |

ND - Compound not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
[illegible]846, September 1986.

[illegible]thod 6010: Inductively Coupled Plasma-Atomic Emission Spectroscopy, SW-846, September 1986.

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# EPA METHOD 8270
## HSL SEMI-VOLATILE COMPOUNDS
## BASE/NEUTRAL/ACID EXTRACTABLES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP05 | Date Reported: | 07/25/94 |
| Laboratory ID: | B946407 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/19/94 |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Benzyl Alcohol | ND | 2 | mg/kg |
| bis(2-Chloroethoxy)methane | ND | 1 | mg/kg |
| bis(2-Chloroethyl)ether | ND | 1 | mg/kg |
| bis(2-Chloroisopropyl)ether | ND | 1 | mg/kg |
| bis(2-Ethylhexyl)phthalate | ND | 5 | mg/kg |
| [illegible]ylbenzylphthalate | ND | 1 | mg/kg |
| [illegible]hrysene | ND | 1 | mg/kg |
| Di-n-Butylphthalate | ND | 5 | mg/kg |
| Di-n-Octylphthalate | ND | 1 | mg/kg |
| Dibenz(a,h)anthracene | ND | 1 | mg/kg |
| Dibenzofuran | ND | 1 | mg/kg |
| Diethylphthalate | ND | 1 | mg/kg |
| Dimethylphthalate | ND | 1 | mg/kg |
| Fluoranthene | ND | 1 | mg/kg |
| Fluorene | ND | 1 | mg/kg |
| Hexachlorobenzene | ND | 1 | mg/kg |
| Hexachlorobutadiene | ND | 2 | mg/kg |
| Hexachlorocyclopentadiene | ND | 1 | mg/kg |
| Hexachloroethane | ND | 2 | mg/kg |
| Indeno(1,2,3-cd)pyrene | ND | 1 | mg/kg |
| Isophorone | ND | 1 | mg/kg |
| N-Nitrosodi-n-propylamine | ND | 1 | mg/kg |
| N-Nitrosodiphenylamine | ND | 1 | mg/kg |
| Naphthalene | ND | 1 | mg/kg |
| Nitrobenzene | ND | 1 | mg/kg |
| Pentachlorophenol | ND | 5 | mg/kg |
| Phenanthrene | ND | 1 | mg/kg |
| Phenol | ND | 1 | mg/kg |
| Pyrene | ND | 1 | mg/kg |

ND - Compound not detected at stated Detection Limit.
J - Meets identification criteria, below Detection Limit.
** - Compounds coelute by GCMS.
B - Compound detected in Method Blank.

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# B QA/QC
# SEMI-VOLATILE ORGANIC COMPOUNDS BY GC/MS
# METHOD BLANK

Date Analyzed: 07/18/94
Laboratory ID: SMB-188
Sample Matrix: Soil
Date Extracted: 07/07/94

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Benzo(g,h,i)perylene | ND | 1 | mg/kg |
| Benzo(k)fluoranthene | ND | 1 | mg/kg |
| Benzoic Acid | ND | 5 | mg/kg |
| Benzyl Alcohol | ND | 2 | mg/kg |
| bis(2-Chloroethoxy)methane | ND | 1 | mg/kg |
| bis(2-Chloroethyl)ether | ND | 1 | mg/kg |
| bis(2-Chloroisopropyl)ether | ND | 1 | mg/kg |
| bis(2-Ethylhexyl)phthalate | ND | 1 | mg/kg |
| Butylbenzylphthalate | ND | 1 | mg/kg |
| Chrysene | ND | 1 | mg/kg |
| di-n-Butylphthalate | ND | 1 | mg/kg |
| di-n-Octylphthalate | ND | 1 | mg/kg |
| z(a,h)acridine | ND | 1 | mg/kg |
| Dibenz(a,h)anthracene | ND | 1 | mg/kg |
| Dibenzofuran | ND | 1 | mg/kg |
| Diethylphthalate | ND | 1 | mg/kg |
| Dimethylphthalate | ND | 1 | mg/kg |
| Fluoranthene | ND | 1 | mg/kg |
| Fluorene | ND | 1 | mg/kg |
| Hexachlorobenzene | ND | 1 | mg/kg |
| Hexachlorobutadiene | ND | 2 | mg/kg |
| Hexachlorocyclopentadiene | ND | 1 | mg/kg |
| Hexachloroethane | ND | 2 | mg/kg |
| Indene | ND | 1 | mg/kg |
| Indeno(1,2,3-cd)pyrene | ND | 1 | mg/kg |
| Isophorone | ND | 1 | mg/kg |
| N-Nitrosodi-n-propylamine | ND | 1 | mg/kg |
| N-Nitrosodiphenylamine | ND | 1 | mg/kg |
| Naphthalene | ND | 1 | mg/kg |
| Nitrobenzene | ND | 1 | mg/kg |
| Pentachlorophenol | ND | 5 | mg/kg |
| Phenanthrene | ND | 1 | mg/kg |
| Phenol | ND | 1 | mg/kg |
| Pyrene | ND | 1 | mg/kg |
| Pyridine | ND | 1 | mg/kg |
| Quinoline | ND | 1 | mg/kg |

ND - Compound not detected at stated Detection Limits.
* - Compounds Coelute by GC/MS.

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# B QA/QC
# EMI-VOLATILE ORGANIC COMPOUNDS BY GC/MS
# METHOD BLANK
# TENTATIVELY IDENTIFIED COMPOUNDS

Date Analyzed: 07/18/94
Laboratory ID: SMB-188
Sample Matrix: Soil
Date Extracted: 07/07/94

| Tentitively Identification | Retention Time (min.) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable levels.

Unknown concentration calculated assuming Relative Response Factor = 1.

## LITY CONTROL:

| Surrogate Recoveries | % | Soil QC Limits |
|---|---|---|
| 2-Fluorophenol | 60 | 25 - 121 |
| Phenol-d6 | 76 | 24 - 113 |
| Nitrobenzene-d5 | 70 | 23 - 120 |
| 2-Fluorobiphenyl | 71 | 30 - 115 |
| 2,4,6-Tribromophenol | 78 | 19 - 122 |
| Terphenyl-d14 | 51 | 18 - 137 |

Reference:

Method 8270, Gas Chromatography/Mass Spectrometry for Semivolatile Organics, Test Methods for Evaluating Solid Wastes, SW846, USEPA, Third Edition, November 1986.

USEPA Contract Lab Program, Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration, OLM01.0, December 1990.

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# LAB QA/QC
# SEMI-VOLATILE ORGANIC COMPOUNDS BY GC/MS
# METHOD BLANK

Date Analyzed: 07/20/94
Laboratory ID: TMB94-24
Sample Matrix: Water
Date Extracted: 07/11/94

| Parameter | Analytical Result (mg/L) | Detection Limit (mg/L) | Regulatory Limit (mg/L) |
|---|---|---|---|
| 1,4-Dichlorobenzene | ND | 0.01 | 7.5 |
| Hexachloroethane | ND | 0.02 | 3 |
| Nitrobenzene | ND | 0.01 | 2 |
| Hexachloro-1,3-butadiene | ND | 0.02 | 0.5 |
| 2,4,6-Trichlorophenol | ND | 0.01 | 2 |
| [illegible]-Trichlorophenol | ND | 0.01 | 400 |
| 2,4-Dinitrotoluene | ND | 0.01 | 0.13 |
| Hexachlorobenzene | ND | 0.01 | 0.13 |
| Pentachlorophenol | ND | 0.02 | 100 |
| *o-Cresol* | ND | 0.01 | 200 ** |
| m & p-Cresol * | ND | 0.01 | 200 ** |
| Pyridine | ND | 0.01 | 5 |

ND - Compound not detected at stated Detection Limit
B - Compound detected in Method Blank.
* - Compounds coelute by GCMS.
** - Regulatory Limit of combined Cresols.

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# QA/QC
# SEMI-VOLATILE ORGANIC COMPOUNDS BY GC/MS
# METHOD BLANK

Date Analyzed: 07/20/94
Laboratory ID: B9224
Sample Matrix: Water
Date Extracted: 07/11/94

| Parameter | Retention Time(min.) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable limits.

Unknown concentrations calculated assuming Relative Response Factor = 1.

## QUALITY CONTROL:

| Surrogate Recoveries | % |
|---|---|
| 2-Fluorophenol | 56 |
| Phenol-d6 | 64 |
| Nitrobenzene-d5 | 78 |
| 2-Fluorobiphenyl | 83 |
| 2,4,6-Tribromophenol | 102 |
| Terphenyl-d14 | 73 |

References:
Method 8270, Gas Chromatography/Mass Spectrometry for Semi-Volatile Organics, Test Methods for Evaluating Solid Wastes, United States Environmental Protection Agency, December 1987.

Toxicity Characteristic Leaching Procedure, Final Rule, Federal Register, 40 CFR 261-302, Part V, Environmental Protection Agency, Vol. 55, No. 126, June 29, 1990.

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# LAB QA/QC
# TOXICITY CHARACTERISTIC LEACHING PROCEDURE - CHLORINATED HERBICIDES
# METHOD BLANK

Date Analyzed: 07/18/94
Laboratory ID: TMB-94-24
Sample Matrix: Water

| Parameter | Analytical Results | Detection Limits | Units |
|---|---|---|---|
| 2,4-D | ND | 0.05 | mg/L |
| 2,4,5-TP (Silvex) | ND | 0.05 | mg/L |

All quantities are expressed as total nanograms.

## QUALITY CONTROL

| Surrogate Recoveries: | % |
|---|---|
| DCAA | 63 |

References:

Method 515.1, Determination of Chlorinated Acids in Water by Gas Chromatography with an Electron Capture Detector, EPA/600/4-88/039, December 1988.

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# GENERAL PARAMETERS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP05 | Date Reported: | 07/27/94 |
| Program ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | B946407 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | | |
| Preservation: | Cool | | |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Cyanide, Total | ND | 0.5 | mg/kg |
| Sulfate | 110 | 10 | mg/kg |

Reference: SW-846, United States Environmental Protection Agency, Nov. 1986
Appendix 9010A : Cyanide Extraction Procedure for Solids and Oils
Method 9010 : Total and Amenable Cyanide
Methods of Soil Analysis, No 9, American Society of Agronomy, 1965

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# EPA METHOD 8240
# HSL VOLATILE COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP06 | Date Reported: | 07/22/94 |
| Project ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | B946408 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | Date Extracted: | 07/06/94 |
| Preservation: | Cool | Date Analyzed: | 07/06/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| 1,1,1-Trichloroethane | ND | 0.2 | mg/kg |
| 1,1,2,2-Tetrachloroethane | ND | 0.2 | mg/kg |
| 1,1,2-Trichloroethane | ND | 0.2 | mg/kg |
| 1,1-Dichloroethane | ND | 0.2 | mg/kg |
| 1,1-Dichloroethene | ND | 0.2 | mg/kg |
| 1,2-Dichloroethane | ND | 0.2 | mg/kg |
| 1,2-Dichloropropane | ND | 0.2 | mg/kg |
| 2-Butanone (MEK) | ND | 1 | mg/kg |
| 2-Hexanone | ND | 0.2 | mg/kg |
| 4-Methyl-2-pentanone (MIBK) | ND | 0.2 | mg/kg |
| Acetone | ND | 1 | mg/kg |
| Benzene | ND | 0.2 | mg/kg |
| Bromodichloromethane | ND | 0.2 | mg/kg |
| Bromoform | ND | 0.2 | mg/kg |
| Bromomethane | ND | 0.2 | mg/kg |
| Carbon Disulfide | ND | 0.2 | mg/kg |
| Carbon Tetrachloride | ND | 0.2 | mg/kg |
| Chlorobenzene | ND | 0.2 | mg/kg |
| Chloroethane | ND | 0.2 | mg/kg |
| Chloroform | ND | 0.2 | mg/kg |
| Chloromethane | ND | 0.2 | mg/kg |
| cis-1,3-Dichloropropene | ND | 0.2 | mg/kg |
| Dibromochloromethane | ND | 0.2 | mg/kg |
| Ethylbenzene | ND | 0.2 | mg/kg |
| m,p-Xylene | ND | 0.2 | mg/kg |
| Methylene chloride | ND | 1 | mg/kg |
| o-Xylene | ND | 0.2 | mg/kg |
| Styrene | ND | 0.2 | mg/kg |

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# EPA METHOD 8240
# HSL VOLATILE COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP06 | Date Reported: | 07/22/94 |
| Laboratory ID: | B946408 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/06/94 |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Tetrachloroethene (PCE) | ND | 0.2 | mg/kg |
| Toluene | ND | 0.2 | mg/kg |
| trans-1,2-Dichloroethene | ND | 0.2 | mg/kg |
| trans-1,3-Dichloropropene | ND | 0.2 | mg/kg |
| Trichloroethene (TCE) | ND | 0.2 | mg/kg |
| Vinyl Chloride | ND | 0.2 | mg/kg |

ND - Compound not detected at stated Detection Limit.
J - Meets identification criteria, below Detection Limit.
B - Compound detected in method blank.

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# EPA METHOD 8240
# TENTATIVELY IDENTIFIED COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP06 | Date Reported: | 07/22/94 |
| Laboratory ID: | 8946408 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/06/94 |

| Tentative Identification | Retention Time (min) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable levels.

Known concentrations calculated assuming a Relative Response Factor = 1.

## QUALITY CONTROL:

| Surrogate Recovery | % | Soil QC Limits |
|---|---|---|
| 1,2-Dichloroethane-d4 | 90 | 70 - 121 |
| Toluene-d8 | 106 | 81 - 117 |
| Bromofluorobenzene | 97 | 74 - 121 |

References:

Method 8240, Gas Chromatography/Mass Spectrometry for Volatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, Third Edition, November 1986.

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# EPA METHOD 8270
# HSL SEMI-VOLATILE COMPOUNDS
# BASE/NEUTRAL/ACID EXTRACTABLES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP06 | Date Reported: | 07/25/94 |
| Laboratory ID: | 8946408 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/19/94 |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Benzyl Alcohol | ND | 2 | mg/kg |
| bis(2-Chloroethoxy)methane | ND | 1 | mg/kg |
| bis(2-Chloroethyl)ether | ND | 1 | mg/kg |
| bis(2-Chloroisopropyl)ether | ND | 1 | mg/kg |
| bis(2-Ethylhexyl)phthalate | ND | 5 | mg/kg |
| Butylbenzylphthalate | ND | 1 | mg/kg |
| [illegible]sene | ND | 1 | mg/kg |
| [illegible]-Butylphthalate | ND | 5 | mg/kg |
| Di-n-Octylphthalate | ND | 1 | mg/kg |
| Dibenz(a,h)anthracene | ND | 1 | mg/kg |
| Dibenzofuran | ND | 1 | mg/kg |
| Diethylphthalate | ND | 1 | mg/kg |
| Dimethylphthalate | ND | 1 | mg/kg |
| Fluoranthene | ND | 1 | mg/kg |
| Fluorene | ND | 1 | mg/kg |
| Hexachlorobenzene | ND | 1 | mg/kg |
| Hexachlorobutadiene | ND | 2 | mg/kg |
| Hexachlorocyclopentadiene | ND | 1 | mg/kg |
| Hexachloroethane | ND | 2 | mg/kg |
| Indeno(1,2,3-cd)pyrene | ND | 1 | mg/kg |
| Isophorone | ND | 1 | mg/kg |
| N-Nitrosodi-n-propylamine | ND | 1 | mg/kg |
| N-Nitrosodiphenylamine | ND | 1 | mg/kg |
| Naphthalene | ND | 1 | mg/kg |
| Nitrobenzene | ND | 1 | mg/kg |
| Pentachlorophenol | ND | 5 | mg/kg |
| Phenanthrene | ND | 1 | mg/kg |
| Phenol | ND | 1 | mg/kg |
| Pyrene | ND | 1 | mg/kg |

ND - Compound not detected at stated Detection Limit.
J - Meets identification criteria, below Detection Limit.
** - Compounds coelute by GCMS.
B - Compound detected in Method Blank.

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# EPA METHOD 8270
# HSL SEMI-VOLATILE COMPOUNDS
# BASE/NEUTRAL/ACID EXTRACTABLES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP06 | Date Reported: | 07/25/94 |
| Project ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | 8946408 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | Date Extracted: | 07/07/94 |
| Preservation: | Cool | Date Analyzed: | 07/19/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| 1,2,4-Trichlorobenzene | ND | 1 | mg/kg |
| 1,2-Dichlorobenzene | ND | 1 | mg/kg |
| 1,3-Dichlorobenzene | ND | 1 | mg/kg |
| 1,4-Dichlorobenzene | ND | 1 | mg/kg |
| 2,4,5-Trichlorophenol | ND | 1 | mg/kg |
| 2,4,6-Trichlorophenol | ND | 1 | mg/kg |
| [illegible]ichlorophenol | ND | 1 | mg/kg |
| 2,4-Dimethylphenol | ND | 1 | mg/kg |
| 2,4-Dinitrophenol | ND | 5 | mg/kg |
| 2,4-Dinitrotoluene | ND | 1 | mg/kg |
| 2,6-Dinitrotoluene | ND | 1 | mg/kg |
| 2-Chloronaphthalene | ND | 1 | mg/kg |
| 2-Chlorophenol | ND | 1 | mg/kg |
| 2-Methylnaphthalene | ND | 1 | mg/kg |
| 2-Methylphenol | ND | 1 | mg/kg |
| 2-Nitroaniline | ND | 5 | mg/kg |
| 2-Nitrophenol | ND | 1 | mg/kg |
| 3,3'-Dichlorobenzidine | ND | 2 | mg/kg |
| 3-Methylphenol/4-Methylphenol ** | ND | 1 | mg/kg |
| 3-Nitroaniline | ND | 5 | mg/kg |
| 4,6-Dinitro-2-methylphenol | ND | 5 | mg/kg |
| 4-Bromophenyl-phenylether | ND | 1 | mg/kg |
| 4-Chloro-3-methylphenol | ND | 2 | mg/kg |
| 4-Chloroaniline | ND | 2 | mg/kg |
| 4-Chlorophenyl-phenylether | ND | 1 | mg/kg |
| 4-Nitroaniline | ND | 2 | mg/kg |
| 4-Nitrophenol | ND | 5 | mg/kg |
| Acenaphthene | ND | 1 | mg/kg |
| Acenaphthylene | ND | 1 | mg/kg |
| Anthracene | ND | 1 | mg/kg |
| [illegible]anthracene | ND | 1 | mg/kg |
| [illegible](a)pyrene | ND | 1 | mg/kg |
| Benzo(b)fluoranthene | ND | 1 | mg/kg |
| Benzo(g,h,i)perylene | ND | 1 | mg/kg |
| Benzo(k)fluoranthene | ND | 1 | mg/kg |
| Benzoic Acid | ND | 5 | mg/kg |

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# EPA METHOD 8270
# TENTATIVELY IDENTIFIED COMPOUNDS
# BASE/NEUTRAL/ACID EXTRACTABLES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP06 | Date Reported: | 07/25/94 |
| Laboratory ID: | B946408 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/19/94 |

| Tentative Identification | Retention Time (minutes) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable levels.

Unknown concentration calculated assuming Relative Response Factor = 1.

## QUALITY CONTROL:

| Surrogate Recoveries | % | Soil QC Limits |
|---|---|---|
| 2-Fluorophenol | 60 | 25 - 121 |
| Phenol-d6 | 79 | 24 - 113 |
| Nitrobenzene-d5 | 72 | 23 - 120 |
| 2-Fluorobiphenyl | 73 | 30 - 115 |
| 2,4,6-Tribromophenol | 75 | 19 - 122 |
| Terphenyl-d14 | 51 | 18 - 137 |

Reference:

Method 8270, Gas Chromatography/Mass Spectrometry for Semivolatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, Third Edition, [illegible]ber 1986.

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# TOTAL METALS ANALYSIS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP06 | Date Reported: | 07/26/94 |
| Project ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | B946408 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | Date Extracted : | 07/11/94 |
| Preservation: | Cool | Date Analyzed: | 07/20/94 |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Aluminum | 16000 | 200 | mg/kg |
| Antimony | ND | 20 | mg/kg |
| Arsenic | ND | 20 | mg/kg |
| Barium | 110 | 50 | mg/kg |
| Beryllium | ND | 2 | mg/kg |
| Cadmium | 3 | 2 | mg/kg |
| Chromium | 22 | 5 | mg/kg |
| Cobalt | 9 | 5 | mg/kg |
| Copper | 45 | 5 | mg/kg |
| Iron | 23000 | 200 | mg/kg |
| Lead | 380 | 20 | mg/kg |
| [illegible]ury | ND | 0.5 | mg/kg |
| [illegible]ganese | 900 | 5 | mg/kg |
| Molybdenum | ND | 5 | mg/kg |
| Nickel | 17 | 5 | mg/kg |
| Selenium | ND | 20 | mg/kg |
| Silver | ND | 10 | mg/kg |
| Thallium | ND | 50 | mg/kg |
| Titanium | 200 | 5 | mg/kg |
| Vanadium | 29 | 10 | mg/kg |
| Zinc | 630 | 5 | mg/kg |
| Gold | ND | 200 | mg/kg |
| Boron | ND | 100 | mg/kg |
| Calcium | 3600 | 100 | mg/kg |
| Potassium | 2300 | 100 | mg/kg |
| Magnesium | 11000 | 100 | mg/kg |
| Sodium | 260 | 200 | mg/kg |
| Phosphorous | 730 | 200 | mg/kg |
| Silicon | 450 | 100 | mg/kg |
| Yttrium | 16 | 5 | mg/kg |

ND - Compound not detected at stated Detection Limit.

References:
Method 3050: Acid digestion of Soils, Sediments, and Sludges.
SW-846, September 1986.

[illegible] 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, September 1986.

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# GENERAL PARAMETERS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 SP06 | Date Reported: | 07/27/94 |
| Program ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | B946408 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | | |
| Preservation: | Cool | | |
| Condition: | Intact | | |

| Parameter | Analytical Result | Detection Level | Units |
|---|---|---|---|
| Cyanide, Total | ND | 0.5 | mg/kg |
| Sulfate | 43 | 10 | mg/kg |

Sulfate result is suspect. Sample had a colloidal suspension that could not be filtered out. When acidified, the suspension precipitated. Filtration was performed; however, all precipitation was not filterable before addition of barium chloride.

Reference: SW-846, United States Environmental Protection Agency, Nov. 1986
Appendix 9010A : Cyanide Extraction Procedure for Solids and Oils
Method 9010 : Total and Amenable Cyanide
Methods of Soil Analysis, No 9, American Society of Agronomy, 1965

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# TOXICITY CHARACTERISTIC LEACHING PROCEDURE - TCLP
## HSL VOLATILE COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 CI | Date Reported: | 07/22/94 |
| Project ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | B946409 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | Date Extracted TCLP: | 07/02/94 |
| Preservation: | Cool | Date Analyzed: | 07/12/94 |
| Condition: | Intact | Date Extracted VOA: | NA |

| Parameter | Analytical Result (mg/L) | Detection Limit (mg/L) | Regulatory Limit (mg/L) |
|---|---|---|---|
| 1,1-Dichloroethene | ND | 0.02 | 0.7 |
| 1,2-Dichloroethane | ND | 0.02 | 0.5 |
| 2-Butanone | ND | 0.1 | 200 |
| Benzene | ND | 0.02 | 0.5 |
| Carbon Tetrachloride | ND | 0.02 | 0.5 |
| Chlorobenzene | ND | 0.02 | 100 |
| [illegible]oform | ND | 0.02 | 6 |
| [illegible]achloroethene (PCE) | ND | 0.02 | 0.7 |
| Trichloroethene (TCE) | ND | 0.02 | 0.5 |
| Vinyl Chloride | ND | 0.02 | 0.2 |

ND - Compound not detected at stated Detection Limit.
J - Meets identification criteria, below Detection Limit.
B - Compound detected in Method Blank.

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# GASOLINE RANGE ORGANICS - GRO

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | DOT 2 | Date Reported: | 08/24/94 |
| Project ID: | Rico CDOT | Date Sampled: | 08/17/94 |
| Laboratory ID: | 8947493 | Date Received: | 08/18/94 |
| Matrix: | Soil | Date Extracted: | 08/18/94 |
| | | Date Analyzed: | 08/18/94 |

| Parameter | Result | PQL | Units |
|---|---|---|---|
| Gasoline Range Organics | 12 | 10 | mg/kg |
| Gasoline Range Organics as Gasoline | 12 | 10 | mg/kg |
| Total Purgeable Hydrocarbons | 13 | 10 | mg/kg |

## QUALITY CONTROL:

| Surrogate Recovery | % |
|---|---|
| Bromofluorobenzene | 120 |

ND - Not detected at stated Practical Quantitation Limit (PQL).

Reference:

GRO - USEPA Method for Determination of Gasoline Range Organics, Revision 5, February 1992.

WTPH-G Total Petroleum Hydrocarbons Analytical Methods for Soil, Washington State Department of Ecology. Revision 3, October 1991.

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# DIESEL RANGE ORGANICS - DRO

| | | | |
|---|---|---|---|
| :lient: | WALSH & ASSOCIATES, INC. | | |
| ;ample ID: | DOT 2 | Date Reported: | 08/24/94 |
| 'roject ID: | Rico CDOT | Date Sampled: | 08/17/94 |
| ab ID: | B947493 | Date Received: | 08/18/94 |
| Matrix: | Soil | Date Extracted: | 08/19/94 |
| | | Date Analyzed: | 08/22/94 |

| Parameter | Result | PQL | Units |
|---|---|---|---|
| )iesel Range Organics | ND | 5 | mg/kg |
| ·iesel Range Organics as Diesel | ND | 5 | mg/kg |
| otal Extractable Hydrocarbons | ND | 5 | mg/kg |

D - Not Detected at Practical Quantitation Level (PQL).

ce: DRO - USEPA Method for Determination of Diesel Range Organics. Revision 2, February 1992.

WTPH-D Total Petroleum Hydrocarbons Analytical Methods for Soil, Washington State Department of Ecology, Revision 3, October 1991.

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# TOXICITY CHARACTERISTIC LEACHING PROCEDURE - TCLP
# TRACE METAL CONCENTRATION

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | DOT 2 | Date Reported: | 08/26/94 |
| Project ID: | Rico CDOT | Date Sampled: | 08/17/94 |
| Laboratory ID: | B947493 | Date Received: | 08/18/94 |
| Sample Matrix: | Soil | Date Extracted TCLP: | 08/23/94 |
| | | Date Analyzed: | 08/25/94 |

| Parameter | Analytical Result (mg/L) | Detection Level (mg/L) | Regulatory Level (mg/L) |
|---|---|---|---|
| Arsenic | ND | 0.2 | 5.0 |
| Barium | 1.2 | 0.5 | 100 |
| Cadmium | 0.05 | 0.05 | 1.0 |
| Chromium | ND | 0.05 | 5.0 |
| Lead | ND | 0.5 | 5.0 |
| Mercury | ND | 0.02 | 0.2 |
| Selenium | ND | 0.2 | 1.0 |
| Silver | ND | 0.05 | 1.0 |

ND-Parameter not detected at stated detection level.

References:

Toxicity Characteristic Leaching Procedure , Final Rule,
Federal Register, 40 CFR 261-302. Part V, EPA Vol 55, No. 126, June 29, 1990

Method 3010: Acid Digestion of Aqueous Samples and Extracts
for Total Metals, SW-846, Sept. 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, Sept. 1990.

Method 7470: Mercury in Liquid Waste (Manual Cold-Vapor
Technique), SW-846, Sept. 1986.

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# EPA METHOD 8020
# AROMATIC VOLATILE COMPOUNDS
# BETX

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | DOT 3 | Date Reported: | 08/22/94 |
| Project ID: | Rico CDOT | Date Sampled: | 08/17/94 |
| Laboratory ID: | B947494 | Date Received: | 08 18 94 |
| Sample Matrix: | Soil | Date Extracted: | 08 18/94 |
| | | Date Analyzed: | 08 19 94 |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Benzene | ND | 0.2 | mg kg |
| Toluene | 1.1 | 0.2 | mg kg |
| Ethylbenzene | ND | 0.2 | mg kg |
| [illegible]Xylene | 1.3 | 0.2 | mg kg |
| o-Xylene | 1.2 | 0.2 | mg kg |

ND - Compound not detected at stated Detection Limit.

Reference:

Method 8021, Volatile Organic Compounds, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, United States Environmental Protection Agency, SW-846, Volume IB, December 1987.

Analysis Method: Gas Chromatograph / Purge and Trap / PID

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# GASOLINE RANGE ORGANICS - GRO

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | DOT 3 | Date Reported: | 08/24/94 |
| Project ID: | Rico CDOT | Date Sampled: | 08/17/94 |
| Laboratory ID: | B947494 | Date Received: | 08/18/94 |
| Matrix: | Soil | Date Extracted: | 08/18/94 |
| | | Date Analyzed: | 08/18/94 |

| Parameter | Result | PQL | Units |
|---|---|---|---|
| Gasoline Range Organics | 120 | 10 | mg/kg |
| Gasoline Range Organics as Gasoline | 120 | 10 | mg/kg |
| Total Purgeable Hydrocarbons | 810 | 10 | mg/kg |

## QUALITY CONTROL:

| Surrogate Recovery | % |
|---|---|
| ** Bromofluorobenzene | 165 |

ND - Not detected at stated Practical Quantitation Limit (PQL).
** - Coelution Matrix Effect.

Reference:

GRO - USEPA Method for Determination of Gasoline Range Organics, Revision 5, February 1992.

WTPH-G Total Petroleum Hydrocarbons Analytical Methods for Soil, Washington State Department of Ecology, Revision 3, October 1991.

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# DIESEL RANGE ORGANICS - DRO

| | | | |
|---|---|---|---|
| :lient: | WALSH & ASSOCIATES, INC. | | |
| ;ample ID: | DOT 3 | Date Reported: | 08/24/94 |
| 'roject ID: | Rico CDOT | Date Sampled: | 08/17/94 |
| .ab ID: | B947494 | Date Received: | 08/18/94 |
| Matrix: | Soil | Date Extracted: | 08/19/94 |
| | | Date Analyzed: | 08/20/94 |

| Parameter | Result | PQL | Units |
|---|---|---|---|
| )iesel Range Organics | 600 | 5 | mg/kg |
| )iesel Range Organics as Diesel | 600 | 5 | mg/kg |
| 'otal Extractable Hydrocarbons | 600 | 5 | mg/kg |

JD - Not Detected at Practical Quantitation Level (PQL).

nce: DRO - USEPA Method for Determination of Diesel Range Organics. Revision 2, February 1992.

WTPH-D Total Petroleum Hydrocarbons Analytical Methods for Soil, Washington State Department of Ecology, Revision 3, October 1991.

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# TOXICITY CHARACTERISTIC LEACHING PROCEDURE - TCLP
## TRACE METAL CONCENTRATION

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | DOT 3 | Date Reported: | 08/26/94 |
| Project ID: | Rico CDOT | Date Sampled: | 08/17/94 |
| Laboratory ID: | B947494 | Date Received: | 08/18/94 |
| Sample Matrix: | Soil | Date Extracted TCLP: | 08/23/94 |
| | | Date Analyzed: | 08/25/94 |

| Parameter | Analytical Result (mg/L) | Detection Level (mg/L) | Regulatory Level (mg/L) |
|---|---|---|---|
| Arsenic | ND | 0.2 | 5.0 |
| Barium | 2 | 0.5 | 100 |
| Cadmium | 0.07 | 0.05 | 1.0 |
| Chromium | ND | 0.05 | 5.0 |
| Lead | 1.7 | 0.5 | 5.0 |
| Mercury | ND | 0.02 | 0.2 |
| Selenium | ND | 0.2 | 1.0 |
| Silver | ND | 0.05 | 1.0 |

ND-Parameter not detected at stated detection level.

References:

Toxicity Characteristic Leaching Procedure , Final Rule,
Federal Register, 40 CFR 261-302. Part V, EPA Vol 55, No. 126, June 29, 1990

Method 3010: Acid Digestion of Aqueous Samples and Extracts for Total Metals, SW-846, Sept. 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission Spectroscopy, SW-846, Sept. 1990.

Method 7470: Mercury in Liquid Waste (Manual Cold-Vapor Technique), SW-846, Sept. 1986.

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# EPA METHOD 8020
# AROMATIC VOLATILE COMPOUNDS
# BETX

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | Trip Blank | Date Reported: | 08/22/94 |
| Project ID: | Rico CDOT | Date Sampled: | 08.15.94 |
| Laboratory ID: | B947495 | Date Received: | 08.18.94 |
| Sample Matrix: | Soil | Date Extracted: | 08.18.94 |
| | | Date Analyzed: | 08/19 94 |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Benzene | ND | 0.2 | mg/kg |
| Toluene | ND | 0.2 | mg/kg |
| Ethylbenzene | ND | 0.2 | mg kg |
| [illegible]Xylene | ND | 0.2 | mg.kg |
| o-Xylene | ND | 0.2 | mg.kg |

ND - Compound not detected at stated Detection Limit.

*Reference:*

Method 8021, Volatile Organic Compounds, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, United States Environmental Protection Agency, SW-846, Volume IB, December 1987.

Analysis Method: Gas Chromatograph / Purge and Trap / PID

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# QUALITY ASSURANCE / QUALITY CONTROL

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QA/QC
# GASOLINE RANGE ORGANICS - GRO
# METHOD BLANK

Date Analyzed: 08/18/94
Laboratory ID: MB 230
Sample Matrix: Water

| Parameter | Result | PQL | Units |
|---|---|---|---|
| Gasoline Range Organics | ND | 0.01 | mg/L |
| Gasoline Range Organics as | ND | 0.01 | mg/L |
| Total Purgeable Hydrocarbon | ND | 0.01 | mg/L |

## QUALITY CONTROL:

| Surrogate Recovery | % |
|---|---|
| Bromofluorobenzene | 134 |

ND - Not detected at stated Practical Quantitation Limit (PQL).

Reference:

GRO - USEPA Method for Determination of Gasoline Range Organics, Revision 5, February 1992.

WTPH-G Total Petroleum Hydrocarbons Analytical Methods for Soil, Washington State Department of Ecology, Revision 3, October 1991.

Method 5030, Purge and Trap, & Method 8000, Gas Chromatography, United States Environmental Protection Agency, SW-846, Volume IB, December 1987 .

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# .AB QA/QC
# )IESEL RANGE ORGANICS - DRO
# ⁄IETHOD BLANK

)ate Analyzed: 08/19/94
.ab ID: MBS00231
⁄latrix: Soil

| Parameter | Result | PQL | Units |
|---|---|---|---|
| )iesel Range Organics | ND | 5 | mg/kg |

ND - Not Detected at Practical Quantitation Level (PQL).

Reference: DRO - USEPA Method for Determination of Diesel Range Organics. Revision 2, February 1992.

WTPH-D Total Petroleum Hydrocarbons Analytical Methods for Soil, Washington State Department of Ecology, Revision 3, October 1991.

Analyst Shawn Pettis

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# LAB QA/QC
# TRACE METALS - TCLP
# METHOD BLANK

Date Analyzed: 08/25/94
Laboratory ID: TMB 94-30
Sample Matrix: Extract

| Parameter | Sample Result | PQL | Regulatory Level | Units |
|---|---|---|---|---|
| Arsenic | ND | 0.2 | 5.0 | mg/L |
| Barium | ND | 5 | 100.0 | mg/L |
| Cadmium | ND | 0.05 | 1.0 | mg/L |
| Chromium | ND | 0.05 | 5.0 | mg/L |
| Lead | ND | 0.2 | 5.0 | mg/L |
| Mercury | ND | 0.02 | 0.2 | mg/L |
| Selenium | ND | 0.2 | 1.0 | mg/L |
| Silver | ND | 0.05 | 1.0 | mg/L |

ND-Parameter not detected at stated detection level.

References:
Toxicity Characteristic Leaching Procedure , Final Rule,
Federal Register, 40 CFR 261-302. Part V, EPA Vol 55, No. 126, June 29, 1990

Method 3010: Acid Digestion of Aqueous Samples and Extracts
for Total Metals, SW-846, Sept. 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, Sept. 1990.

Method 7470: Mercury in Liquid Waste (Manual Cold-Vapor
Technique), SW-846, Sept. 1986.

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# LAB QA/QC
# EPA METHOD 8020 / 602
# AROMATIC VOLATILE COMPOUNDS
# EXTRACTION MATRIX SPIKE / EXTRACTION MATRIX SPIKE DUPLICATE SUMMARY

Date Analyzed: 08/19/94
Laboratory ID: EMS/EMSD 7366
Sample Matrix: Soil
Date Extracted 8/18/94

ORIGINAL SAMPLE PARAMETERS

| Parameter | Spike Added (mg/kg) | Sample Conc. (mg/kg) | EMS Conc. (mg/kg) | EMS Recovery (%) | QC Limits (% Rec.) |
|---|---|---|---|---|---|
| Benzene | 8 | 0.0 | 7.3 | 91 | 50-110 |
| Toluene | 8 | 0.0 | 7.5 | 94 | 58-110 |
| Ethylbenzene | 8 | 0.0 | 7.1 | 89 | 59-116 |
| m,p-Xylene | 16 | 0.0 | 14 | 88 | 61-112 |
| o-Xylene | 8 | 0.0 | 7.4 | 93 | 60-117 |

DUPLICATE SAMPLE PARAMETERS

| Parameter | Spike Added (mg/kg) | EMSD Conc. (mg/kg) | EMSD Recovery (%) | RPD (%) | QC Limits RPD | QC Limits Rec. |
|---|---|---|---|---|---|---|
| Benzene | 8 | 7.1 | 89 | 3 | 25 | 50-110 |
| Toluene | 8 | 7.2 | 90 | 4 | 25 | 58-110 |
| Ethylbenzene | 8 | 6.6 | 83 | 7 | 25 | 59-116 |
| m,p-Xylene | 16 | 13 | 81 | 7 | 25 | 61-112 |
| o-Xylene | 8 | 6.7 | 84 | 10 | 25 | 60-117 |

Spike Recovery: 0 out of 10 outside QC limits.
RPD: 0 out of 5 outside QC limits.

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# QA/QC
# TRACE METALS - TCLP
# METHOD BLANK

Date Analyzed: 08/25/94
Laboratory ID: TMB 94-30
Sample Matrix: Extract

| Parameter | Sample Result | PQL | Regulatory Level | Units |
|---|---|---|---|---|
| Arsenic | ND | 0.2 | 5.0 | mg/L |
| Barium | ND | 5 | 100.0 | mg/L |
| Cadmium | ND | 0.05 | 1.0 | mg/L |
| Chromium | ND | 0.05 | 5.0 | mg/L |
| Lead | ND | 0.2 | 5.0 | mg/L |
| Mercury | ND | 0.02 | 0.2 | mg/L |
| Selenium | ND | 0.2 | 1.0 | mg/L |
| [illegible] | ND | 0.05 | 1.0 | mg/L |

ND-Parameter not detected at stated detection level.

References:
Toxicity Characteristic Leaching Procedure , Final Rule,
Federal Register, 40 CFR 261-302. Part V, EPA Vol 55, No. 126, June 29, 1990

Method 3010: Acid Digestion of Aqueous Samples and Extracts
for Total Metals, SW-846, Sept. 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, Sept. 1990.

Method 7470: Mercury in Liquid Waste (Manual Cold-Vapor
Technique), SW-846, Sept. 1986.

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# QA/QC
# EPA METHOD 8020 / 602
# AROMATIC VOLATILE COMPOUNDS
# EXTRACTION MATRIX SPIKE / EXTRACTION MATRIX SPIKE DUPLICATE SUMMARY

Date Analyzed: 08/19/94
Laboratory ID: EMS/EMSD 7366
Sample Matrix: Soil
Date Extracted 8/18/94

ORIGINAL SAMPLE PARAMETERS

| Parameter | Spike Added (mg/kg) | Sample Conc. (mg/kg) | EMS Conc. (mg/kg) | EMS Recovery (%) | QC Limits (% Rec.) |
|---|---|---|---|---|---|
| Benzene | 8 | 0.0 | 7.3 | 91 | 50-110 |
| Toluene | 8 | 0.0 | 7.5 | 94 | 58-110 |
| Ethylbenzene | 8 | 0.0 | 7.1 | 89 | 59-116 |
| m,p-Xylene | 16 | 0.0 | 14 | 88 | 61-112 |
| o-Xylene | 8 | 0.0 | 7.4 | 93 | 60-117 |

DUPLICATE SAMPLE PARAMETERS

| Parameter | Spike Added (mg/kg) | EMSD Conc. (mg/kg) | EMSD Recovery (%) | RPD (%) | QC Limits RPD | QC Limits Rec. |
|---|---|---|---|---|---|---|
| Benzene | 8 | 7.1 | 89 | 3 | 25 | 50-110 |
| Toluene | 8 | 7.2 | 90 | 4 | 25 | 58-110 |
| Ethylbenzene | 8 | 6.6 | 83 | 7 | 25 | 59-116 |
| m,p-Xylene | 16 | 13 | 81 | 7 | 25 | 61-112 |
| o-Xylene | 8 | 6.7 | 84 | 10 | 25 | 60-117 |

Spike Recovery: 0 out of 10 outside QC limits.
RPD: 0 out of 5 outside QC limits.

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# QA/QC
# TRACE METALS - TCLP
# DUPLICATE SUMMARY

Date Analyzed: 08/25/94
Laboratory ID: B947385
Sample Matrix: Soil

| Parameter | Sample Result | Duplicate Sample Result | RPD % | PQL | Units |
|---|---|---|---|---|---|
| Arsenic | ND | ND | 0 | 0.2 | mg/L |
| Barium | 0.7 | 0.7 | 0 | 5 | mg/L |
| Cadmium | 0.08 | 0.08 | 0 | 0.05 | mg/L |
| Chromium | ND | ND | 0 | 0.05 | mg/L |
| Lead | 21 | 22 | 5 | 0.2 | mg/L |
| Mercury | ND | ND | 0 | 0.02 | mg/L |
| Selenium | ND | ND | 0 | 0.2 | mg/L |
| [illegible] | ND | ND | 0 | 0.05 | mg/L |

ND-Parameter not detected at stated detection level.

References:
Toxicity Characteristic Leaching Procedure , Final Rule,
Federal Register, 40 CFR 261-302. Part V, EPA Vol 55, No. 126, June 29, 1990

Method 3010: Acid Digestion of Aqueous Samples and Extracts
for Total Metals, SW-846, Sept. 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, Sept. 1990.

Method 7470: Mercury in Liquid Waste (Manual Cold-Vapor
Technique), SW-846, Sept. 1986.

[illegible]
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# QA/QC
## RACE METALS - TCLP
## MATRIX SPIKE

Date Analyzed: 08/25/94
Laboratory ID: B947386
Sample Matrix: Soil

| Parameter | Spike Added (mg/L) | Sample Conc. (mg/L) | MS Conc. (mg/L) | MS Recovery (%) | QC Limits (% Rec.) |
|---|---|---|---|---|---|
| Arsenic | 2.5 | ND | 2.6 | 105 | 75 - 125 |
| Barium | 5.0 | 1.1 | 6.0 | 97 | 75 - 125 |
| Cadmium | 0.50 | 0.66 | 1.12 | 92 | 75 - 125 |
| Chromium | 2.0 | ND | 2.0 | 98 | 75 - 125 |
| Lead | 2.0 | 4.3 | 6.1 | 91 | 75 - 125 |
| Mercury | 0.20 | ND | 0.21 | 103 | 75 - 125 |
| Selenium | 2.5 | ND | 2.9 | 114 | 75 - 125 |
| [illegible] | 0.05 | ND | 0.06 | 121 | 75 - 125 |

ND-Parameter not detected at stated detection level.

References:
Toxicity Characteristic Leaching Procedure , Final Rule,
Federal Register, 40 CFR 261-302. Part V, EPA Vol 55, No. 126, June 29, 1990

Method 3010: Acid Digestion of Aqueous Samples and Extracts
for Total Metals, SW-846, Sept. 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission
Spectroscopy, SW-846, Sept. 1990.

Method 7470: Mercury in Liquid Waste (Manual Cold-Vapor
Technique), SW-846, Sept. 1986.

[illegible]
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# LAB QA/QC
## GASOLINE RANGE ORGANICS - GRO
## EXTRACTION MATRIX SPIKE / EXTRACTION MATRIX SPIKE DUPLICATE

Date Analyzed: 08/19/94
Laboratory ID: EMS/EMSD 7366
Sample Matrix: Soil
Date Extracted 8/15/94

| Parameter | EMS Found Results (mg/kg) | EMS Expected Results (mg/kg) | EMS Percent Recovery |
|---|---|---|---|
| Gasoline Range Organics | 63 | 50 | 126% |

| Parameter | EMSD Found Results (mg/kg) | EMSD Expected Results (mg/kg) | EMSD Percent Recovery | RPD % |
|---|---|---|---|---|
| Gasoline Range Organics | 65 | 50 | 130% | 3 |

References:

GRO - USEPA Method for Determinination of Gasoline Range Organics. Revision 5, February 1992.

WTPH-G Total Petroleum Hydrocarbons Analytical Methods for Soil, Washington State Department of Ecology. Revision 3, October 1991.

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.B QA/QC
RANGE ORGANICS - DRO
ANK SPIKE

te Analyzed: 08/19/94
) ID: BSS00231
trix: Soil

| arameter | Spike Added (mg/kg) | Sample Result (mg/kg) | Spike Result (mg/kg) | BS Recovery % | QC Limits Rec. |
|---|---|---|---|---|---|
| sel Range Organics | 25 | 0 | 17 | 68 | 50 -150 |

ke Recovery: 0 out of 1 outside QC limits.

erence: DRO - USEPA Method for Determination of Diesel Range Organics. Revision 2, February 1992.

WTPH-D Total Petroleum Hydrocarbons Analytical Methods for Soil, Washington State Department of Ecology, Revision 3, October 1991.

lyst Shawn Rettig

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# CHAIN OF CUSTODY RECORD

Client/Project Name: Walsh / Rico CDOT

Project Location:

Sampler: (Signature)

Chain of Custody Tape No.

ANALYSES / PARAMETERS

| Sample No./ Identification | Date | Time | Lab Number | Matrix | No. of Containers | TCLP RCRA 8 Metals | BTEX/TPH | TPH | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DOT 1 | 8/17/94 | 1040 | B94-7492 | Soil | 2 | ✓ | ✓ | | | | Gasoline & diesel range |
| DOT 2 | | 1050 | 7493 | | 2 | ✓ | ✓ | | | | hydrocarbons |
| DOT 3 | | 1120 | 7494 | | 2 | ✓ | ✓ | | | | ↓ |
| trip blank | 8/15/94 | | 7495 | | 1 | | ✓ | | | | |
| | | | | | | | | | | | cooler temp. 17.6° |
| | | | | | | | | | | | |
| | | | | | | | | | | | 2-40 ml |
| | | | | | | | | | | | |
| | | | | | | | | | | | samples intact |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

| Relinquished by: (Signature) | Date | Time | Received by: (Signature) | Date | Time |
|---|---|---|---|---|---|
| | 1857 | 8/17/94 | (carrier) | | |
| Relinquished by: (Signature) (carrier) | | | Received by: (Signature) | 8/18/94 | 7m |
| Relinquished by: (Signature) | | | Received by laboratory: (Signature) | | |


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19718

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LAB QA/QC
VOLATILE COMPOUNDS BY GC/MS
METHOD BLANK

Date Analyzed: 07/12/94
Laboratory ID: 3MB-193A
Sample Matrix: Water

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Chloromethane | ND | 5 | ug/L |
| Bromomethane | ND | 5 | ug/L |
| Vinyl Chloride | ND | 5 | ug/L |
| Chloroethane | ND | 5 | ug/L |
| Methylene Chloride | ND | 20 | ug/L |
| Acetone | ND | 20 | ug/L |
| [illegible]n Disulfide | ND | 5 | ug/L |
| 1,1-Dichloroethene | ND | 5 | ug/L |
| 1,1-Dichloroethane | ND | 5 | ug/L |
| 1,2-Dichloroethene | ND | 5 | ug/L |
| Chloroform | ND | 5 | ug/L |
| 1,2-Dichloroethane | ND | 5 | ug/L |
| 2-Butanone | ND | 20 | ug/L |
| 1,1,1-Trichloroethane | ND | 5 | ug/L |
| Cyclohexane | ND | 5 | ug/L |
| Carbon Tetrachloride | ND | 5 | ug/L |
| Bromodichloromethane | ND | 5 | ug/L |
| 1,2-Dichloropropane | ND | 5 | ug/L |
| 1,4-Dioxane | ND | 500 | ug/L |
| cis-1,3-Dichloropropene | ND | 5 | ug/L |
| Trichloroethene | ND | 5 | ug/L |
| Dibromochloromethane | ND | 5 | ug/L |
| 1,1,2-Trichloroethane | ND | 5 | ug/L |
| Benzene | ND | 5 | ug/L |
| trans-1,3-Dichloropropene | ND | 5 | ug/L |
| 1,2-Dibromoethane | ND | 5 | ug/L |
| Bromoform | ND | 5 | ug/L |
| 4-Methyl-2-pentanone | ND | 5 | ug/L |
| 2-Hexanone | ND | 5 | ug/L |
| [illegible]hloroethene | ND | 5 | ug/L |
| [illegible],2-Tetrachloroethane | ND | 5 | ug/L |

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# VOLATILE COMPOUNDS BY GC/MS

Date Analyzed: 07/12/94
Laboratory ID: 3MB-193A
Sample Matrix: Water

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Toluene | ND | 5 | ug/L |
| Chlorobenzene | ND | 5 | ug/L |
| Ethylbenzene | ND | 5 | ug/L |
| Styrene | ND | 5 | ug/L |
| m,p-Xylene | ND | 5 | ug/L |
| o-Xylene | ND | 5 | ug/L |

ND - Compound not detected at stated Detection Limit.
J - Meets identification criteria, below Detection Limit.
B - Compound detected in method blank.

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# TENTATIVELY IDENTIFIED COMPOUNDS
# METHOD BLANK ANALYSIS

Date Analyzed: 07/12/94
Laboratory ID: 3MB-193A
Sample Matrix: Water

| Tentative Identification | Retention Time (min) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable levels.

Unknown concentrations calculated assuming a Relative Response Factor = 1.

## QUALITY CONTROL:

| Surrogate Recovery | % | Water QC Limits |
|---|---|---|
| 1,2-Dichloroethane-d4 | 100 | 76 - 114 |
| Toluene-d8 | 103 | 88 - 110 |
| Bromofluorobenzene | 97 | 86 - 115 |

References:

Method 8240. Gas Chromatography/Mass Spectrometry for Volatile Organics. Test Methods for Evaluating Solid Wastes, SW-846. United States Environmental Protection Agency, Third Edition, November 1986.

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# LAB QA/QC
# VOLATILE COMPOUNDS BY GC/MS
# TCLP BLANK

Date Analyzed: 07/21/94
Laboratory ID: 3TB-202A
Sample Matrix: Extraction fluid
Date Extracted: 07/20/94

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| 1,1-Dichloroethene | ND | 0.005 | mg/L |
| 1,2-Dichloroethane | ND | 0.005 | mg/L |
| 2-Butanone | ND | 0.02 | mg/L |
| Benzene | ND | 0.005 | mg/L |
| Carbon Tetrachloride | ND | 0.005 | mg/L |
| Chlorobenzene | ND | 0.005 | mg/L |
| Chloroform | ND | 0.005 | mg/L |
| Tetrachloroethene | ND | 0.005 | mg/L |
| Trichloroethene | ND | 0.005 | mg/L |
| Vinyl Chloride | ND | 0.005 | mg/L |

ND - Compound not detected at stated Detection Limit.
J - Meets identification criteria, below Detection Limit.
B - Compound detected in method blank.

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# TATIVELY IDENTIFIED COMPOUNDS

Date Analyzed: 07/21/94
Laboratory ID: 3TB-202A
Sample Matrix: Extraction fluid
Date Extracted: 07/20/94

| Tentative Identification | Retention Time (min) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable levels.

own concentrations calculated assuming a Relative Response Factor = 1.

## QUALITY CONTROL:

| Surrogate Recovery | % |
|---|---|
| 1,2-Dichloroethane-d4 | 91 |
| Toluene-d8 | 98 |
| Bromofluorobenzene | 100 |

References:

Method 8240, Gas Chromatography/Mass Spectrometry for Volatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, Third Edition, November 1986.

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QA/QC
# SEMI-VOLATILE ORGANIC COMPOUNDS BY GC/MS
# METHOD BLANK

Date Analyzed: 07/19/94
Laboratory ID: MB-192
Sample Matrix: Water
Date Extracted: 07/11/94

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| 1,2,4-Trichlorobenzene | ND | 10 | ug/L |
| 1,2-Dichlorobenzene | ND | 10 | ug/L |
| 1,3-Dichlorobenzene | ND | 10 | ug/L |
| 1,4-Dichlorobenzene | ND | 10 | ug/L |
| 1-Methylnaphthalene | ND | 10 | ug/L |
| 2,4,5-Trichlorophenol | ND | 10 | ug/L |
| 2,4,6-Trichlorophenol | ND | 10 | ug/L |
| 2,4-Dichlorophenol | ND | 10 | ug/L |
| 2,4-Dimethylphenol | ND | 10 | ug/L |
| 2,4-Dinitrophenol | ND | 50 | ug/L |
| 2,4-Dinitrotoluene | ND | 10 | ug/L |
| 2,6-Dinitrotoluene | ND | 10 | ug/L |
| 2-Chloronaphthalene | ND | 10 | ug/L |
| 2-Chlorophenol | ND | 10 | ug/L |
| 2-Methylnaphthalene | ND | 10 | ug/L |
| 2-Methylphenol | ND | 10 | ug/L |
| 2-Nitroaniline | ND | 50 | ug/L |
| 2-Nitrophenol | ND | 10 | ug/L |
| 3,3'-Dichlorobenzidine | ND | 20 | ug/L |
| 3-Methylphenol/4-Methylphenol * | ND | 10 | ug/L |
| 3-Nitroaniline | ND | 50 | ug/L |
| 4,6-Dinitro-2-methylphenol | ND | 50 | ug/L |
| 4-Bromophenyl-phenylether | ND | 10 | ug/L |
| 4-Chloro-3-methylphenol | ND | 20 | ug/L |
| 4-Chloroaniline | ND | 20 | ug/L |
| 4-Chlorophenyl-phenylether | ND | 10 | ug/L |
| 4-Nitroaniline | ND | 20 | ug/L |
| 4-Nitrophenol | ND | 50 | ug/L |
| 6-Methyl chrysene | ND | 10 | ug/L |
| 7,12-Dimethylbenz(a)anthracene | ND | 10 | ug/L |
| Acenaphthene | ND | 10 | ug/L |
| Acenaphthylene | ND | 10 | ug/L |
| Anthracene | ND | 10 | ug/L |
| Benzenethiol | ND | 10 | ug/L |
| Benzo(a)anthracene | ND | 10 | ug/L |
| Benzo(a)pyrene | ND | 10 | ug/L |
| Benzo(b)fluoranthene | ND | 10 | ug/L |

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## SEMI-VOLATILE ORGANIC COMPOUNDS BY GC/MS
## METHOD BLANK

Date Analyzed: 07/19/94
Laboratory ID: 07/10/00
Sample Matrix: Water
Date Extracted: 07/11/94

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Benzo(g,h,i)perylene | ND | 10 | ug/L |
| Benzo(k)fluoranthene | ND | 10 | ug/L |
| Benzoic Acid | ND | 50 | ug/L |
| Benzyl Alcohol | ND | 20 | ug/L |
| bis(2-Chloroethoxy)methane | ND | 10 | ug/L |
| bis(2-Chloroethyl)ether | ND | 10 | ug/L |
| bis(2-Chloroisopropyl)ether | ND | 10 | ug/L |
| bis(2-Ethylhexyl)phthalate | ND | 10 | ug/L |
| Butylbenzylphthalate | ND | 10 | ug/L |
| Chrysene | ND | 10 | ug/L |
| di-n-Butylphthalate | ND | 10 | ug/L |
| [illegible]ctylphthalate | ND | 10 | ug/L |
| [illegible]z(a,h)acridine | ND | 10 | ug/L |
| Dibenz(a,h)anthracene | ND | 10 | ug/L |
| Dibenzofuran | ND | 10 | ug/L |
| Diethylphthalate | ND | 10 | ug/L |
| Dimethylphthalate | ND | 10 | ug/L |
| Fluoranthene | ND | 10 | ug/L |
| Fluorene | ND | 10 | ug/L |
| Hexachlorobenzene | ND | 10 | ug/L |
| Hexachlorobutadiene | ND | 20 | ug/L |
| Hexachlorocyclopentadiene | ND | 10 | ug/L |
| Hexachloroethane | ND | 20 | ug/L |
| Indene | ND | 10 | ug/L |
| Indeno(1,2,3-cd)pyrene | ND | 10 | ug/L |
| Isophorone | ND | 10 | ug/L |
| N-Nitrosodi-n-propylamine | ND | 10 | ug/L |
| N-Nitrosodiphenylamine | ND | 10 | ug/L |
| Naphthalene | ND | 10 | ug/L |
| Nitrobenzene | ND | 10 | ug/L |
| Pentachlorophenol | ND | 50 | ug/L |
| Phenanthrene | ND | 10 | ug/L |
| Phenol | ND | 10 | ug/L |
| Pyrene | ND | 10 | ug/L |
| Pyridine | ND | 10 | ug/L |
| Quinoline | ND | 10 | ug/L |

ND - Compound not detected at stated Detection Limits.
* - Compounds Coelute by GC/MS.

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# QA/QC
## SEMI-VOLATILE ORGANIC COMPOUNDS BY GC/MS
## METHOD BLANK
## TENTATIVELY IDENTIFIED COMPOUNDS

Date Analyzed: 07/19/94
Laboratory ID: 07/10/00
Sample Matrix: Water
Date Extracted: 07/11/94

| Tentitively Identification | Retention Time (min.) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable levels.

Unknown concentration calculated assuming Relative Response Factor = 1.

## LITY CONTROL:

| Surrogate Recoveries | % | Water QC Limits |
|---|---|---|
| 2-Fluorophenol | 55 | 21 - 100 |
| Phenol-d6 | 60 | 10 - 94 |
| Nitrobenzene-d5 | 73 | 35 - 114 |
| 2-Fluorobiphenyl | 65 | 43 - 116 |
| 2,4,6-Tribromophenol | 69 | 10 - 123 |
| Terphenyl-d14 | 52 | 33 - 141 |

Reference:

Method 8270, Gas Chromatography/Mass Spectrometry for Semivolatile Organics, Test Methods for Evaluating Solid Wastes, SW846, USEPA, Third Edition, November 1986.

USEPA Contract Lab Program, Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration, OLM01.0, December 1990.

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# LAB QA/QC
# SEMI-VOLATILE ORGANIC COMPOUNDS BY GC/MS
# METHOD BLANK

Date Analyzed: 07/18/94
Laboratory ID: SMB-188
Sample Matrix: Soil
Date Extracted: 07/07/94

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| 1,2,4-Trichlorobenzene | ND | 1 | mg/kg |
| 1,2-Dichlorobenzene | ND | 1 | mg/kg |
| 1,3-Dichlorobenzene | ND | 1 | mg/kg |
| 1,4-Dichlorobenzene | ND | 1 | mg/kg |
| 1-Methylnaphthalene | ND | 1 | mg/kg |
| 2,4,5-Trichlorophenol | ND | 1 | mg/kg |
| 2,4,6-Trichlorophenol | ND | 1 | mg/kg |
| 2,4-Dichlorophenol | ND | 1 | mg/kg |
| 2,4-Dimethylphenol | ND | 1 | mg/kg |
| 2,4-Dinitrophenol | ND | 5 | mg/kg |
| [illegible]-Dinitrotoluene | ND | 1 | mg/kg |
| 2,6-Dinitrotoluene | ND | 1 | mg/kg |
| 2-Chloronaphthalene | ND | 1 | mg/kg |
| 2-Chlorophenol | ND | 1 | mg/kg |
| 2-Methylnaphthalene | ND | 1 | mg/kg |
| 2-Methylphenol | ND | 1 | mg/kg |
| 2-Nitroaniline | ND | 5 | mg/kg |
| 2-Nitrophenol | ND | 1 | mg/kg |
| 3,3'-Dichlorobenzidine | ND | 2 | mg/kg |
| 3-Methylphenol/4-Methylphenol * | ND | 1 | mg/kg |
| 3-Nitroaniline | ND | 5 | mg/kg |
| 4,6-Dinitro-2-methylphenol | ND | 5 | mg/kg |
| 4-Bromophenyl-phenylether | ND | 1 | mg/kg |
| 4-Chloro-3-methylphenol | ND | 2 | mg/kg |
| 4-Chloroaniline | ND | 2 | mg/kg |
| 4-Chlorophenyl-phenylether | ND | 1 | mg/kg |
| 4-Nitroaniline | ND | 2 | mg/kg |
| 4-Nitrophenol | ND | 5 | mg/kg |
| 6-Methyl chrysene | ND | 1 | mg/kg |
| 7,12-Dimethylbenz(a)anthracene | ND | 1 | mg/kg |
| Acenaphthene | ND | 1 | mg/kg |
| Acenaphthylene | ND | 1 | mg/kg |
| Anthracene | ND | 1 | mg/kg |
| Benzenethiol | ND | 1 | mg/kg |
| Benzo(a)anthracene | ND | 1 | mg/kg |
| Benzo(a)pyrene | ND | 1 | mg/kg |
| Benzo(b)fluoranthene | ND | 1 | mg/kg |

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# LAB QA/QC
# TOXICITY CHARACTERISTIC LEACHING PROCEDURE - CHLORINATED HERBICIDES
# METHOD BLANK

Date Analyzed: 07/18/94
Laboratory ID: MB-195
Sample Matrix: Water

| Parameter | Analytical Results | Detection Limits | Units |
|---|---|---|---|
| 2,4-D | ND | 0.05 | mg/L |
| 2,4,5-TP (Silvex) | ND | 0.05 | mg/L |

All quantities are expressed as total nanograms.

## QUALITY CONTROL

| Surrogate Recoveries: | % |
|---|---|
| DCAA | 67 |

References:

Method 515.1, Determination of Chlorinated Acids in Water by Gas Chromatography with an Electron Capture Detector, EPA/600/4-88/039, December 1988.

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# LAB QA/QC
# EPA METHOD 8081
## Method Blank

Date Analyzed: 07/25/94
Laboratory ID: MB202
Sample Matrix: Water

| Parameter | Analytical Results | Detection Limit | Units |
|---|---|---|---|
| Endrin | ND | 0.0005 | mg/L |
| Lindane | ND | 0.0005 | mg/L |
| Heptachlor | ND | 0.0005 | mg/L |
| Heptachlor Epoxide | ND | 0.0005 | mg/L |
| Methoxychlor | ND | 0.0005 | mg/L |
| [illegible]dane | ND | 0.005 | mg/L |
| Toxaphene | ND | 0.005 | mg/L |

ND - Parameter Not Detected at Stated Detection Limit

References: Method 8081, Organochlorine Pesticides and PCB's, Test Methods for Evaluating Solid Waste, United States Environmental Protection Agency SW-846, November 1990.

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# LAB QA/QC
# TRACE METALS - TCLP
# METHOD BLANK

Date Analyzed: 07/20/94
Laboratory ID: TMB 94-24
Sample Matrix: Extract

| Parameter | Sample Result | PQL | Regulatory Level | Units |
|---|---|---|---|---|
| Arsenic | ND | 0.2 | 5.0 | mg/L |
| Barium | ND | 5 | 100.0 | mg/L |
| Cadmium | ND | 0.05 | 1.0 | mg/L |
| Chromium | ND | 0.05 | 5.0 | mg/L |
| Lead | ND | 0.2 | 5.0 | mg/L |
| Mercury | ND | 0.02 | 0.2 | mg/L |
| [illegible]ium | ND | 0.2 | 1.0 | mg/L |
| Silver | ND | 0.05 | 1.0 | mg/L |

ND-Parameter not detected at stated Practical Quantitation limit (PQL).

Reference: Toxicity Characteristic Leaching Procedure , Final Rule, Federal Register, 40 CFR 261-302. Part V, EPA Vol 55, No. 126, June 29, 1990

Method 3010: Acid Digestion of Aqueous Samples and Extracts for Total Metals, SW-846, September, 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission Spectroscopy, SW-846, September, 1990.

Method 7000: Atomic Absorption Spectroscopy SW-846, September 1986.

Method 7470: Mercury in Liquid Waste (Manual Cold-Vapor Technique), SW-846, September 1986.

Analyst _____ Reviewed _____

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# LAB QA/QC
# 9010 TOTAL CYANIDE
# QUALITY CONTROL SUMMARY

Date Analyzed: 07/27/94
Laboratory ID: B946403-6408;6778
Sample Matrix: Water

| Sample ID | Expected ug/L | Result ug/L | Recovery % |
|---|---|---|---|
| CBS9410 | 20 | 23 | 115.0 |
| CMB9410 | 0 | 0 | NA |

NA - Not Applicable

Reference: SW-846, United States Environmental Protection Agency, Nov. 1986
Method 9010: Total Cyanide

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# LAB QA/QC
## PURGEABLE ORGANIC COMPOUNDS
## MATRIX SPIKE / MATRIX SPIKE DUPLICATE SUMMARY

Date Analyzed: 07/06/94
Laboratory ID: 3MSD6406
Sample Matrix: Soil
Date Extracted: 7/6/94

ORIGINAL SAMPLE PARAMETERS

| Parameter | Spike Added (mg/kg) | Sample Conc. (mg/kg) | MS Conc. (mg/kg) | MS Recovery (%) | QC Limits (% Rec.) |
|---|---|---|---|---|---|
| 1,1-Dichloroethene | 2 | 0 | 1.4 | 66 | 59-172 |
| Trichloroethene | 2 | 0 | 1.6 | 80 | 62-137 |
| Benzene | 2 | 0 | 1.6 | 80 | 66-142 |
| Toluene | 2 | 0 | 1.7 | 81 | 59-139 |
| Chlorobenzene | 2 | 0 | 1.8 | 90 | 60-133 |

DUPLICATE SAMPLE PARAMETERS

| Parameter | Spike Added (mg/kg) | MSD Conc. (mg/kg) | MSD Recovery (%) | RPD (%) | QC Limits RPD | QC Limits Rec. |
|---|---|---|---|---|---|---|
| 1,1-Dichloroethene | 2 | 1.3 | 61 | 8 | 22 | 59-172 |
| Trichloroethene | 2 | 1.6 | 80 | 0 | 24 | 62-137 |
| Benzene | 2 | 1.6 | 80 | 11 | 21 | 66-142 |
| Toluene | 2 | 1.7 | 81 | 0 | 21 | 59-139 |
| Chlorobenzene | 2 | 1.8 | 90 | 0 | 21 | 60-133 |

Spike Recovery: 0 out of 10 outside QC limits.
RPD: 0 out of 5 outside QC limits.

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# LAB QA/QC
# PURGEABLE ORGANIC COMPOUNDS
# MATRIX SPIKE / MATRIX SPIKE DUPLICATE SUMMARY

Date Analyzed: 07/12/94
Laboratory ID: 3MSD6533
Sample Matrix: Water

ORIGINAL SAMPLE PARAMETERS

| Parameter | Spike Added (ug/L) | Sample Conc. (ug/L) | MS Conc. (ug/L) | MS Recovery (%) | QC Limits (% Rec.) |
|---|---|---|---|---|---|
| 1,1-Dichloroethene | 100 | 0 | 75 | 75 | 61-145 |
| Trichloroethene | 100 | 0 | 81 | 81 | 71-120 |
| Benzene | 100 | 0 | 83 | 83 | 76-127 |
| Toluene | 100 | 0 | 87 | 87 | 71-127 |
| Chlorobenzene | 100 | 0 | 86 | 86 | 75-130 |

DUPLICATE SAMPLE PARAMETERS

| Parameter | Spike Added (ug/L) | MSD Conc. (ug/L) | MSD Recovery (%) | RPD (%) | QC Limits RPD | QC Limits Rec. |
|---|---|---|---|---|---|---|
| 1,1-Dichloroethene | 100 | 74 | 74 | 1 | 14 | 61-145 |
| Trichloroethene | 100 | 78 | 78 | 4 | 14 | 71-120 |
| Benzene | 100 | 81 | 81 | 2 | 11 | 76-127 |
| Toluene | 100 | 83 | 83 | 5 | 13 | 71-127 |
| Chlorobenzene | 100 | 83 | 83 | 4 | 13 | 75-130 |

Spike Recovery: 0 out of 10 outside QC limits.
RPD: 0 out of 5 outside QC limits.

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QA/QC
PURGEABLE ORGANIC COMPOUNDS BY GC/MS - TCLP
MATRIX SPIKE SUMMARY

Date Analyzed: 07/08/94
Laboratory ID: 3TMS5970
Sample Matrix: Water
Date Extracted: 7/7/94

| Parameter | Spike Added mg/L | Sample Concentration mg/L | Matrix Spike Concentration mg/L | Matrix Spike Recovery (%) |
|---|---|---|---|---|
| Vinyl Chloride | 0.1 | 0 | 0.090 | 90 |
| 1,1-Dichloroethene | 0.1 | 0 | 0.090 | 90 |
| 1,2-Dichloroethane | 0.1 | 0 | 0.091 | 91 |
| Chloroform | 0.1 | 0 | 0.091 | 91 |
| Carbon Tetrachloride | 0.1 | 0 | 0.092 | 92 |
| Trichloroethene | 0.1 | 0 | 0.092 | 92 |
| [illegible]ne | 0.1 | 0 | 0.093 | 93 |
| Tetrachloroethene | 0.1 | 0 | 0.099 | 99 |
| Chlorobenzene | 0.1 | 0 | 0.10 | 100 |
| Methyl Ethyl Ketone | 0.1 | 0 | 0.049 | 49 |

QUALITY CONTROL:

| Surrogate Recovery | % |
|---|---|
| 1,2-Dichloroethane-d4 | 97 |
| Toluene-d8 | 104 |
| Bromofluorobenzene | 97 |

References:

Method 8240, Gas Chromatography/Mass Spectrometry for Volatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, Third Edition, November 1986.

Toxicity Characteristic Leaching Procedure, Final Rule, Federal Register, 40 CFR 261-302, Part V, Environmental Protection Agency, Vol. 55, No. 126, June 29, 1990.

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LAB QA/QC
TOXICITY CHARACTERISTIC LEACHING PROCEDURE - CHLORINATED HERBICIDES
BLANK SPIKE

Date Analyzed: 07/18/94
Laboratory ID: BS-195
Sample Matrix: Water

| Parameter | Found Results (mg/L) | Expected Results (mg/L) | Percent Recovery |
|---|---|---|---|
| 2,4-D | 0.00077 | 0.0011 | 70% |
| 2,4,5-TP (Silvex) | 0.00063 | 0.0011 | 57% |

QUALITY CONTROL

| Surrogate Recoveries: | % |
|---|---|
| DCAA | 88 |

References:

Method 515.1, Determination of Chlorinated Acids in Water by Gas Chromatography with an Electron Capture Detector, EPA/600/4-88/039, December 1988.

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QA/QC
EPA METHOD 8081
Blank Spike

Date Analyzed: 07/25/94
Laboratory ID: BS202
Sample Matrix: Water

| Parameter | Expected Results (mg/L) | Found Results (mg/L) | Percent Recovery |
|---|---|---|---|
| Endrin | 0.0004 | 0.00043 | 107% |
| Heptachlor | 0.0004 | 0.00019 | 47% |
| Heptachlor Epoxide | 0.0004 | 0.00033 | 82% |

QUALITY CONTROL

| Surrogate Recoveries: | % |
|---|---|
| Dibutyl Chlorendate | 111% |

References: Method 8081, Organochlorine Pesticides and PCB's, Test Methods for Evaluating Solid Waste, United States Environmental Protection Agency SW-846, November 1990.

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# LAB QA/QC
# TRACE METALS - TCLP
# MATRIX SPIKE

Date Analyzed: 07/20/94
Laboratory ID: B946409
Sample Matrix: Soil

| Parameter | Spike Added | Sample Result | Spiked Result | MS % Recovery | PQL | Units |
|---|---|---|---|---|---|---|
| Arsenic | 2.5 | ND | 2.5 | 100 | 0.2 | mg/L |
| Barium | 5.0 | ND | 4.5 | 89 | 5 | mg/L |
| Cadmium | 0.5 | 0.14 | 0.6 | 94 | 0.05 | mg/L |
| Chromium | 2.0 | ND | 1.9 | 97 | 0.05 | mg/L |
| Lead | 2.0 | 0.91 | 2.8 | 97 | 0.2 | mg/L |
| Mercury | 0.2 | ND | 0.2 | 96 | 0.02 | mg/L |
| [illegible]um | 2.5 | ND | 2.5 | 99 | 0.2 | mg/L |
| Silver | 0.05 | ND | 0.04 | 80 | 0.05 | mg/L |

ND-Parameter not detected at stated Practical Quantitation limit (PQL).

Reference: Toxicity Characteristic Leaching Procedure , Final Rule, Federal Register, 40 CFR 261-302. Part V, EPA Vol 55, No. 126, June 29, 1990

Method 3010: Acid Digestion of Aqueous Samples and Extracts for Total Metals, SW-846, September, 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission Spectroscopy, SW-846, September, 1990.

Method 7000: Atomic Absorption Spectroscopy SW-846, September 1986.

Method 7470: Mercury in Liquid Waste (Manual Cold-Vapor Technique), SW-846, September 1986.

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# LAB QA/QC
# TRACE METALS - TCLP
# DUPLICATE SUMMARY

Date Analyzed: 07/20/94
Laboratory ID: B946409
Sample Matrix: Soil

| Parameter | Sample Result | Duplicate Sample Result | RPD % | PQL | Units |
|---|---|---|---|---|---|
| Arsenic | ND | ND | | 0.2 | mg/L |
| Barium | ND | ND | | 5 | mg/L |
| Cadmium | 0.14 | 0.14 | | 0.05 | mg/L |
| Chromium | ND | ND | | 0.05 | mg/L |
| Lead | 0.91 | 0.91 | | 0.2 | mg/L |
| Mercury | ND | ND | | 0.02 | mg/L |
| [illegible]ium | ND | ND | | 0.2 | mg/L |
| Silver | ND | ND | | 0.05 | mg/L |

ND-Parameter not detected at stated Practical Quantitation limit (PQL).

Reference: Toxicity Characteristic Leaching Procedure , Final Rule, *Federal Register*, 40 CFR 261-302. Part V, EPA Vol 55, No. 126, June 29, 1990

Method 3010: Acid Digestion of Aqueous Samples and Extracts for Total Metals, SW-846, September, 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission Spectroscopy, SW-846, September, 1990.

Method 7000: Atomic Absorption Spectroscopy SW-846, September 1986.

Method 7470: Mercury in Liquid Waste (Manual Cold-Vapor Technique), SW-846, September 1986.

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# QA/QC
## SEMI-VOLATILE ORGANIC COMPOUNDS BY GC/MS
## BLANK SPIKE

Date Analyzed: 07/18/94
Laboratory ID: SBS - 188
Sample Matrix: Soil
Date Extracted: 07/07/94

| Parameter | Spike Added (mg/kg) | Sample Conc. (mg/kg) | MS Conc. (mg/kg) | MS Recovery (%) | QC Limits (% Rec.) |
|---|---|---|---|---|---|
| Phenol | 200 | 0 | 127 | 64 | 26 - 90 |
| 2-Chlorophenol | 200 | 0 | 115 | 58 | 25 - 102 |
| 1,4-Dichlorobenzene | 100 | 0 | 62 | 62 | 28 - 104 |
| n-Nitroso-di-n-propylamine | 100 | 0 | 72 | 72 | 41-126 |
| 1,2,4-Trichlorobenzene | 100 | 0 | 62 | 62 | 38 - 107 |
| 4-Chloro-3-methylphenol | 200 | 0 | 117 | 59 | 26 - 103 |
| Acenaphthene | 100 | 0 | 67 | 67 | 31 - 137 |
| [illegible]ophenol | 200 | 0 | 146 | 73 | 11-114 |
| 2,4-Dinitrotoluene | 100 | 0 | 88 | 88 | 28 - 89 |
| Pentachlorophenol | 200 | 0 | 124 | 62 | 17 - 109 |
| Pyrene | 100 | 0 | 55 | 55 | 35 - 142 |

## QUALITY CONTROL:

| Surrogate Recoveries | % | Soil QC Limits |
|---|---|---|
| 2-Fluorophenol | 71 | 25 - 121 |
| Phenol-d5 | 89 | 24 - 113 |
| Nitrobenzene-d5 | 73 | 23 - 120 |
| 2-Fluorobiphenyl | 73 | 30 - 115 |
| 2,4,6-Tribromophenol | 90 | 19 - 122 |
| p-Terphenyl | 58 | 18 - 137 |

Spike Recovery: 0 out of 11 outside QC limits.

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# QA/QC
# SEMI-VOLATILE ORGANIC COMPOUNDS BY GC/MS
# MATRIX SPIKE / MATRIX SPIKE DUPLICATE SUMMARY

Date Analyzed: 07/21/94
Laboratory ID: TBS-192
Sample Matrix: Water
Date Extracted: 07/11/94

| Parameter | Spike Added (ug/L) | Sample Concentration (ug/L) | Matrix Spike Concentration (ug/L) | Matrix Spike Recovery (%) |
|---|---|---|---|---|
| 1,4-Dichlorobenzene | 100 | 0 | 64 | 64 |
| Hexachloroethane | 100 | 0 | 64 | 64 |
| Nitrobenzene | 100 | 0 | 85 | 85 |
| Hexachlorobutadiene | 100 | 0 | 68 | 68 |
| [illegible]-Trichlorophenol | 100 | 0 | 78 | 78 |
| 2,4,5-Trichlorophenol | 100 | 0 | 80 | 80 |
| 2,4-Dinitrotoluene | 100 | 0 | 103 | 103 |
| Hexachlorobenzene | 100 | 0 | 77 | 77 |
| Pentachlorophenol | 100 | 0 | 84 | 84 |
| o-Cresol | 100 | 0 | 78 | 78 |
| m,p-Cresol | 200 | 0 | 138 | 69 |
| Pyridine | 100 | 0 | 55 | 55 |

All values are total nanograms.

Reference:

Method 8270, Semivolatile Organics - GC/MS, Test Methods for Evaluating Solid Waste, United States Environmental Protection Agency, SW-846, Vol. IB, November 1986.

Toxicity Characteristic Leaching Procedure, Final Rule, Federal Register, 40 CFR 261-302, Part V, Environmental Protection Agency, Vol. 55, No. 126, June 29, 1990.

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# CHAIN OF CUSTODY RECORD

Inter-Mountain Laboratories, Inc.

Client/Project Name: Walsh Rico Assay Bldg 1897-010

Project Location: Rico CO

Sampler: (Signature): [signature]

Chain of Custody Tape No.:

ANALYSES / PARAMETERS

| Sample No./ Identification | Date | Time | Lab Number | Matrix | No. of Containers | VOA SVOA | ICP Metals Hg | Cyanide Sulfide | Full TCLP | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 1897 SP01 | 6/30/94 | 1120 | B946403 | Soil | 2 | ✓ | ✓ | ✓ | | 2-4 oz ea. |
| 1897 SP02 | | 1147 | 6404 | | 2 | ✓ | ✓ | ✓ | | |
| 1897 SP03 | | 1216 | 6405 | | 2 | ✓ | ✓ | ✓ | | |
| 1897 SP04 | | 1300 | 6406 | | 2 | ✓ | ✓ | ✓ | | |
| 1897 SP05 | | 1316 | 6407 | | 2 | ✓ | ✓ | ✓ | | |
| 1897 SP06 | | 1325 | 6408 | | 2 | ✓ | ✓ | ✓ | | |
| 1897 C1 | | 1440 | 6409 | | 1 | | | | ✓ | 1 liter |
| | | | | | | | 1 | | | |
| | | | | | | | | | | 7.1°C |
| | | | | | | | | | | Federal Express |

| Relinquished by: (Signature) | Date | Time | Received by: (Signature) | Date | Time |
|---|---|---|---|---|---|
| [signature] | 7/1/94 | 1415 | Tim J. Trocher | 7/6 | Rico |
| Relinquished by: (Signature) | Date | Time | Received by: (Signature) | Date | Time |
| | | | | | |
| Relinquished by: (Signature) | Date | Time | Received by laboratory: (Signature) | Date | Time |
| | | | | | |

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18814

*PRIVILEGED AND CONFIDENTIAL*

# HIGHWAY DEPARTMENT ANALYTICAL DATA

Inter-Mountain Laboratories, Inc.

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## *CASE NARRATIVE*

On August 18, 1994, three samples were received for analysis at Inter-Mountain Laboratories, Bozeman, Montana. The chain of custody form requested analysis for Toxicity Characteristic Leaching Procedure Parameters, metals only, and also BTEX/TVH(GRO), and TEH(DRO). Client name / Project name was listed as Walsh & Associates, Inc. / Rico CDOT.

Detectable amounts of targeted compounds were present in the samples.

The Toxicity Characteristic Leaching Procedure methodology used is outlined in the Federal Register, 40 CFR 261, Vol. 55, No. 126, June 29, 1990. Results are reported in mass per unit volume of leachate (mg/L).

Limits of detection for each instrument/analysis are determined by sample matrix effects, instrument performance under standard conditions, and dilution requirements to maintain chromatography output within calibration ranges.

*Wynn Sudtelgte*
IML-Bozeman

0826wa

Inter-Mountain Laboratories, Inc.

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# EPA METHOD 8020
# AROMATIC VOLATILE COMPOUNDS
# BETX

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | DOT 1 | Date Reported: | 08/22/94 |
| Project ID: | Rico CDOT | Date Sampled: | 08/17/94 |
| Laboratory ID: | B947492 | Date Received: | 08/18/94 |
| Sample Matrix: | Soil | Date Extracted: | 08/18/94 |
| | | Date Analyzed: | 08/19/94 |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Benzene | ND | 0.2 | mg/kg |
| Toluene | ND | 0.2 | mg/kg |
| Ethylbenzene | ND | 0.2 | mg/kg |
| m-Xylene | ND | 0.2 | mg/kg |
| o-Xylene | ND | 0.2 | mg/kg |

ND - Compound not detected at stated Detection Limit.

Reference:

Method 8021, Volatile Organic Compounds, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, United States Environmental Protection Agency, SW-846, Volume IB, December 1987.

Analysis Method: Gas Chromatograph / Purge and Trap / PID

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# GASOLINE RANGE ORGANICS - GRO

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | DOT 1 | Date Reported: | 08/24/94 |
| Project ID: | Rico CDOT | Date Sampled: | 08/17/94 |
| Laboratory ID: | B947492 | Date Received: | 08/18/94 |
| Matrix: | Soil | Date Extracted: | 08/18/94 |
| | | Date Analyzed: | 08/18/94 |

| Parameter | Result | PQL | Units |
|---|---|---|---|
| Gasoline Range Organics | 14 | 10 | mg/kg |
| Gasoline Range Organics as Gasoline | 14 | 10 | mg/kg |
| Total Purgeable Hydrocarbons | 14 | 10 | mg/kg |

## QUALITY CONTROL:

| Surrogate Recovery | % |
|---|---|
| Bromofluorobenzene | 121 |

ND - Not detected at stated Practical Quantitation Limit (PQL).

Reference:

GRO - USEPA Method for Determination of Gasoline Range Organics, Revision 5, February 1992.

WTPH-G Total Petroleum Hydrocarbons Analytical Methods for Soil, Washington State Department of Ecology, Revision 3, October 1991.

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# DIESEL RANGE ORGANICS - DRO

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | DOT 1 | Date Reported: | 08/24/94 |
| Project ID: | Rico CDOT | Date Sampled: | 08/17/94 |
| Lab ID: | B947492 | Date Received: | 08/18/94 |
| Matrix: | Soil | Date Extracted: | 08/19/94 |
| | | Date Analyzed: | 08/22/94 |

| Parameter | Result | PQL | Units |
|---|---|---|---|
| Diesel Range Organics | 23 | 5 | mg/kg |
| Diesel Range Organics as Diesel | 23 | 5 | mg/kg |
| Total Extractable Hydrocarbons | 28 | 5 | mg/kg |

ND - Not Detected at Practical Quantitation Level (PQL).

Reference: DRO - USEPA Method for Determination of Diesel Range Organics, Revision 2, February 1992.

WTPH-D Total Petroleum Hydrocarbons Analytical Methods for Soil, Washington State Department of Ecology, Revision 3, October 1991.

Analyst: [illegible]

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# TOXICITY CHARACTERISTIC LEACHING PROCEDURE - TCLP
## TRACE METAL CONCENTRATION

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | DOT 1 | Date Reported: | 08/26/94 |
| Project ID: | Rico CDOT | Date Sampled: | 08/17/94 |
| Laboratory ID: | B947492 | Date Received: | 08/18/94 |
| Sample Matrix: | Soil | Date Extracted TCLP: | 08/23/94 |
| | | Date Analyzed: | 08/25/94 |

| Parameter | Analytical Result (mg/L) | Detection Level (mg/L) | Regulatory Level (mg/L) |
|---|---|---|---|
| Arsenic | ND | 0.2 | 5.0 |
| Barium | 0.8 | 0.5 | 100 |
| Cadmium | 0.08 | 0.05 | 1.0 |
| Chromium | ND | 0.05 | 5.0 |
| Lead | ND | 0.5 | 5.0 |
| Mercury | ND | 0.02 | 0.2 |
| [illegible]nium | ND | 0.2 | 1.0 |
| Silver | ND | 0.05 | 1.0 |

ND-Parameter not detected at stated detection level.

References:

Toxicity Characteristic Leaching Procedure , Final Rule,
Federal Register, 40 CFR 261-302. Part V, EPA Vol 55, No. 126, June 29, 1990

Method 3010: Acid Digestion of Aqueous Samples and Extracts for Total Metals, SW-846, Sept. 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission Spectroscopy, SW-846, Sept. 1990.

Method 7470: Mercury in Liquid Waste (Manual Cold-Vapor Technique), SW-846, Sept. 1986.

Analyst

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# EPA METHOD 8020
# AROMATIC VOLATILE COMPOUNDS
# BETX

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES, INC. | | |
| Sample ID: | DOT 2 | Date Reported: | 08.22.94 |
| Project ID: | Rico CDOT | Date Sampled: | 08/17.94 |
| Laboratory ID: | B947493 | Date Received: | 08/18/94 |
| Sample Matrix: | Soil | Date Extracted: | 08/18/94 |
| | | Date Analyzed: | 08.19.94 |

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Benzene | ND | 0.2 | mg kg |
| Toluene | ND | 0.2 | mg kg |
| Ethylbenzene | ND | 0.2 | mg kg |
| [illegible] Xylene | ND | 0.2 | mg.kg |
| o-Xylene | ND | 0.2 | mg kg |

ND - Compound not detected at stated Detection Limit.

Reference:

Method 8021, Volatile Organic Compounds, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, United States Environmental Protection Agency, SW-846, Volume IB, December 1987.

Analysis Method: Gas Chromatograph / Purge and Trap / PID

SB-H
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# TOXICITY CHARACTERISTIC LEACHING PROCEDURE
# TENTATIVELY IDENTIFIED COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 CI | Date Reported: | 07/22/94 |
| Laboratory ID: | 8946409 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/12/94 |

| Tentative Identification | Retention Time (min) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable levels.

Unknown concentrations calculated assuming a Relative Response Factor = 1.

## QUALITY CONTROL:

| Surrogate Recovery | % |
|---|---|
| 1,2-Dichloroethane-d4 | 101 |
| Toluene-d8 | 101 |
| Bromofluorobenzene | 96 |

References:

Method 8240, Gas Chromatography/Mass Spectrometry for Volatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, Third Edition, November 1986.

Toxicity Characteristic Leaching Procedure, Final Rule, Federal Register, 40 CFR 261-302, Part V, Environmental Protection Agency, Vol. 55, No. 126, June 29, 1990.

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# TOXICITY CHARACTERISTIC LEACHING PROCEDURE - TCLP
## HSL SEMI-VOLATILE COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 CI | Date Reported: | 07/25/94 |
| Project ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | B946409 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | Date Extracted-TCLP: | 07/09/94 |
| Preservation: | Cool | Date Analyzed: | 07/20/94 |
| Condition: | Intact | Date Extracted-BNA: | 07/11/94 |

| Parameter | Analytical Result (mg/L) | Detection Limit (mg/L) | Regulatory Limit (mg/L) |
|---|---|---|---|
| 1,4-Dichlorobenzene | ND | 0.01 | 7.5 |
| Hexachloroethane | ND | 0.02 | 3 |
| Nitrobenzene | ND | 0.01 | 2 |
| Hexachloro-1,3-butadiene | ND | 0.02 | 0.5 |
| 2,4,6-Trichlorophenol | ND | 0.01 | 2 |
| [illegible]-Trichlorophenol | ND | 0.01 | 400 |
| [illegible]nitrotoluene | ND | 0.01 | 0.13 |
| Hexachlorobenzene | ND | 0.01 | 0.13 |
| Pentachlorophenol | ND | 0.02 | 100 |
| o-Cresol | ND | 0.01 | 200 ** |
| m & p-Cresol * | ND | 0.01 | 200 ** |
| Pyridine | ND | 0.01 | 5 |

ND - Compound not detected at stated Detection Limit
B - Compound detected in Method Blank.
* - Compounds coelute by GCMS.
** - Regulatory Limit of combined Cresols.

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# TOXICITY CHARACTERISTIC LEACHING PROCEDURE
# TENTATIVELY IDENTIFIED COMPOUNDS

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 CI | Date Reported: | 07/25/94 |
| Laboratory ID: | B946409 | Date Sampled: | 06/30/94 |
| Sample Matrix: | Soil | Date Analyzed: | 07/20/94 |

| Parameter | Retention Time(min.) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable levels.

Unknown concentrations calculated assuming Relative Response Factor = 1.

## QUALITY CONTROL:

| Surrogate Recoveries | % |
|---|---|
| 2-Fluorophenol | 62 |
| Phenol-d6 | 70 |
| Nitrobenzene-d5 | 85 |
| 2-Fluorobiphenyl | 88 |
| 2,4,6-Tribromophenol | 106 |
| Terphenyl-d14 | 114 |

References:
Method 8270, Gas Chromatography/Mass Spectrometry for Semi-Volatile Organics, Test Methods for Evaluating Solid Wastes, United States Environmental Protection Agency, December 1987.

Toxicity Characteristic Leaching Procedure, Final Rule, Federal Register, 40 CFR 261-302, Part V, Environmental Protection Agency, [illegible]5, No. 126, June 29, 1990.

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# TOXICITY CHARACTERISTIC LEACHING PROCEDURE
# ORGANOCHLORINE PESTICIDES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 CI | Date Reported: | 07/28/94 |
| Project ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | B946409 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | Date Extracted-Pest | 07/15/94 |
| Preservation: | Cool | Date Analyzed: | 07/19/94 |
| Condition: | Intact | | |

| Parameter | Analytical Results | Detection Limit | Units |
|---|---|---|---|
| Endrin | ND | 0.05 | mg/L |
| Lindane | ND | 0.05 | mg/L |
| Heptachlor | ND | 0.05 | mg/L |
| Heptachlor Epoxide | ND | 0.05 | mg/L |
| Methoxychlor | ND | 0.05 | mg/L |
| Chlordane | ND | 0.05 | mg/L |
| Toxaphene | ND | 0.05 | mg/L |

ND - Parameter Not Detected at Stated Detection Limit

## QUALITY CONTROL:

| Surrogate Recoveries: | % |
|---|---|
| Dibutyl Chlorendate | 110% |

References: Method 8081, Organochlorine Pesticides and PCB's, Test Methods for Evaluating Solid Waste, United States Environmental Protection Agency SW-846, November 1990.

Toxicity Characteristic Leaching Procedure, Final Rule, Federal Register, 40 CFR 261-302, Part V, Environmental Protection Agency, Vol. 55, No. 126, June 29, 1990.

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# TOXICITY CHARACTERISTIC LEACHING PROCEDURE
# CHLORINATED HERBICIDES

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 CI | Date Reported: | 07/28/94 |
| Project ID: | Rico Assay Bldg. 1897-010 | Date Sampled: | 06/30/94 |
| Laboratory ID: | 8946409 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | Date Extracted: | 07/14/94 |
| Preservation: | Cool | Date Analyzed: | 07/18/94 |
| Condition: | Intact | | |

| Parameter | Analytical Results | Detection Limit | Units |
|---|---|---|---|
| 2,4,-D | ND | 1 | mg/L |
| Silvex | ND | 0.1 | mg/L |

ND - Parameter Not Detected at Stated Detection Limit

References: Method 8150, Chlorinated Herbicides, Test Methods for Evaluating Solid Waste, United States Environmental Protection Agency, SW-846, Vol. IB, November, 1986.

Toxicity Characteristic Leaching Procedure, Final Rule, Federal Register, 40 CFR 261-302, Part V, Environmental Protection Agency, Vol. 55, No. 126, June 29, 1990.

Analyst

Reviewed

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# TOXICITY CHARACTERISTIC LEACHING PROCEDURE
# TRACE METAL CONCENTRATION

| | | | |
|---|---|---|---|
| Client: | WALSH & ASSOCIATES | | |
| Sample ID: | 1897 CI | Date Reported: | 07/20/94 |
| Project ID: | Rico Assay Bldg. | Date Sampled: | 06/30/94 |
| Laboratory ID: | B946409 | Date Received: | 07/02/94 |
| Sample Matrix: | Soil | Date Extracted: | 07/13/94 |
| Preservation: | Cool | Date Analyzed: | 07/20/94 |
| Condition: | Intact | | |

| Parameter | Sample Result | PQL | Regulatory Level | Units |
|---|---|---|---|---|
| Arsenic | ND | 0.2 | 5.0 | mg/L |
| Barium | ND | 5 | 100.0 | mg/L |
| Cadmium | 0.14 | 0.05 | 1.0 | mg/L |
| Chromium | ND | 0.05 | 5.0 | mg/L |
| Lead | 0.91 | 0.2 | 5.0 | mg/L |
| Mercury | ND | 0.02 | 0.2 | mg/L |
| Selenium | ND | 0.2 | 1.0 | mg/L |
| Silver | ND | 0.05 | 1.0 | mg/L |

ND-Parameter not detected at stated Practical Quantitation limit (PQL).

Reference: Toxicity Characteristic Leaching Procedure , Final Rule, Federal Register, 40 CFR 261-302. Part V, EPA Vol 55, No. 126, June 29, 1990

Method 3010: Acid Digestion of Aqueous Samples and Extracts for Total Metals, SW-846, September, 1986.

Method 6010: Inductively Coupled Plasma-Atomic Emission Spectroscopy, SW-846, September, 1990.

Method 7000: Atomic Absorption Spectroscopy SW-846, September 1986.

Method 7470: Mercury in Liquid Waste (Manual Cold-Vapor Technique), SW-846, September 1986.

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# QUALITY ASSURANCE / QUALITY CONTROL

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# LAB QA/QC
# VOLATILE COMPOUNDS BY GC/MS
# METHOD BLANK

Date Analyzed: 07/06/94
Laboratory ID: 3MB-187A
Sample Matrix: Water

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Chloromethane | ND | 5 | ug/L |
| Bromomethane | ND | 5 | ug/L |
| Vinyl Chloride | ND | 5 | ug/L |
| Chloroethane | ND | 5 | ug/L |
| Methylene Chloride | ND | 20 | ug/L |
| Acetone | ND | 20 | ug/L |
| Carbon Disulfide | ND | 5 | ug/L |
| 1,1-Dichloroethene | ND | 5 | ug/L |
| 1,1-Dichloroethane | ND | 5 | ug/L |
| 1,2-Dichloroethene | ND | 5 | ug/L |
| Chloroform | ND | 5 | ug/L |
| 1,2-Dichloroethane | ND | 5 | ug/L |
| 2-Butanone | ND | 20 | ug/L |
| 1,1,1-Trichloroethane | ND | 5 | ug/L |
| Cyclohexane | ND | 5 | ug/L |
| Carbon Tetrachloride | ND | 5 | ug/L |
| Bromodichloromethane | ND | 5 | ug/L |
| 1,2-Dichloropropane | ND | 5 | ug/L |
| 1,4-Dioxane | ND | 500 | ug/L |
| cis-1,3-Dichloropropene | ND | 5 | ug/L |
| Trichloroethene | ND | 5 | ug/L |
| Dibromochloromethane | ND | 5 | ug/L |
| 1,1,2-Trichloroethane | ND | 5 | ug/L |
| Benzene | ND | 5 | ug/L |
| trans-1,3-Dichloropropene | ND | 5 | ug/L |
| 1,2-Dibromoethane | ND | 5 | ug/L |
| Bromoform | ND | 5 | ug/L |
| 4-Methyl-2-pentanone | ND | 5 | ug/L |
| 2-Hexanone | ND | 5 | ug/L |
| Tetrachloroethene | ND | 5 | ug/L |
| 1,1,2,2-Tetrachloroethane | ND | 5 | ug/L |

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# LATILE COMPOUNDS BY GC/MS

Date Analyzed: 07/06/94
Laboratory ID: 3MB-187A
Sample Matrix: Water

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Toluene | ND | 5 | ug/L |
| Chlorobenzene | ND | 5 | ug/L |
| Ethylbenzene | ND | 5 | ug/L |
| Styrene | ND | 5 | ug/L |
| m,p-Xylene | ND | 5 | ug/L |
| o-Xylene | ND | 5 | ug/L |

ND - Compound not detected at stated Detection Limit.
J - Meets identification criteria, below Detection Limit.
B - Compound detected in method blank.

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# TENTATIVELY IDENTIFIED COMPOUNDS
# METHOD BLANK ANALYSIS

Date Analyzed: 07/06/94
Laboratory ID: 3MB-187A
Sample Matrix: Water

| Tentative Identification | Retention Time (min) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable levels.

Unknown concentrations calculated assuming a Relative Response Factor = 1.

## QUALITY CONTROL:

| Surrogate Recovery | % | Water QC Limits |
|---|---|---|
| 1,2-Dichloroethane-d4 | 101 | 76 - 114 |
| Toluene-d8 | 99 | 88 - 110 |
| Bromofluorobenzene | 99 | 86 - 115 |

References:

Method 8240, Gas Chromatography/Mass Spectrometry for Volatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, Third Edition, November 1986.

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# [illegible]B QA/QC
# VOLATILE COMPOUNDS BY GC/MS
# EXTRACTION BLANK

Date Analyzed: 07/06/94
Laboratory ID: 3EB-187
Sample Matrix: Soil
Date Extracted: 07/06/94

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Chloromethane | ND | 0.2 | mg/kg |
| Bromomethane | ND | 0.2 | mg/kg |
| Vinyl Chloride | ND | 0.2 | mg/kg |
| Chloroethane | ND | 0.2 | mg/kg |
| Methylene Chloride | ND | 1 | mg/kg |
| Acetone | ND | 1 | mg/kg |
| [illegible]n Disulfide | ND | 0.2 | mg/kg |
| 1,1-Dichloroethene | ND | 0.2 | mg/kg |
| 1,1-Dichloroethane | ND | 0.2 | mg/kg |
| 1,2-Dichloroethene | ND | 0.2 | mg/kg |
| Chloroform | ND | 0.2 | mg/kg |
| 1,2-Dichloroethane | ND | 0.2 | mg/kg |
| 2-Butanone | ND | 1 | mg/kg |
| 1,1,1-Trichloroethane | ND | 0.2 | mg/kg |
| Carbon Tetrachloride | ND | 0.2 | mg/kg |
| Bromodichloromethane | ND | 0.2 | mg/kg |
| 1,2-Dichloropropane | ND | 0.2 | mg/kg |
| cis-1,3-Dichloropropene | ND | 0.2 | mg/kg |
| Trichloroethene | ND | 0.2 | mg/kg |
| Dibromochloromethane | ND | 0.2 | mg/kg |
| 1,1,2-Trichloroethane | ND | 0.2 | mg/kg |
| Benzene | ND | 0.2 | mg/kg |
| trans-1,3-Dichloropropene | ND | 0.2 | mg/kg |
| Bromoform | ND | 0.2 | mg/kg |
| 4-Methyl-2-pentanone | ND | 0.2 | mg/kg |
| 2-Hexanone | ND | 0.2 | mg/kg |
| Tetrachloroethene | ND | 0.2 | mg/kg |
| 1,1,2,2-Tetrachloroethane | ND | 0.2 | mg/kg |

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# LATILE COMPOUNDS BY GC/MS

Date Analyzed: 07/06/94
Laboratory ID: 3EB-187
Sample Matrix: Soil
Date Extracted: 07/06/94

| Parameter | Analytical Result | Detection Limit | Units |
|---|---|---|---|
| Toluene | ND | 0.2 | mg/kg |
| Chlorobenzene | ND | 0.2 | mg/kg |
| Ethylbenzene | ND | 0.2 | mg/kg |
| Styrene | ND | 0.2 | mg/kg |
| m,p-Xylene | ND | 0.2 | mg/kg |
| o-Xylene | ND | 0.2 | mg/kg |

ND - Compound not detected at stated Detection Limit.
J - Meets identification criteria, below Detection Limit.
B - Compound detected in method blank.

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# NTATIVELY IDENTIFIED COMPOUNDS
# EXTRACTION BLANK ANALYSIS

Date Analyzed: 07/06/94
Laboratory ID: 3EB-187
Sample Matrix: Soil
Date Extracted: 07/06/94

| Tentative Identification | Retention Time (min) | Concentration | Units |
|---|---|---|---|

No additional compounds found at reportable levels.

wn concentrations calculated assuming a Relative Response Factor = 1.

## QUALITY CONTROL:

| Surrogate Recovery | % | Soil QC Limits |
|---|---|---|
| 1,2-Dichloroethane-d4 | 93 | 70 - 121 |
| Toluene-d8 | 103 | 81 - 117 |
| Bromofluorobenzene | 99 | 74 - 121 |

References:

Method 8240, Gas Chromatography/Mass Spectrometry for Volatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, Third Edition, November 1986.

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# APPENDIX H

# EPA INFORMATION ON RICO-ARGENTINE MINE AND NPL SITES IN COLORADO

Rico Argentine

RECORD OF COMMUNICATION

Pat Smith
Site Assessment Manager

December 3, 1993
9 am

Stan Powers
Bureau of Reclamation
Durango Colorado
(303)385-6555

COPY

MK had called the Bureau of Reclamation to ask for their data. They have done considerable study on the mercury in lakes issue for McPhee, Totten, and Narraguinnep. I had not even heard of the Totten mercury. Water, fish and sediment samples have been taken in the river and in these three lakes. Totten and Narraguinnep are off-river.

Mercury was found in the fish in all three reservoirs, but not in the fish in the Dolores River above the reservoirs. There was no mercury in fish downstream of McPhee. Lake analysis was of fish filets. He couldn't recall offhand, but he thought the river fish analysis was for whole fish or filets.

After all the samples they've collected, their theory is that the mercury is naturally occuring and that it isn't methylated and taken up by the fish until it reaches the lake (at least at McPhee). At Ridgeway reservoir, where mining and naturally occuring metals loading could take place (downstream of Idarado), they scraped the surface down to bedrock before creating the reservoir and have no problems with elevated concentrations in the fish.

One area of significant metals loading they found in their study was the Rico-Argentine area. He mentioned that tailings were used for street cover there, and after rains there were complaints of dying yards. Metals loading here included mercury. Silver Creek flows down from the Argentine. It is devoid of aquatic life. Above the mine is clean and there may be life up there. Rico gets its water supply from above the mine.

He'll send the raw data to MK for their SI. We both hoped it would replace our need to do further sampling for the McPhee SI.

---

ACTION:

Take the No Further Action flag off the Rico Argentine site.

043849

COPY

ANALYTICAL RESULTS FOR
RICO-ARGENTINE MINE
RICO, ARGENTINE
TDD# R8-8502-09

EPA PROJECT OFFICER: DAVE SCHALLER
FIT PROJECT OFFICER: MEG BABITS

SUBMITTED TO: KEITH SCHWAB - FIT DPO

DATE SUBMITTED: July 29, 1985

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ANALYTICAL RESULTS FOR
RICO-ARGENTINE MINE
IN RICO, COLORADO

## I. INTRODUCTION

This report was prepared to satisfy the requirements of Technical Directive Document (TDD) R8-8502-09 issued to Ecology and Environment, Inc. Field Investigation Team (E&E FIT) by the Region VIII Environmental Protection Agency (EPA). The report describes analytical data resulting from sample collection at the Rico-Argentine Mine on November 14, 1985. The purpose of this sampling effort was to evaluate the extent of contamination that has occurred as a result of past mining activities at the Rico-Argentine Mine. Sampling focused on possible contamination of surface water.

The Rico-Argentine Mine is located north of Rico, Colorado and is an inactive operation owned by the Anaconda Minerals Company. Initially, the chief metal produced in the Rico District was silver. There was a switch to pyrite for sulfuric acid production during the 1954 uranium boom and a sulfuric acid plant was built. Operations consisted of a mill and tailings pond on Silver Creek and an acid plant, cyanide heap leach, and settling ponds on the Dolores River. There were two discharge points associated with the operation. Discharge point 001 was the discharge from the Blaine Tunnel on Silver Creek. There is no longer discharge from 001 because it is redirected underground to the St. Louis Tunnel where it drains into the St. Louis Settling Pond System on the Dolores River. The outfall of the final pond into the Dolores River is discharge point 002.

In April of 1984, Anaconda Minerals Company put into effect a water treatment operation at the St. Louis Tunnel. The operation consists of neutralization using slaked lime.

The city of Rico receives its drinking water supply from Silver Creek above the major mining impacts. The water is treated through infiltration galleries and chlorinated. The site is discussed further in FIT's Site Visit Report and Sampling Plan (TDD R8-8408-17) and the Sampling Activities Report (TDD R8-8411-02). The site location map is shown in Figure 1.

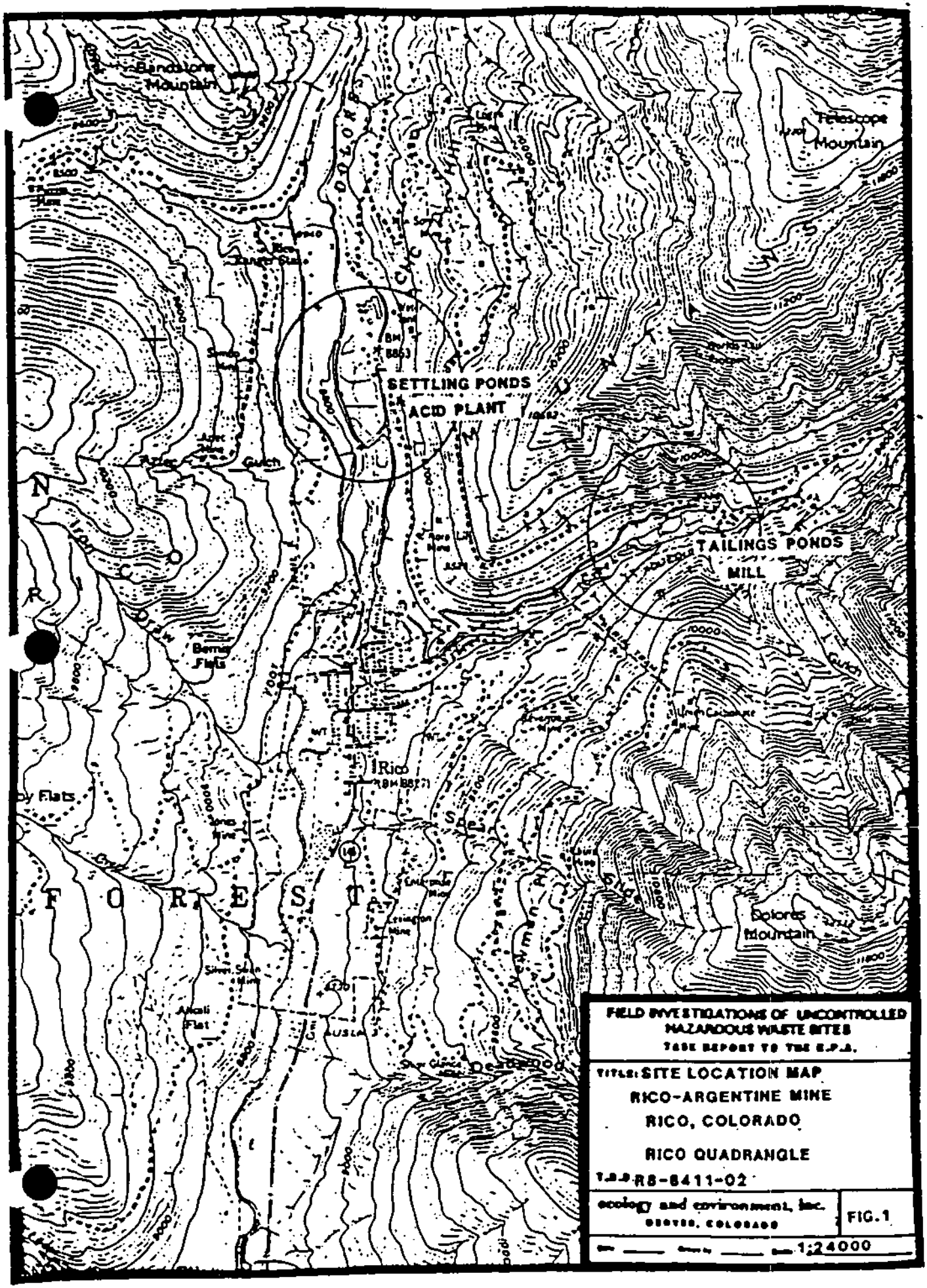
## II. QUALITY ASSURANCE REVIEW

All surface water samples were analyzed by Rocky Mountain Analytical Laboratory (RMA) in Arvada, Colorado. The surface water samples were analyzed for cyanide, sulfate and Task 1 and 2 metals including both total and dissolved analyses. The review of methodology and results was performed by John Graves and Lynn Roberts, both of E&E FIT. The inorganic data produced by RMA were found acceptable for use with one qualification. The holding time for cyanide exceeded the contract requirement. The data will be presented but footnoted as per the previous comment.

All sediment samples were analyzed by the Radian Corporation in Austin, Texas. The sediment samples were analyzed for Task 1 and 2 metals. The review of methodology and results was performed by Lynn Roberts, of E&E FIT. The data were found acceptable for use with several qualifications. The holding time for mercury was exceeded by 2 months. The matrix spike recoveries for antimony, selenium, thallium (recoveries were at 0%) and beryllium, nickel, silver and tin were not within the contract required recoveries. Finally, chromium was detected in the blank at 7.0 mg/kg. The data will be presented but footnoted as per the previous comments. See Appendix A for the complete QC Summary Report.

## III. ANALYTICAL RESULTS

Analytical results for the Rico-Argentine Mine sampling effort have been tabulated below. The analyses of the total inorganic




FIELD INVESTIGATIONS OF UNCONTROLLED HAZARDOUS WASTE SITES
TASK REPORT TO THE E.P.A.

TITLE: SITE LOCATION MAP
RICO-ARGENTINE MINE
RICO, COLORADO

RICO QUADRANGLE

T.D.# R8-8411-02

ecology and environment, inc.
DENVER, COLORADO

FIG. 1

1:24000

parameters and the dissolved inorganic parameters in surface water are presented in Table 1 and 2, respectively. The analyses of inorganic parameters in sediment are provided in Table 3. Water Quality Standards for the Dolores River and Silver Creek are presented in Tables 4 and 5, respectively. The National Interim Primary and Secondary Drinking Water Standards and Criteria are provided in Table 6. Location of all samples are shown in Figure 2.

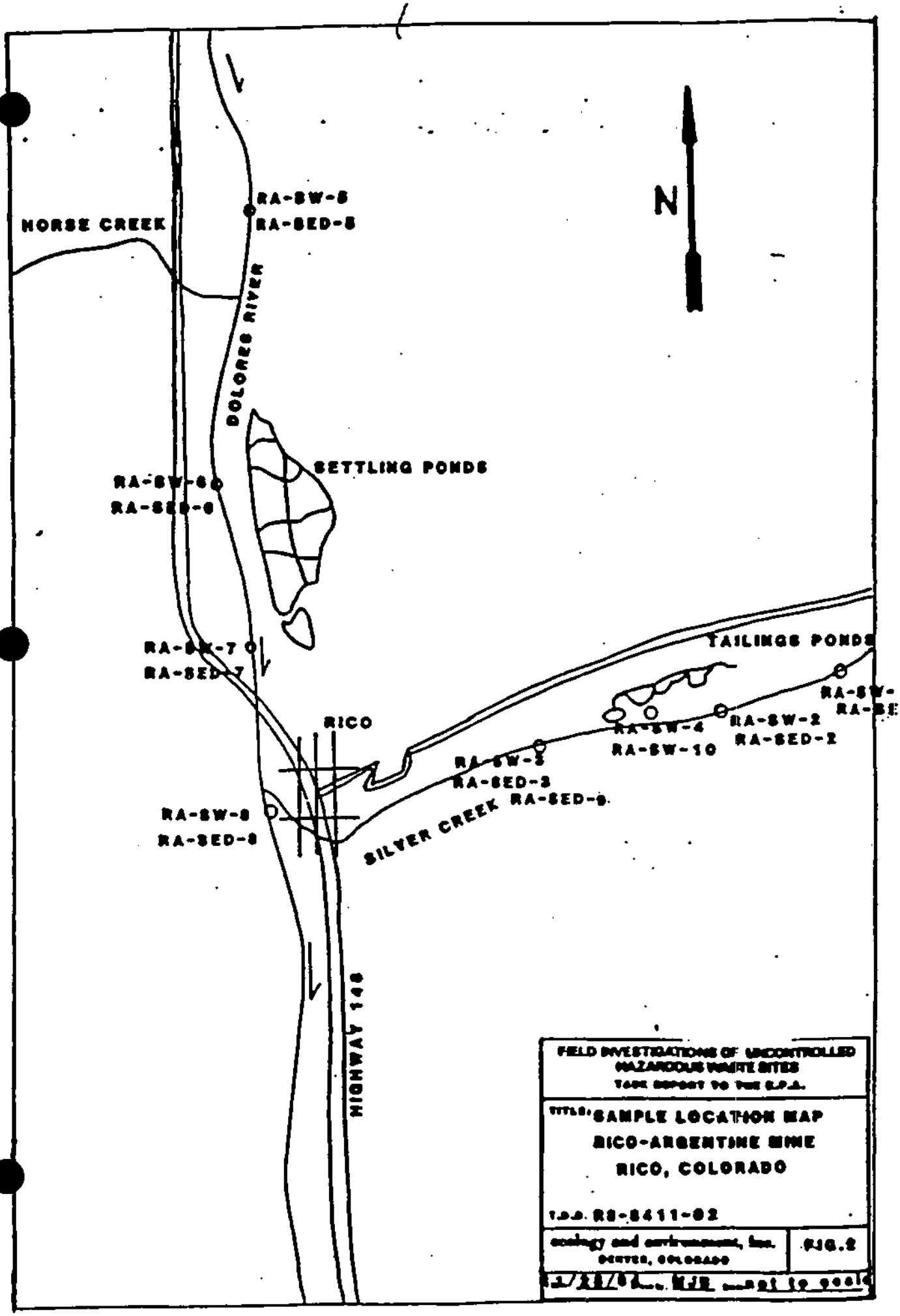
## IV. INTERPRETATION OF RESULTS

Water samples from streams were compared with the drinking water standards and criteria in Table 6. The standards are legally enforceable, while criteria are recommended levels. Some elements such as calcium, magnesium and potassium do not have criteria. It is important to emphasize that these waters are apparently not used as drinking water sources. The comparison is made as a measurement of water quality degradation. In comparing drinking water standards to samples, dissolved concentrations of surface water are used. the drinking water standards are also reported in dissolved concentrations.

There were no occurences of any standards being exceeded in Silver Creek. Leachate samples RA-SW-4 and duplicate RA-SW-10 had concentrations of beryllium, iron, manganese and zinc that exceeded the criteria. Surface water sample RA-SW-3 had manganese concentrations that exceeded its criteria. RA-SW-4 and RA-SW-10 had sulfate concentrations that were 700,000 ug/l greater than the background surface water sample.

There were no occurrences of any standards being exceeded in the Dolores River. Surface water sample RA-SW-6, RA-SW-7 and RA-SW-8 all had concentrations of manganese that exceeded the criteria level.

Water samples from streams were also compared with water quality standards for the Dolores River and Silver Creek. These standards are not control regulations, but are data put out by the Colorado


N
HORSE CREEK
RA-SW-5
RA-SED-5
DOLORES RIVER
SETTLING PONDS
RA-SW-6
RA-SED-6
RA-SW-7
RA-SED-7
TAILINGS PONDS
RICO
RA-SW-4
RA-SW-10
RA-SW-2
RA-SED-2
RA-SW-3
RA-SED-3
RA-SED-9
RA-SW-8
RA-SED-8
SILVER CREEK
HIGHWAY 145
FIELD INVESTIGATIONS OF UNCONTROLLED HAZARDOUS WASTE SITES
TASK REPORT TO THE E.P.A.
TITLE: SAMPLE LOCATION MAP
RICO-ARGENTINE MINE
RICO, COLORADO
T.O.# R8-8411-02
ecology and environment, inc.
DENVER, COLORADO
FIG. 2

Department of Health (CDH). The CDH reports standards in total concentration. In comparing standards to samples, total concentrations of surface water are used. On Silver Creek, RA-SW-4 and duplicate RA-SW-10 which are leachate samples from tailings exceeded criteria for cadmium, copper, iron, lead, manganese, silver, zinc. There are no sulfate standards for Silver Creek. On the Dolores River, no criteria were exceeded. There are no sulfate standards for the Dolores River.

Sediment samples from Silver Creek and the Dolores River were collected form each surface water sampling location. In Silver Creek, concentrations of arsenic, cadmium, copper, iron, lead, manganese and zinc were detected in the downgradient samples (RA-SED-2, RA-SED-3, RA-SED-9) in much higher quantities than the upgradient sample (RA-SED-1). In the Dolores River, concentrations of arsenic, cadmium, copper, iron, lead, manganese and zinc were detected in the downgradient samples (RA-SED-7 and RA-SED-8) in much higher quantities than the upgradient sample (RA-SED-5).

## V. CONCLUSION

The surface water data from RMA were found acceptable for use with one qualification. The holding time for cyanide was exceeded by one month. The sediment data from Radian were found acceptable for use with several qualifications. The holding time for mercury was exceeded by two months, matrix spike recoveries for six compounds were less than the acceptable limit and chromium was found in the blank.

When interpreting the surface water data from both Silver Creek and the Dolores River, it seems that the only compound of high concentration in downstream waters is manganese. The leachate from the Silver Creek tailings ponds appears to be diluted in a short distance.

The sediment data shows concentrations of metals that are clearly greater than the upstream samples. It is apparent that the metals are either precipitating from solutions or are being transported clastically. A strong coorelation can be made between metals found in downstream samples and mining operations. An extensive sediment sampling effort might be useful at this site.

The sediment data shows concentrations of metals that are clearly greater than the upstream samples. It is apparent that the metals are either precipitating from solutions or are being transported elastically. A strong coorelation can be made between metals found in downstream samples and mining operations. An extensive sediment sampling effort might be useful at this site.

TABLE 1: TOTAL INORGANIC PARAMETERS DETECTED IN SILVER CREEK SURFACE WATER SAMPLES COLLECTED FROM RICO-ARGENTINE MINE IN RICO, COLORADO ON NOVEMBER 14, 1985.
(concentrations in ug/l)

| | SW-1 | SW-2 | SW-3 | SW-4 |
|---|---|---|---|---|
| ALUMINUM | ND(35) | 58[a] | 85[a] | 1,220 |
| ANTIMONY | 54 | ND(51) | ND(51) | ND(51) |
| ARSENIC | ND(10) | ND(10) | ND(10) | 3.6[a] |
| BARIUM | 112[a] | 111[a] | 94[a] | 20[a] |
| BERYLLIUM | ND(.6) | ND(.6) | ND(.6) | 1.8[a] |
| CADMIUM | ND(5) | 5.6 | ND(5) | 7.5 |
| CALCIUM | 34,900 | 36,800 | 52,800 | 252,000 |
| CHROMIUM | ND(4) | ND(4) | ND(4) | 5.0[a] |
| COBALT | ND(6) | ND(6) | ND(6) | 17[a] |
| COPPER | 6.8[a] | 5.9[a] | 6.2[a] | 15[a] |
| CYANIDE[b] | ND(.1) | ND(.1) | ND(.1) | ND(.1) |
| [illegible] | 44[a] | 126 | 353 | 22,900 |
| [illegible] | ND(2) | ND(5) | ND(5) | 130 |
| MAGNESIUM | 3,690[a] | 4,160[a] | 6,610 | 43,900 |
| MANGANESE | 5.7[a] | 37 | 474 | 12,500 |
| MERCURY | ND(.1) | ND(.1) | ND(.1) | ND(.1) |
| NICKEL | ND(7) | ND(7) | ND(7) | 19[a] |
| POTASSIUM | ND(1,200) | ND(1,200) | ND(1,200) | 2,580[a] |
| SELENIUM | ND(5) | ND(5) | ND(5) | ND(50) |
| SILVER | ND(5) | ND(5) | ND(5) | ND(5) |
| SODIUM | 1,750[a] | ND(720) | ND(720) | 2,500[a] |
| SULFATE | 8,000 | 15,000 | 64,000 | 740,000 |
| THALLIUM | ND(10) | ND(10) | ND(10) | ND(10) |
| TIN | ND(28) | ND(28) | ND(28) | ND(28) |
| VANADIUM | ND(5) | ND(5) | ND(5) | ND(5) |
| ZINC | 17[a] | 329 | 65.1 | 11,800 |
| pH[c] | 6.60 | 6.88 | 7.30 | 6.25 |
| ec[c] | 240 | 200 | 290 | 1,200 |

[illegible] Detected but less than CLP detection limits
[illegible] Holding times were exceeded
c - pH reported as standard units, ec reported as umhos/cm
ND (#) - not detected (detection limit)

TABLE 1 (cont.): TOTAL INORGANIC PARAMETERS DETECTED IN DOLORES RIVER SURFACE WATER SAMPLES COLLECTED FROM RICO-ARGENTINE MINE IN RICO, COLORADO ON NOVEMBER 14, 1985.
(concentrations in ug/l)

| | SW-5 | SW-6 | SW-7 | SW-8 |
|---|---|---|---|---|
| ALUMINUM | ND(35) | 63[a] | 73[a] | 37[a] |
| ANTIMONY | ND(51) | ND(51) | ND(51) | ND(51) |
| ARSENIC | ND(10) | ND(10) | ND(10) | ND(10) |
| BARIUM | 61[a] | 57[a] | 44[a] | 58[a] |
| BERYLLIUM | ND(.6) | ND(.6) | ND(.6) | ND(.6) |
| CADMIUM | ND(5) | ND(5) | ND(5) | ND(5) |
| CALCIUM | 33,600 | 39,900 | 92,000 | 53,600 |
| CHROMIUM | ND(4) | ND(4) | ND(4) | ND(4) |
| COBALT | ND(6) | ND(6) | ND(6) | ND(6) |
| COPPER | ND(5) | 8.7[a] | 6.2[a] | 8.0[a] |
| CYANIDE[b] | ND(.1) | ND(.1) | ND(.1) | ND(.1) |
| IRON | 138 | 320 | 223 | 199 |
| LEAD | ND(5) | ND(5) | ND(5) | ND(5) |
| MAGNESIUM | 5,340 | 5,900 | 7,380 | 6,720 |
| MANGANESE | 17 | 221 | 155 | 141 |
| MERCURY | ND(.1) | ND(.1) | ND(.1) | ND(.1) |
| NICKEL | ND(7) | ND(7) | ND(7) | ND(7) |
| POTASSIUM | ND(1,200) | ND(1,200) | ND(1,200) | ND(1,200) |
| SELENIUM | ND(5) | ND(5) | ND(5) | ND(5) |
| SILVER | ND(5) | ND(5) | ND(5) | ND(5) |
| SODIUM | ND(720) | ND(720) | 2,370[a] | ND(720) |
| SULFATE | 21,000 | 44,000 | 185,000 | 72,000 |
| THALLIUM | ND(10) | ND(10) | ND(10) | ND(10) |
| TIN | ND(28) | ND(38) | ND(28) | ND(28) |
| VANADIUM | ND(5) | ND(5) | ND(5) | ND(5) |
| ZINC | 67 | 61 | 59 | 74 |
| pH[c] | 6.88 | 6.77 | 6.86 | 6.74 |
| ec[c] | 200 | 200 | 570 | 400 |

a - Detected but less than CLP detection limits
b - Holding times were exceeded
c - pH reported as standard units, ec reported as umhos/cm
ND (#) - not detected (detection limit)

TABLE 1 (cont.): TOTAL INORGANIC PARAMETERS DETECTED IN SURFACE WATER SAMPLES COLLECTED FROM RICO-ARGENTINE MINE IN RICO, COLORADO ON NOVEMBER 14, 1985. (concentrations in ug/l)

| | SW-9 | SW-10 |
|---|---|---|
| ALUMINUM | ND(35) | 4,150 |
| ANTIMONY | 79 | ND(51) |
| ARSENIC | ND(10) | 19 |
| BARIUM | ND(12) | 40[a] |
| BERYLLIUM | 1.0[a] | 3.3[a] |
| CADMIUM | 5.6 | 8.2 |
| CALCIUM | 342[a] | 244,000 |
| CHROMIUM | ND(4) | 11 |
| COBALT | ND(6) | 25[a] |
| COPPER | 12[a] | 83 |
| CYANIDE[b] | ND(.1) | ND(.1) |
| IRON | 12[a] | 66,200 |
| LEAD | 4.3[a] | 1,140 |
| MAGNESIUM | ND(390) | 43,400 |
| MANGANESE | ND(4) | 14,400 |
| MERCURY | ND(.1) | ND(.1) |
| NICKEL | ND(7) | 15[a] |
| POTASSIUM | ND(1,200) | 2,980[a] |
| SELENIUM | ND(5) | ND(50) |
| SILVER | ND(5) | 9.9[a] |
| SODIUM | ND(720) | 2,580[a] |
| SULFATE | ND(5,000) | 650,000 |
| THALLIUM | ND(10) | ND(10) |
| TIN | ND(28) | ND(28) |
| VANADIUM | ND(5) | 6.7[a] |
| ZINC | 32 | 13,800 |
| pH[c] | -- | 6.26 |
| ec[c] | -- | 1,200 |

a - Detected but less than CLP detection limits
b - Holding times were exceeded
c - pH reported as standard units, ec reported as umhos/cm
ND (#) - not detected (detection limit)

TABLE 2: DISSOLVED INORGANIC PARAMETERS DETECTED IN SILVER CREEK SURFACE WATER SAMPLES COLLECTED FROM RICO-ARGENTINE MINE IN RICO, COLORADO ON NOVEMBER 14, 1985.
(concentrations in ug/l)

| | SW-1 | SW-2 | SW-3 | SW-4 |
|---|---|---|---|---|
| ALUMINUM | ND(35) | ND(35) | ND(35) | 785 |
| ANTIMONY | ND(51) | ND(51) | ND(51) | ND(51) |
| ARSENIC | ND(3) | ND(3) | ND(3) | ND(10) |
| BARIUM | 157[a] | 160[a] | 133[a] | 54[a] |
| BERYLLIUM | ND(.6) | ND(.6) | ND(.6) | 1.5[a] |
| CADMIUM | ND(5) | ND(5) | ND(5) | ND(5) |
| CALCIUM | 34,200 | 35,900 | 52,700 | 231,000 |
| CHROMIUM | ND(4) | ND(4) | ND(4) | ND(4) |
| COBALT | ND(6) | ND(6) | ND(6) | 14[a] |
| COPPER | ND(5) | ND(5) | ND(5) | ND(5) |
| IRON | 12[a] | 49[a] | ND(10) | 16,500 |
| LEAD | ND(2) | ND(2) | ND(2) | ND(5) |
| MAGNESIUM | 3,400[a] | 3,930[a] | 6,470 | 40,100 |
| MANGANESE | ND(4) | 38 | 454 | 11,200 |
| MERCURY | ND(.1) | ND(.1) | ND(.1) | ND(.1) |
| NICKEL | ND(7) | ND(7) | ND(7) | 12[a] |
| POTASSIUM | ND(1,200) | ND(1,200) | ND(1,200) | 2,440[a] |
| SELENIUM | ND(2) | ND(2) | ND(2) | ND(20) |
| SILVER | ND(5) | ND(5) | ND(5) | ND(5) |
| SODIUM | ND(720) | ND(720) | ND(720) | ND(720) |
| THALLIUM | ND(6) | ND(6) | ND(6) | ND(6) |
| TIN | ND(28) | ND(28) | ND(28) | 35[a] |
| VANADIUM | ND(5) | ND(5) | ND(5) | ND(5) |
| ZINC | 14[a] | 283 | 561 | 10,800 |

a - Detected but less than CLP detection limits
ND (#) - not detected (detection limit)

TABLE 2 (cont.): DISSOLVED INORGANIC PARAMETERS DETECTED IN DOLORES RIVER SURFACE WATER SAMPLES COLLECTED FROM RICO-ARGENTINE MINE IN RICO, COLORADO ON NOVEMBER 14, 1985.
(concentrations in ug/l)

| | SW-5 | SW-6 | SW-7 | SW-8 |
|---|---|---|---|---|
| ALUMINUM | ND(35) | ND(35) | ND(35) | ND(35) |
| ANTIMONY | ND(51) | ND(51) | ND(51) | ND(51) |
| ARSENIC | ND(10) | ND(10) | ND(10) | ND(10) |
| BARIUM | 96[a] | 92[a] | 84[a] | 108[a] |
| BERYLLIUM | ND(.6) | ND(.6) | ND(.6) | ND(.6) |
| CADMIUM | ND(5) | ND(5) | ND(5) | ND(5) |
| CALCIUM | 29,300 | 35,000 | 82,100 | 55,600 |
| CHROMIUM | ND(4) | ND(4) | ND(4) | ND(4) |
| COBALT | ND(6) | ND(6) | ND(6) | ND(6) |
| COPPER | ND(5) | ND(5) | ND(5) | ND(5) |
| IRON | 45[a] | 89[a] | 24[a] | 40[a] |
| LEAD | ND(2) | ND(2) | ND(5) | ND(2) |
| MAGNESIUM | 4,590[a] | 5,060 | 6,540 | 6,850 |
| MANGANESE | 10[a] | 188 | 134 | 140 |
| MERCURY | ND(.1) | ND(.1) | ND(.1) | ND(.1) |
| NICKEL | ND(7) | ND(7) | ND(7) | ND(7) |
| POTASSIUM | ND(1,200) | ND(1,200) | 1,230[a] | ND(1,200) |
| SELENIUM | ND(2) | ND(2) | ND(2) | ND(2) |
| SILVER | ND(5) | ND(5) | ND(5) | ND(5) |
| SODIUM | ND(720) | ND(720) | ND(720) | ND(720) |
| THALLIUM | ND(6) | ND(6) | ND(6) | ND(6) |
| TIN | ND(28) | ND(28) | 31[a] | ND(28) |
| VANADIUM | ND(5) | ND(5) | ND(5) | ND(5) |
| ZINC | 29 | 30 | 47 | 90 |

a - Detected but less than CLP detection limits
b - Holding times were exceeded
c - pH reported as standard units, ec reported as umhos/cm
ND (#) - not detected (detection limit)

TABLE 2 (cont.): DISSOLVED INORGANIC PARAMETERS DETECTED IN SURFACE WATER SAMPLES COLLECTED FROM RICO-ARGENTINE MINE IN RICO, COLORADO ON NOVEMBER 14, 1985. (concentrations in ug/l)

| | SW-9 | SW-10 |
|---|---|---|
| ALUMINUM | ND(35) | 830 |
| ANTIMONY | ND(51) | ND(51) |
| ARSENIC | ND(10) | ND(10) |
| BARIUM | 26[a] | 60[a] |
| BERYLLIUM | ND(.6) | 1.8[a] |
| CADMIUM | ND(5) | 9.6 |
| CALCIUM | ND(330) | 240,000 |
| CHROMIUM | ND(4) | ND(4) |
| COBALT | ND(6) | 17[a] |
| COPPER | ND(5)[a] | ND(5) |
| IRON | ND(10) | 17,200 |
| LEAD | ND(2) | ND(5) |
| MAGNESIUM | ND(390) | 41,500 |
| MANGANESE | ND(4) | 11,600 |
| MERCURY | ND(.1) | ND(.1) |
| NICKEL | ND(7) | 11[a] |
| POTASSIUM | ND(1,200) | 2,540[a] |
| SELENIUM | ND(2) | ND(20) |
| SILVER | ND(5) | ND(5) |
| SODIUM | ND(720) | 1,370[a] |
| THALLIUM | ND(6) | ND(6) |
| TIN | ND(28) | ND(28) |
| VANADIUM | ND(5) | ND(5) |
| ZINC | 11 | 11,100 |

a - Detected but less than CLP detection limits
ND (#) - not detected (detection limit)

TABLE 3: INORGANIC PARAMETERS DETECTED IN SILVER CREEK SEDIMENT SAMPLES COLLECTED FROM RICO-ARGENTINE MINE IN RICO, COLORADO ON NOVEMBER 14, 1985. (concentrations in mg/kg)

| | RA-SED-1 | RA-SED-2 | RA-SED-3 | RA-SED-9 |
|---|---|---|---|---|
| ALUMINUM | 4,560 | 10,600 | 6,990 | 7,600 |
| ANTIMONY | 20[ab] | ND(17)[b] | ND(18)[b] | 45[b] |
| ARSENIC | 9.0 | 21 | 31 | 26 |
| BARIUM | 102 | 117 | 149 | 157 |
| BERYLLIUM (b) | ND(1.1) | ND(1.1) | ND(1.2) | ND(1.3) |
| CADMIUM | 1.3[a] | 3.1 | 6.7 | 9.9 |
| CALCIUM | 3,810 | 11,600 | 7,180 | 6,380 |
| CHROMIUM (d) | 12 | 14 | 7.7 | 17 |
| COBALT | 7.7[a] | 6.6[a] | ND(8.9) | 11[a] |
| COPPER | 9.4[a] | 75 | 256 | 224 |
| IRON | 8,120 | 22,300 | 25,100 | 23,000 |
| LEAD | 19 | 545 | 1,350 | 1,300 |
| MAGNESIUM | 2,910 | 9,710 | 4,100 | 4,100 |
| MANGANESE | 504 | 1,650 | 3,160 | 2,550 |
| MERCURY (c) | 13[a] | ND(.2) | .11[a] | .12[a] |
| NICKEL (a,b) | 7.2 | 13 | 4.2 | 11 |
| POTASSIUM (a) | 1,160 | 821 | 1,130 | 1,620 |
| SELENIUM (b) | ND(1.0) | ND(4.9) | ND(5.4) | ND(1.3) |
| SILVER (b) | ND(2.3) | ND(2.2) | 5.8 | 8.4 |
| SODIUM (a) | 1,010 | 1,040 | 1,260 | 1,330 |
| THALLIUM (b) | ND(1.1) | ND(1.1) | ND(1.2) | ND(1.3) |
| TIN (b) | ND(8.6) | ND(8.3) | ND(8.9) | ND(9.4) |
| VANADIUM | 19 | ND(22) | ND(24) | 25 |
| ZINC | 62 | 846 | 2280 | 1830 |
| PERCENT SOLIDS (%) | 87 | 90 | 84 | 80 |

a - Detected but less than CLP detection limits
b - Spike recovery was less than acceptable limit.
c - Holding time was exceeded
d - Detected concentrations in the blank
ND (#) - not detected (detection limit)

TABLE 3 (cont.): INORGANIC PARAMETERS DETECTED IN DOLORES RIVER SEDIMENT SAMPLES COLLECTED FROM RICO-ARGENTINE MINE IN RICO, COLORADO ON NOVEMBER 14, 1985.
(concentrations in mg/kg)

| | RA-SED-5 | RA-SED-6 | RA-SED-7 | RA-SED-8 |
|---|---|---|---|---|
| ALUMINUM | 5,040 | 5,600 | 9,060 | 7,430 |
| ANTIMONY | ND(16)[b] | 25[ab] | 23[ab] | 40[b] |
| ARSENIC | 8.8 | 9.8 | 12 | 12 |
| BARIUM | 8.9[a] | 111 | 115 | 100 |
| BERYLLIUM (b) | ND(1.1) | ND(1.1) | ND(1.1) | 3.0 |
| CADMIUM | ND(2.2) | ND(2.3) | 2.5 | 11 |
| CALCIUM | 11,100 | 15,900 | 7,900 | 6,050 |
| CHROMIUM (d) | 3.2[a] | 5.0 | 16 | 20 |
| COBALT | ND(8.3) | ND(8.5) | 13[a] | 13[a] |
| COPPER | 3.2[a] | 12 | 39 | 128 |
| IRON | 10,600 | 11,900 | 22,000 | 18,700 |
| LEAD | 12 | 14 | 179 | 222 |
| MAGNESIUM | 3,180 | 4,200 | 6,690 | 4,620 |
| MANGANESE | 190 | 350 | 1,380 | 1,380 |
| MERCURY (c) | .10[a] | ND(.2) | ND(.2) | ND(.2) |
| NICKEL (a,b) | 2.3 | 5.7 | 16 | 14 |
| POTASSIUM (a) | 843 | 981 | 1,370 | 1,510 |
| SELENIUM (b) | ND(.99) | ND(1.0) | ND(4.8) | ND(1.1) |
| SILVER (b) | ND(2.2) | ND(2.3) | ND(2.2) | ND(2.5) |
| SODIUM | 909[a] | 962[a] | 1,230 | 1,200 |
| THALLIUM (b) | ND(1.1) | ND(1.1) | ND(1.1) | ND(1.3) |
| TIN (b) | ND(8.3) | ND(8.5) | ND(8.2) | ND(9.4) |
| VANADIUM | ND(22) | 7.1 | 24 | 32 |
| ZINC | 46 | 75 | 568 | 716 |
| PERCENT SOLIDS (%) | 90 | 88 | 91 | 80 |

a - Detected but less than CLP detection limits
b - Spike recovery was less than acceptable limit.
c - Holding time was exceeded
d - Detected concentrations in the blank
ND (#) - not detected (detection limit)

TABLE 4: WATER QUALITY STANDARDS FOR THE DOLORES RIVER IN RICO, COLORADO
(concentration are in ug/l unless otherwise noted)
(standards for metals are total unless otherwise noted)

| | |
|---|---|
| ARSENIC | 50 |
| CADMIUM | .4 |
| CHROMIUM | 100 |
| COPPER | 14 |
| CYANIDE | 5[1] |
| IRON | 1,000 |
| LEAD | 4 |
| MANGANESE | 1,000 |
| MERCURY | .05 |
| NICKEL | 50 |
| SELENIUM | 20 |
| SILVER | .1 |
| pH | 6.5-9.0[2] |

1. Represents free concentrations
2. pH reported as standard units

TABLE 5: WATER QUALITY STANDARDS FOR THE SILVER CREEK IN RICO, COLORADO
(concentrations are in ug/l unless otherwise noted)
(standards for metals are total unless otherwise noted)

| | |
|---|---|
| ARSENIC | 50 |
| CADMIUM | 6 |
| CHROMIUM | 100 |
| COPPER | 20 |
| CYANIDE | 5[1] |
| IRON | 1,000 |
| LEAD | 16 |
| MANGANESE | 1,000 |
| MERCURY | .05 |
| NICKEL | 50 |
| SELENIUM | 20 |
| SILVER | .1 |
| ZINC | 1,400 |
| pH | 6.5-9.0[2] |

1. Represents free concentrations
2. pH reported as standard units

## TABLE 6: NATIONAL INTERIM PRIMARY AND SECONDARY DRINKING WATER STANDARDS AND CRITERIA

I. From: National Interim Primary Drinking Water Regulations, EPA - 570/9-76-003 (USEPA, 1976a).

| | |
|---|---|
| Arsenic | 50 ug/L |
| Barium | 1000 ug/L |
| Cadmium | 10 ug/L |
| Chromium | 50 ug/L |
| Lead | 50 ug/L |
| Mercury | 2.0 ug/L |
| Selenium | 50 ug/L |
| Silver | 50 ug/L |

II. From: U.S. EPA Water Quality Criteria, Federal Register 45 (231) (U.S. EPA, 1980).

| | |
|---|---|
| Antimony | 146 ug/L |
| Beryllium | 0.037 ug/L |
| Copper | 1000 ug/L |
| Nickel | 13.4 ug/L |
| Thallium | 13 ug/L |
| Zinc | 5000 ug/L |

III. From: U.S. EPA Quality Criteria for Water (1976b)

| | |
|---|---|
| Iron | 300 ug/L |
| Manganese | 50 ug/L |

IV. From: Drinking Water and Health, Safe Drinking Water Committee (1980)

| | |
|---|---|
| Aluminum | 5000 ug/L |

# APPENDIX A

FORM A

QC SUMMARY REPORT

REGION VIII CONTRACT LAB DATA

Project # ~~R8 8411-02~~ 8502-09

Data Reviewer Lynn M Roberts / John Hynes

Date of Review 2/12/85

Contractor Laboratory Rocky Mtn Analytical Lab.

Case No. 3549 Matrix Water

Site Rico - Argentine Mine

Sample No. MH 0706 0711

0707 0712

0708 0713

0709 ~~0715~~ 0714

0710 0715

( ✓ ) Data are acceptable for use

( ) Data are acceptable for use with qualification noted above

( ) Data are preliminary - pending verification by contractor laboratory

( ) Data are unacceptable

Following are our findings:

These data are of good quality except possibly the cyanide results. The cyanide holding time was exceeded by about 1 month. Therefore, the cyanide results must be considered as estimated concentrations.

E&E Form 6/84-1

Form A

# Inorganic Data Completeness Checklist

- ✓ Inorganic analysis data sheets
- ✓ Instrument Detection limits
- ✓ Duplicate results
- ✓ Spike results
- ✓ ICP interference check sample
- ✓ Blank results
- ✓ Raw data for calibration standards
- ✓ Raw data for blanks
- ✓ Raw data for samples
- ✓ Raw data for duplicates
- ✓ Raw data for spikes
- ✓ Initial calibration and calibration verification results
- ✓ Continuing calibration verification

Form B

All inorganic standards were within specified contract limits.

Yes ✓ No_____

Comments: Thallium continuing calibration was slightly low on 1-24-85.

All inorganic detection limits met the contract requirements.

Yes ✓ No_____

Comments:

All matrix spike requirements were met.

Yes_____ No ✓

Comments: Selenium recovery was 69%

The interference check sample was run twice per eight hour shift. No massive interferences were present.

Yes ✓ No_____

Comments:

Form C

A blank was run with every twenty samples or less per case.

Yes ✓ No ____

How many elements were detected above the required detectionlimit? 0

How many elements were detected at greater than one half the amount detected in any sample?: 0

Comments:

A duplicate sample was run with every twenty or fewer samples of a similar matrix, or one per case, whichever is more frequent.

Yes ✓ No ____

The RPD's were tabulated.

Yes ✓ No ____

Comments:

All holding times were met.

Yes ✓ No ✓

Comments: Cyanide holding times were exceeded. The cyanide results must be considered as estimates.

E+E PO

REGION VIII SUMMARY OF DATA QUALITY ASSURANCE REVIEW

Case No. 3549 Project No. _____

Site ~~Baker Park~~ Rico Argentine

Contractor Laboratory Radian

Data Reviewer DMRoberts Date of Review 5/15/85

Sample Matrix Soil

Sample No. sed3 MH0529 sed7 MH0203 _____ _____
sed5 MH0536 sed8 MH0204 _____ _____
sed4 MH0531 sed9 MH0205 _____ _____
sed1 MH0599 _____ _____ _____
sed2 MH0600 _____ _____ _____

( ) Data are acceptable for use.

(✓) Data are acceptable for use with qualification noted ~~above~~ below

( ) Data are preliminary - pending action or verification

( ) Data are unacceptable

Action required by DPO?

No ✓ Yes ____ Following items require action _____

Action required by Project Officer (PO)?

No ✓ Yes ____

Several elements are flagged with an "B" because of poor spike recovery. It should be noted that antimony, selenium, and thallium had zero spike recovery. Arsenic was flagged with an "R" by lab personnel. However according to the criteria listed on page E-6 of SOW 789, arsenic should not be flagged.

Chromium was detected in the blank at 7 mg/kg. Because of this, chromium results were flagged with a "B".

Form 3

All inorganic standards were within specified contract limits.

Yes____ No ✓

Comments: Three standards were analyzed. One standard had low %R for several elements. The limit is ±20%.

| | |
|---|---|
| Arsenic | 29% |
| Cadmium | 76% |
| Chromium | 79% |
| Nickel | 79% |

All inorganic detection limits met the contract requirements.

Yes ✓ No____

Comments:

All matrix spike requirements were met.

Yes____ No ✓

Comments:

Zero spike recovery for Antimony, Selenium, and Thallium

| | |
|---|---|
| Beryllium | 74% |
| Nickel | 150% |
| Silver | 70% |
| Tin | 330% |

These elements are flagged with an "R".

The interference check sample was run twice per eight hour shift. No massive interferences were present.

Yes ✓ No____

Comments:

The initial %R for vanadium was 128%. This is outside of the ±20% limit. However, the final present recovery was within the control limit (108%)

Form C

A blank was run with every twenty samples or less per case.

Yes ✓ No ____

How many elements were detected above the required detection limit? 1

Chromium was detected at 7.0 mg/kg, the detection limit was 5 mg/kg.

How many elements were detected at greater than one half the amount detected in any sample?: 1

Comments:

Chromium

A duplicate sample was run with every twenty or fewer samples of a similar matrix, or one per case, whichever is more frequent.

Yes ✓ No ____

The RPD's were tabulated.

Yes ✓ No ____

Comments: Silver RPD = 32%

All holding times were met.

Yes ____ No ✓

Comments:

The mercury holding time was exceeded by 2 months.

Form A

# Inorganic Data Completeness Checklist

- ✓ Inorganic analysis data sheets
- ✓ Instrument Detection limits
- ✓ Duplicate results
- ✓ Spike results
- ✓ ICP interference check sample
- ✓ Blank results
- ✓ Raw data for calibration standards
- ✓ Raw data for blanks
- ✓ Raw data for samples
- ✓ Raw data for duplicates
- ✓ Raw data for spikes
- ✓ Initial calibration and calibration verification results
- ✓ Continuing calibration verification

contract requirements.

Yes ✓ No____

Comments: ..... .

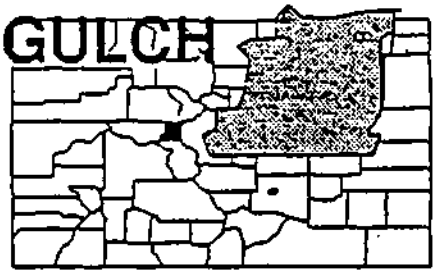
All samples were extracted and analyzed within contract holding times..

Yes____ No ✓

Comments:

one mercury holding time was exceeded by 2 months.

# CALIFORNIA GULCH
## COLORADO
EPA ID# COD980717938



EPA REGION 8
Lake County
100 miles west of Denver

## Site Description

The 130 year old California Gulch site is a mining area covering 16 1/2 square miles of a watershed area that drains along California Gulch to the Arkansas River. Starting in 1859, the area was mined extensively for gold, lead, silver, copper, zinc, and manganese. California Gulch collects runoff that drains numerous abandoned mines and wastes from mining, milling, and smelting. Miners built the Yak Tunnel to drain water from the mine works and to make mineral exploration and development easier. This tunnel drains hundreds of miles of mine workings in its 4-mile underground course and discharges approximately 210 tons of various heavy metals each year into California Gulch. Seventy-five known mills dumped tailings into 5-6 miles of drainages and 6 impounded tailings dumps surround the City of Leadville. Seventeen smelters operated at various times around the City processing silver, lead, and zinc. Heavy metal residues are present in much of the City. Contaminated runoff flows through local town storm drains and city streets. The Arkansas River, which receives water from the California Gulch, has been classified as a recreational resource, and is used heavily for irrigation, livestock watering, public water supplies, and fisheries. Approximately 4,000 people live in nearby Leadville and Lake County.

**Site Responsibility:** This site is being addressed through Federal and potentially responsible parties' actions.

**NPL LISTING HISTORY**
Proposed Date: 12/30/82
Final Date: 09/08/83

## Threats and Contaminants

The primary contaminants of concern affecting surface water, sediments, and groundwater are the heavy metals cadmium, copper, lead, arsenic, and zinc. The water in several shallow groundwater wells in California Gulch and in some private wells has been shown to exceed the EPA's drinking water standards for cadmium and zinc. Arsenic, cadmium, and lead are present in waste piles and soils. Adverse effects on the fish population have been observed in the Arkansas River. Contaminants have degraded vegetation in pastures downstream, and plant tissues in some cases contained levels of metals toxic to livestock and wildlife. Water in the main stem of California Gulch is unsafe to drink. Other potential threats to the health of the resident population include direct contact with contaminants in the soil.

## Cleanup Approach

This site is being addressed in six stages: immediate actions and long-term remedial phases focusing on cleanup of the Yak Tunnel, mine waste rock and tailings, smelters and slag, residential areas, and groundwater and surface water.

### Response Action Status

**Immediate Actions:** In 1986, EPA emergency response workers extended public water supply system lines to residences using private wells. In 1990, a potentially responsible party improved the area storm water drainage system in east Leadville to prevent contaminated surface water from coming into contact with residential areas.

**Yak Tunnel Operable Unit:** In 1991, the EPA modified its 1988 remedy to treat the flow of acid water from the Yak Tunnel and to prevent the uncontrolled release of tunnel drainage to the environment. It features: (1) a surge pond to capture tunnel drainage and dissipate the effect of surges from the tunnel on the California Gulch and the Arkansas River; (2) a permanent system to treat the tunnel water before discharging it; (3) installing a flow control bulkhead in the tunnel to stop the uncontrolled discharge of mine drainage; (4) sealing shafts, drill holes, and fractured rock, and diverting surface water to reduce the amount of water entering the tunnel; (5) establishing a surface water and groundwater monitoring system; and (6) preparing a contingency plan. Under EPA direction, the parties potentially responsible for site contamination are designing the remedies and conducting the cleanup. The parties finished building the surge pond and filter unit in 1989 and completed the permanent treatment plant in 1992. Remaining Yak Tunnel activities are scheduled for completion by the end of 1994.

**Groundwater and Surface Water:** The EPA began an investigation in 1987 of materials contributing to contamination of the site. Fullscale studies of surface water and groundwater began in 1991 including surface water sampling, streambed sampling, and toxicity testing of the California Gulch, adjacent drainages, and the Arkansas River. Installation of 56 additional monitoring wells and piezometers has been done as part of a larger groundwater study.

**Mine Waste Rock and Tailings:** The potentially responsible parties began an investigation of the primary waste sources in 1991. The investigation is exploring the extent of lead and zinc contamination contained in the mine waste rock and fluvial and impounded tailings. Runoff from these sources drains into surface and groundwater. The investigations and a screening feasibility study were completed in 1993, at which time analysis of alternatives for cleanup will proceed.

**Smelters and Slag:** In 1991, the potentially responsible parties began investigations to determine the possibility and nature and extent of heavy metal releases from smelters and slag. Once the investigation is completed, expected in 1993, alternative cleanup options for final remedy selection will be identified.

**Residential Areas:** In 1991, EPA released a Preliminary Human Health Risk Assessment for the Site. The EPA and the potentially responsible parties are undertaking intensive studies of the concentration of lead, cadmium and arsenic in residential soils and household dust. These and other studies will be used to define the nature and extent of contamination and resulting risk in this area of the site, as well as the best alternatives for cleanup.

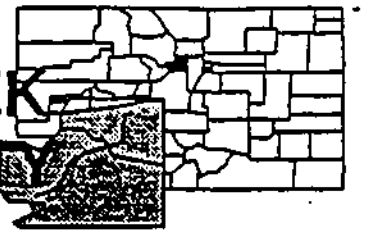
## Environmental Progress

Extending the public water supply has provided safe drinking water for affected area residents. The surge pond retaining [this unit has been taken out of service since the treatment plant replaced its function] sediment and supended solids in the surface waterflow in California Gulch has been operational since 1989; operation of the Yak Tunnel treatment facility in 1992 has improved water quality significantly in California Gulch and the Upper Arkansas River. Metal sludges resulting from treatment plan operations are being shipped off-site for recycling at the PRP's East Helena Smelter. This resource recovery initiative eliminates the need for sludge disposal in landfills and prevents additional pollution at the smelter through substitution of metal fluxing agents.

## Site Repository

Lake County Public Library, 1115 Harrison Avenue, Leadville, CO 80461

# CLEAR CREEK-CENTRAL CITY
## COLORADO
EPA ID# COD980717557



EPA REGION 8
CONGRESSIONAL DIST. 02
Clear Creek and Gilpin Counties
30 miles west of Denver

**Other Names:**
**Argo Tunnel**
**Big Five Tunnel**
**Burleigh Tunnel**
**Central City Mining District**
**Gregory Incline**
**National Tunnel**
**Quartz Hill Tunnel**
**Chase Gulch**
**Gregory Gulch**
**Golden Gilpin Mill**
**Boodle Mill**
**Clay County Tailings**
**North Clear Creek Tailings**
**Black Eagle Tailings**
**Little Bear Creek Tailings**
**McClelland Tailings**

## Site Description

The Clear Creek/Central City Superfund site is located approximately 30 miles west of Denver, Colorado. The site boundary has not been narrowly defined because of the nature of the contamination. Extensive historical mining activity at the site took place on a large number of small mining claims. In general, this resulted in the disposal of mine waste rock and tailings piles, which are distributed over a very large area. Additionally, numerous mine tunnels, which were constructed for ore haulage and mine water drainage, are found in the area. Consequently, the investigations at the site have involved identification and prioritization of contamination within the approximately 400 square mile drainage basin for Clear Creek.

Clear Creek has three major tributaries - South, West, and North Clear Creek - as well as numerous smaller tributaries. Designated uses of Clear Creek include agriculture, recreation, and drinking. Recreational uses in Clear Creek include fishing, kayaking, rafting, and tubing. Clear Creek and its tributaries are used in whole or in part as a drinking water source by several municipalities including Georgetown, Idaho Springs, Black Hawk, Golden, Westminster, Thornton, and Arvada.

The Clear Creek drainage basin is located in Clear Creek and Gilpin Counties. The 1988 population estimates show 2,649 residents in Gilpin County and 7,379 residents in Clear Creek County. More densely populated areas include the towns of Silver Plume, Georgetown, Empire, and Idaho Springs in Clear Creek County; and Central City and Black Hawk in Gilpin County. In addition, a large number of the residents of both Counties live in smaller communities, or are dispersed throughout the Counties and live on small acreage.

Land uses in Clear Creek and Gilpin Counties include tourism, commerce, recreation, and to a limited extent, ranching and agriculture. Areas of both Counties were extensively mined in the past because of the abundance of precious and base metals. Active mines are still present at some locations in the Counties. In October 1991, limited stakes gaming was permitted in the towns of Black Hawk and Central City. This new industry is changing the land use and population density in these areas.

**Site Responsibility:** This site is being addressed through Federal and State actions.

**NPL LISTING HISTORY**
Proposed Date: 07/23/82
Final Date: 09/08/83

## Threats and Contaminants

Soils, including tailings and waste rock, contain heavy metals such as arsenic, cadmium, chromium, copper, and lead. Children may be at risk from playing on these contaminated areas. Ground water and surface waters also contain heavy metals. People can become exposed by drinking contaminated ground water from private wells in the shallow and deep aquifers. The aquatic environment has been and continues to be severely affected by the elevated levels of metals in Clear Creek and its tributaries.

## Cleanup Approach

The site is being addressed in four stages: immediate actions and three long-term remedial phases directed at cleanup of both mine surface water discharges and tailings and waste rock piles.

### Response Action Status

**Immediate Actions:** In 1987, the EPA constructed a new retaining wall to support the waste rock and tailings known as the Gregory Incline mine dump. The EPA decreased the slope of the waste pile and replaced the retaining wall to prevent it from collapsing into North Clear Creek. The EPA surveyed local households to determine whether residents were using contaminated water from their private wells. Of the wells tested, only one showed significant levels of contamination from cadmium. The EPA provided the residents with bottled water as an interim measure until their home could be connected to the Idaho Springs municipal water supply. Additionally, EPA connected four other nearby residences to the city water supply; these wells were at risk from future contamination because they drew water from the same aquifer. The Colorado Department of Health conducted a second survey in 1989, and two new problem wells were identified. These will be addressed by future actions.

In 1991, EPA removed mercury contamination from an abandoned trailer in Idaho Springs. The mercury was likely left over from a mine assay laboratory operated inside the trailer.

As mentioned above, limited stakes gaming was legalized in Central City and Black Hawk in 1991. EPA has successfully negotiated five administrative orders on consent with gaming developers. The orders require the developers to clean-up their property prior to the construction of casinos or casino support facilities. Several other consent orders with developers are anticipated, resulting in site clean-up of areas that would otherwise have to be cleaned up at government expense.

**Mine Discharge Treatment of Surface Water Contaminants:** The EPA and the State plan to construct a wetland passive treatment system to treat the mine tunnel discharge from the Burleigh mine tunnel before it reaches Clear Creek. Colorado Department of Health already has constructed a pilot-treatment system here to determine the ability of passive treatment to meet water quality standards. Results have been promising. An active treatment system using chemical precipitation will be constructed to treat the Argo mine tunnel discharge. These systems will be designed to reduce the mobility, of dissolved and suspended metals in the mine drainages, decrease the acidity of the mine drainages, and meet water quality standards. The State and the EPA will in the future consider treating other mine tunnel discharges in the area.

**Tailings/Waste Rock Remediation:** Tailings and waste rock piles at the Argo, Gregory Incline, Big Five, Quartz Hill, and National will be graded to stable configuration and diversion ditches will be added to the upslope side of the piles to provide drainage control. The tailings stabilization was completed at the Argo and the Gregory in 1991 and the majority of the Gregory Incline tails were removed by a casino developer in 1994. Tailings stabilization is being designed for the Big Five, the Quartz Hill, and National areas. Design of capping and/or erosion control measures will soon begin for nearly 20 other tailings and waste rock piles. The EPA, the State, and local officials are evaluating institutional measures as a means to control threats that future development on the tailings and waste rock piles could pose to people or the environment.

**Ground Water:** The Colorado Department of Health will soon begin seeking volunteers for private ground water well testing. This will be the third such solicitation. Owners of wells contaminated with metals resulting from mining activities will be eligible to receive bottled water or will be connected to a public water supply system.

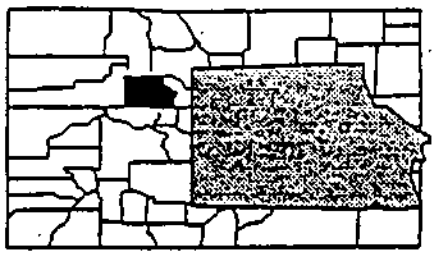
**Site Facts:** The Colorado Department of Health is the lead agency for all activities except enforcement-related activities.

## Environmental Progress

Numerous removal actions have prevented the further spread of contamination from tailings and waste rock piles into North Clear Creek. The EPA provided affected residences with bottled water prior to hooking them up to the municipal water supply. Remedies have been chosen for the treatment of the acidic water and the design of those systems is underway.

Remedial Action has been completed at the McClelland tailings pile near Dumont, Colorado.

# EAGLE MINE
## COLORADO
EPA ID# COD081961518



**EPA REGION 8**
Eagle County
8 miles west of Vail

**Other Names:**
New Jersey Zinc, Inc.
Gilman

## Site Description

The Eagle Mine site includes the Eagle Mine workings, the town of Gilman, the mine tailings pond areas, Rex Flats, Rock Creek Canyon, and waste rock and roaster piles. This site encompasses an area of approximately 5 to 7 miles along the Eagle River. Over the last 100 years, zinc miners deposited about 10 million tons of mine wastes and mill tailings along the Eagle River. The mining conditions and wastes formed acid, which leached toxic metals into surrounding surface water and groundwater. Five major sources of contamination have been identified at the site: (1) ponds containing tailings over a total of 107 acres; (2) roaster piles, five of which are found at this site; (3) a 25-acre pipeline corridor that extends from Rex Flats to the new tailings pond; (4) twelve major waste rock piles that cover about 93 acres; and (5) seepage from the flooded mine. The closest residence to the Eagle Mine site is approximately 1,000 feet to the northwest. Minturn, the closest population center, has 1,500 people, and its filter ponds and municipal wells lie 2,000 feet to the northwest of the mine tailings and across Cross Creek. Minturn draws its public water supply both from area wells and from Cross Creek. A middle school is located only 400 yards from the largest tailings pile.

**Site Responsibility:** This site is being addressed through Federal, State, and potentially responsible parties' actions.

**NPL LISTING HISTORY**
Proposed Date: 10/15/84
Final Date: 06/10/86

## Threats and Contaminants

Soil, surface water, and groundwater below the tailings piles and the now-flooded mine contain various heavy metals including arsenic, cadmium, chromium, copper, lead, and zinc. Fish populations have declined in the reaches of the river next to mine waste areas. Water from two town wells located near the site could be threatened. Wind-blown particulates from the tailings pile are of concern because of the proximity of a middle school. One wetland area, Maloit Park, located adjacent to the New Tailings Pile, has been affected by surface water and groundwater flowing from the pile and from mass wastage off the pile.

## Cleanup Approach

This site is being addressed in three stages: initial and emergency actions and two long-term remedial phases focusing on cleanup of the entire site and the soils.

### Response Action Status

**Initial and Emergency Actions:** Between 1976 and 1979, the mine owners undertook early cleanup activities such as treating mine water, revegetating small test plots located in the Rex Flats and old tailings pond areas, and building surface water diversion ditches along the old and new tailings ponds. Workers removed about half the tailings deposited on Rex Flats and built a surface runoff ditch. They also built a seepage collection pond and a sump and liming facility between the old tailings pond and the Eagle River. When the mine was abandoned in approximately 1983 and the pumps were turned off, the mine began to flood. Transformers containing polychlorinated biphenyls (PCBs), located in the mine shaft, posed a threat if flooded. EPA emergency workers removed the transformers from the shaft, secured and stored them on site as usable products, and supplied the electricity needed to run the pump and water treatment systems while the salvage operations were underway. They also constructed dikes in the mine to divert water from the upper mine areas and to prevent its release.

**Entire Site:** In 1988, the State selected a remedy for cleaning up the sources of pollution at the site featuring: plugging the mine portals; removing the roaster piles, Rex Flats tailings, and tailings pile and consolidating them in the "new" tailings pile; capping the new pile and pumping groundwater; and monitoring the Eagle River. The State and a potentially responsible party reached an agreement on performance of a long-term cleanup action. To prevent discharge of contaminated water to the river from the mine, the former owners constructed five concrete bulkheads in mine openings. Under State monitoring, the former mine owners plugged the mine and reworked many millions of cubic yards of mine tailings. They have consolidated approximately 95 percent of the wastes from the roaster piles, Rex Flats, and the old tailings pile into the new tailings pile. In early 1990, however, it became apparent that problems had developed with the ongoing cleanup. Mine seepage, a failed groundwater pump-back system, and run-off from various tailings areas were putting a large quantity of metals into the Eagle River. In 1990, the State and the potentially responsible party agreed to place a water treatment plant on site and to collect and treat visible mine seepage and consolidated pile groundwater.

In the fall of 1992, EPA decided to be more involved in solving problems at the site. EPA evaluated additional clean up measures and issued a Record of Decision in March 1993. These measures included further collection of Eagle Mine seeps, accelerated revegetation, and additional monitoring. EPA also lowered the clean up standards for the Eagle Mine.

**Soils:** In late 1992, an investigation was to begin to explore the nature and extent of contaminated soils at the Eagle Mine site. The study is was completed in late 1993. Soil metals levels were found to be of no concern in Minturn and the Middle School area. Levels are elevated on the Maloit Park wetlands and in Gilman. These problems are being addressed.

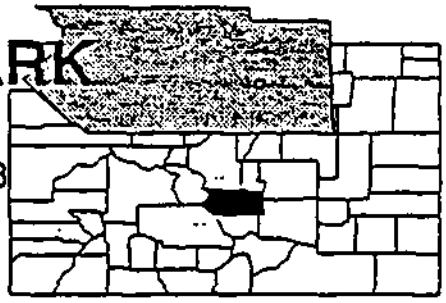
## Environmental Progress

The EPA has taken emergency actions at the Eagle Mine site to remove the PCB-laden transformers and to construct dikes to prevent the further spread of contamination. To date, most of the tailings and roaster pile material has been consolidated at the new tailings pile, which is 60 percent capped. A groundwater extraction system is operational, and the mine is plugged and nearly completely flooded. However, water drainage treatment and monitoring river impacts will continue while long-term cleanup actions and additional site investigations are underway in order to protect the Eagle River from contaminated runoff from the site.

## Site Repository

Town Clerk's Office, Minturn Town Hall, 302 Pine Street, Minturn, CO 81645

# LINCOLN PARK
## COLORADO
EPA ID# COD042167858



**EPA REGION 8**
*Fremont County*
Canon City

**Other Names:**
**Uranium Mill**
**Cotter Corporation**

## Site Description

Beginning in 1958, the Cotter Corporation operated a uranium mill approximately 1 1/2 miles from the community of Lincoln Park. Mill operations caused the release of radionuclides and heavy metals into the environment. Contaminants migrated through the groundwater to Lincoln Park prior to the construction of a dam on Sand Creek. Drinking water wells in the impacted area have been abandoned and residents have stopped using groundwater for domestic purposes. These homes have been connected to the Canon City water supply; however, some individuals in Lincoln Park are still using groundwater for irrigation purposes. The Lincoln Park area has approximately 3,500 residents.

**Site Responsibility:** This site is being addressed through Federal, State, and potentially responsible parties' actions.

**NPL LISTING HISTORY**
Proposed Date: 09/08/83
Final Date: 09/21/84

## Threats and Contaminants

Groundwater underlying the mill area and the community of Lincoln Park has been shown to be contaminated with uranium, molybdeum, and other radionuclides. Soils in the mill area also are contaminated with similar uranium products. Drinking or otherwise coming into contact with contaminated well water may cause adverse health effects. Wind-blown contaminants and migration of contaminants through surface streams also pose potential threats.

## Cleanup Approach

This site is being addressed in a single long-term remedial phase focusing on cleanup of the entire site.

## Response Action Status

**Entire Site:** In 1988, the State selected a remedy to clean up the site by: connecting area residences to an alternate water supply; pumping and treating the groundwater above the dam on Sand Creek to remove the contaminants; flushing the contaminants out of the water below the dam; revegetating the site; implementing air quality controls; and stopping off-site groundwater migration. Area residences have been furnished with safe drinking water. A pilot groundwater treatment system has been installed. Soil, vegetation, and sediment sampling is continuing. To date, the Cotter Corporation has contained the contaminants from the uranium mill using a groundwater cut-off barrier and by pumping the water back into holding ponds. The company is designing the technical specifications for the remedy. Most of the design phase is scheduled to be completed in 1994. A risk study of the site was completed in 1992 to determine the effectiveness of selected cleanup remedies.

**Site Facts:** In 1988, the State and the Cotter Corporation signed a Consent Decree, under which the Cotter Corporation agreed to implement a Remedial Action Plan to clean up the contamination at the site. In addition, in 1988, a Memorandum of Understanding was signed between EPA and the State, giving the State a lead role in overseeing clean-up of the site.

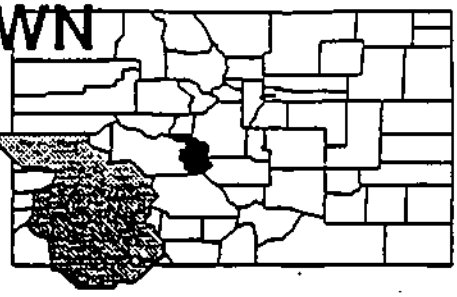
## Environmental Progress

Residences near the Lincoln Park site have been furnished with safe drinking water. A pilot groundwater treatment system has been installed and containment measures have been taken at the site to prevent uranium-contaminated groundwater from migrating off the mill site. Currently, the design for the cleanup remedies that will restore the site to environmentally safe levels is underway.

## Site Repository

Canon City Library, 516 Macon Avenue, Canon City, CO 81212
Colorado State Attorney General's Office
EPA Superfund Records Center

# SMELTERTOWN
## COLORADO
EPA ID# COD983769738



EPA REGION 8
Chaffee County
Near Salida

## Site Description

The Smeltertown site is located in a rural area northwest of Salida, Colorado on the eastern bank of the Arkansas River. The Site encompasses an area of 120 areas and has been impacted by three different industrial activities, smelting, woodtreating, and zinc sulfate manufacturing.

A lead/zinc smelter was operated from the turn of the century until about 1920 on the Site. During this period, hot slag was dumped along the banks of the Arkansas River. The slag still lines the eastern bank of the river. Contaminated soils and slag associated with the smelter operations contain elevated levels of arsenic, cadmium, copper, lead, manganese, and zinc. The smelter smokestack has been placed on the National Register of Historic Places.

Beginning in 1925, wood treatment occurred at this site. Railroad ties and other lumber products were treated with creosote and possible pentachlorophenol. These chemicals were allowed to drip on the ground after the lumber was treated. Creosote contaminated soils were removed from the site in 1986 and 1992.

The CoZinCo facility presently manufactures a zinc sulfate monohydrate by treating galvanizing wastes with sulfuric acid. Localized areas of contamination include several drum piles, sludge disposal and storage areas, and two wastewater lagoons. These sources of contamination are being addressed under a RCRA corrective action Order issued by the State of Colorado.

**Site Responsibility:** This site is being addressed through Federal actions.

**NPL LISTING HISTORY**
Proposed Date: 02/07/92

## Threats and Contaminants

Confirmed site contaminants include: zinc, lead, aluminum, nickel, chromium, arsenic, creosote, and pentachlorophenol.

## Cleanup Approach

This site is being addressed in one long-term remedial phase focusing on cleanup of the entire site.

### Response Action Status

**Entire Site:** An investigation was completed in February 1994 to characterize site contaminant sources that might pose an immediate human health threat.

## Environmental Progress

Several short-term actions have taken place on the site. Investigations to identify final cleanup remedies are planned to be completed in 1994. Final cleanup to begin in 1995.

## Site Repository

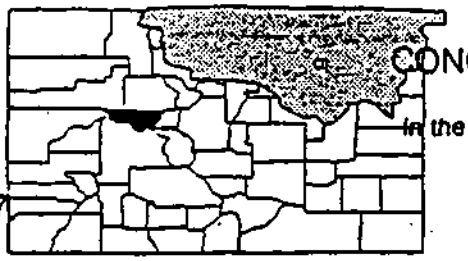
Town of Salida Public Library

Initial Actions: In 1993, several houses were provided bottled water in response to residential wells contaminated with zinc. Soils contaminated with lead and creosote were removed from several residences.

Smelter: The EPA is investigating contamination derived from the historic smelter operations. This investigation is scheduled to be completed in August 1994. Clean up is planned to begin in 1995.

Wood Treating: Beazer East, Inc., has begun a study to investigate the extent of contamination from the historic wood treating operations. The investigation is scheduled to be completed in 1994. Clean-up is planned to begin in 1995.

# SMUGGLER MOUNTAIN
## COLORADO
EPA ID# COD980806277



EPA REGION 8
CONGRESSIONAL DIST. 03
Pitkin County
In the northeast corner of the City of Aspen

## Site Description

The 116-acre Smuggler Mountain site is an inactive silver and lead mining site that was in operation from 1879 to 1918. Waste rock and mine tailings from mills and mines in the area have been deposited between the Roaring Fork River and the steep slope that forms the western side of Smuggler Mountain. Most of the mines are abandoned, but limited mineral exploration activities are still conducted on-site. Tailings and mine wastes were mixed with native soil, and spread a crossed the site. The total volume of mine waste material has been estimated at 1,300,000 cubic yards. In many cases, development in the Aspen area has taken place directly over waste piles, or mine waste has been dozed into mounds that remain as berms of contaminated soil. Contaminated soil has also been used as fill material in some areas. The site is situated in a residential area in the northeastern portion of the City of Aspen. The City has a year-round population of approximately 4,500, as well as substantial seasonal visitors. The City of Aspen obtains its drinking water from the Roaring Fork River, approximately 1,000 feet downstream from the site.

**Site Responsibility:** The site is being cleaned up through a combination of Federal, State and *potentially responsible parties' actions.*

**NPL LISTING HISTORY**
Proposed Date: 10/15/84
Final Date: 06/01/86

## Threats and Contaminants

Soil is contaminated with heavy metals including lead, cadmium, and arsenic. The potential health threats to area residents include accidentally ingesting contaminated surface soils or eating vegetables grown in contaminated soils. The Roaring Fork River is not contaminated by the site, and thus is not considered a potential health risk to the residents of Aspen.

## Cleanup Approach

This site is being addressed in three stages: immediate actions and two long-term remedial phases focusing on cleanup of the residential areas and cleanup of the mine area.

### Response Action Status

**Immediate Actions:** In 1985, a party potentially responsible for site contamination installed fencing around portions of the site and posted warning signs, as directed by the EPA. In 1990, EPA excavated, recontoured, and capped contaminated soil on two residential properties as a demonstration project.

**Residential Areas:** The remedy selected by EPA in an ESD issued in 1993 was based on the recommendations of the Technical Advisory Committee, and includes: (1) Capping and revegetation of the highly contaminated berm area. Common-use areas of exposed mine waste, including the Mollie Gibson Park, will also be covered, revegetated and monitored; (2) Implementation of a blood lead surveillance program for young children by the Pitkin County Health Department; (3) Vegetable gardens will be planted in at least 12 inches of clean soil; (4) The Aspen/Pitkin Environmental Health Department will evaluate site construction projects or land use changes to determine whether they present a threat of soil exposure to young children; and (5) EPA will make a final determination regarding remediation of residential soils based on EPA's review of lead speciation studies that have been completed, on-going biovavailability studies, and review of the Pitkin County Health Department's blood lead and dust monitoring program.

**Mine Area:** EPA is currently conducting an environmental engineering/cost evaluation to examine alternatives for addressing contamination in the mine area.

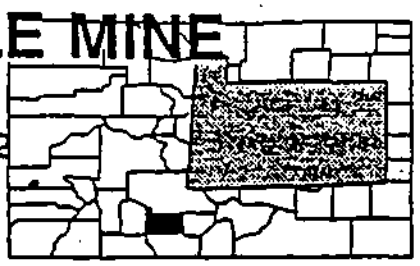
**Site Facts:** In 1985, the EPA issued three Administrative Orders to the potentially responsible parties. The orders required the property owners to notify the EPA of any plans to move soils or mining wastes on the site, investigate site contamination, recommend alternatives for final cleanup, and provide for the fencing and securing of a portion of the site to prevent public access.

## Environmental Progress

Initial actions such as fencing portions of the site and excavating, removing, and capping contaminated soil in other areas have reduced the threat of direct contact with contaminants.

The Region is currently negotiating settlements with the PRPs named in the cost-recovery case. The Region is proceeding to conduct additional technical studies on the bioavailability of the mine wastes to demonstrate the potential risk based on site specific characteristics.

# SUMMITVILLE MINE
## COLORADO
EPA ID# COD983778432



EPA REGION 8
Rio Grande County
Del Norte

## Site Description

The Summitville mine site is located in the San Juan Mountains of Colorado. The site, which covers 1,400 acres, is extremely remote at an elevation of over 11,000 feet above sea level and is usually accessible by vehicle only during the summer months. Mining operations began at the site in the late 1800s. In 1986, the most recent operator, Summitville Consolidated Mining Corp. Inc. (SCMCI) began pit mining and gold recovery operations through cyanide heap leaching. SCMCI originally designed the mining operation as a non-discharging wastewater facility. However, problems with discharges eventually compelled SCMCI to obtain a National Pollutant Discharge Elimination System (NPDES) permit from the State to operate a wastewater treatment plant. Throughout operations, several releases of water contaminated with cyanide and metals have occurred. The State has issued Notices of Violation to SCMCI for the unpermitted releases of contaminated water.

**Site Responsibility:** The site is being addressed through Federal and State actions.

**NPL LISTING HISTORY**
Proposed Date: 05/10/93

## Threats and Contaminants

Several releases of water contaminated with cyanide and metals at the site have been documented. In the past, fish kills have been reported from Wightman Fork to the Terrace Reservoir, approximately 20 miles downstream from the site.

## Cleanup Approach

This site is being addressed in two stages: initial actions and a long-term remedial phase focusing on the cleanup of the entire site.

## Response Action Status

**Initial Actions:** The EPA currently is maintaining the site to ensure that 150 million gallons of contaminated water is not released into Wightman Fork, a tributary to the Alamosa River.

Two additional removal actions were initiated in September 1993. The adit system which drains water from the historic underground mine workings is being plugged. This action is expected to flood the mine workings and reduce production of the acidic, metals contaminated water. This action is scheduled for completion in spring 1994.

Working on placing the Cropsy Waste Pile into the mine-pits continued through the winter of 1993. This first phase of moving several of the waste piles on-site was completed on February 11, 1994. Phase II is scheduled to begin during the 1994 construction season and completion of the enter "Cropsy" action is expected to effectively eliminate 70 million gallons of water from entering the Reynolds Adit system. This will further reduce the volume of contaminants generated from the Site.

**Entire Site:** The EPA has to initiated studies to investigate the nature and extent of contamination.

**Site Facts:** The State of Colorado has issued several Notices of Violation to SCMCI. In 1992 SCMCI declared bankruptcy. As a result, the EPA is maintaining the site using Superfund emergency funds.

## Environmental Progress

The EPA is maintaining the site to ensure that no accidental releases of contaminated water occur while investigations to determine the nature and extent of site contamination are being planned.

## Site Repository

*PRIVILEGED AND CONFIDENTIAL*

# APPENDIX I

# QUALIFICATIONS OF CORPORATION AND PREPARERS OF PHASE I ENVIRONMENTAL SITE ASSESSMENT (ESA)

## James P. Walsh Chief Executive Officer

M.S., Geology, University of Colorado, Boulder, 1973
B.A., Geology, University of Colorado, Boulder, 1971
C.P.S.S., Certified Professional Soil Scientist
P.G., Professional Geologist

**Experience**

Mr. Walsh has 21 years of professional experience as a multi-disciplinary project manager, environmental geologist, and soil scientist. He is the Chief Executive Officer of Walsh Environmental Scientists and Engineers, Inc., which he founded in 1979. He has served as a consultant to the Office of Technology Assessment - Congress of the United States.

His areas of technical expertise include soil morphology, genesis, classification and mapping, reclamation of disturbed lands, physical and chemical characterization of contaminated soils, hazardous waste site investigations, wind and water erosion, age-dating of geologic and pedologic features, and wetland delineation and reclamation.

Mr. Walsh has participated in many aspects of the environmental regulatory process including project feasibility/environmental fatal flaw studies, project planning and design, safety analysis, project siting studies, the EA/EIS process, public meetings, the RCRA and CERCLA process, and litigation support. In the latter he has been deposed and served as an expert witness, he has experience conducting litigation support research and advising council on technical matters in both civil and criminal cases for both the plaintiff and for the defense.

**Geology/ Soil Science**

Mr. Walsh is presently conducting soil investigations at several major hazardous waste or mining waste sites including the Rocky Mountain Arsenal; the Globe Smelter site; the California Gulch CERCLA site at Leadville, Colorado; the Anaconda/Butte/Silver Bow Creek CERCLA site in Montana; and the Cañon City, Colorado site. Mr. Walsh has many years of field experience in soil mapping in highly contaminated and dangerous areas including experience under Level B (supplied air) situations. He is conducting pilot studies to evaluate the feasibility of restoration of tropical rain forests on drastically disturbed lands and remediation of soil contamination in the Amazon Basin.

## John Murray Ph.D., Principal Engineer

Ph.D., Geophysical Engineering, Co. School of Mines, 1974
M.S., Geophysics, Michigan Technological University, 1970
B.S., Geology, Michigan Technological University, 1968
C.H.M.M., Certified Hazardous Materials Manager
R.E.P., Registered Environmental Professional
R.E.A., Registered Environmental Assessor
R.G., Registered Geologist

**Experience**

Dr. Murray has 20 years of experience in engineering, regulatory compliance, and earth science investigations. His expertise includes environmental permitting, air quality assessments, environmental site assessments, feasibility studies, and site mitigation/remediation. He has served as project manager at numerous site assessments including petroleum contaminated sites, abandoned landfill assessments, and hazardous waste site investigations. His responsibilities have included project design, site health and safety programs, field site management, and project reporting. His technical experience includes GPR, seismic, electromagnetic, electrical, magnetic, and gravity surveys. He has designed and supervised the drilling of numerous wells throughout the western U.S. and has performed extensive downhole geophysical studies. Dr. Murray conducted drilling and sampling programs on the Rocky Mountain Arsenal to locate and delineate old pesticide and army-agent disposal areas.

As manager of the Environmental Audit/Industrial Hygiene Division, Dr. Murray has managed or conducted over 50 initial site assessments, more than 30 preliminary or detailing site assessments, and several remediation projects at industrial and manufacturing facilities, uncontrolled landfills and vacant lands, some with complex former land usage issues. He has conducted several regulatory compliance audits involving RCRA, CERCLA, CWA, SDWA, and OSHA regulations as well as state and local agency requirements.

**Environmental Science and Industrial Hygiene**

Dr. Murray was co-founder of the Environmental Science and Technology Program at Front Range Community College and is currently an adjunct professor. He developed the curriculum for OSHA compliance training, environmental laws and policies, and environmental engineering courses. Dr. Murray served as the Corporate Health and Safety Officer for WALSH and developed company procedures for the development and implementation of project health and safety plans.

## Deb Anderson — Audit and Compliance Manager, Environmental Scientist

B.S., Microbiology, University of Wyoming, 1979
Registered Environmental Manager (REM) 1994

**Experience**

Ms. Anderson has 14 years of professional experience in environmental science including environmental auditing, permitting, and regulatory compliance. As Audit and Compliance Manager, Ms. Anderson prepares permit applications, conducts compliance audits, and manages site assessments for a variety of clients. Her recent experience includes conducting an extensive site assessment and regulatory compliance review on several thousand acres of land proposed for development, preparing a regulatory compliance audit for a governmental agency's transportation activities, and completing a hazardous waste characterization and disposal project for a former pesticide and fertilizer sales facility.

**Regulatory Compliance**

Ms. Anderson specializes in environmental site assessments, having participated in over 200 assessments including Phase I and II site assessments, compliance audits, and CERCLA preliminary assessments. She has completed studies on industrial, retail, residential, and commercial facilities.

Ms. Anderson has worked directly with the application of the various environmental regulations including RCRA, CERCLA, CWA, and TSCA. She has managed the NPDES, PCB, UST, and solid waste disposal programs for a coal-fired generating plant, prepared permit applications and compliance reports, established compliance monitoring programs, and prepared regulatory advisories. In addition to Ms. Anderson's regulatory experience, she also has extensive field experience in obtaining surface water, ground-water, soil, and waste samples.

Ms. Anderson is a Registered Environmental Manager (REM 7399), and a certified asbestos inspector in the states of Colorado and Nebraska.

## David Buscher Ecological Engineer/Soil Scientist

M.S., Ecological Engineering, Colorado School of Mines, 1992
B.S., Geological Engineering, South Dakota School of Mines and Technology, 1982.
B.S., Wildlife Management and Biology, South Dakota State University, 1978.

**Experience**

Mr. Buscher has 14 years of professional experience, six years as a geologist, three years as a soil scientist with the U.S. Soil Conservation Service (SCS), and five years as a soil scientist/environmental engineer. For Getty Mining Company, Mr. Buscher was assistant head field geologist for a gold exploration project. He also supervised all reclamation activities of drilling pads, access roads, and trenches. He conducted a research project on mercury contamination in gold mining areas in south central Brazil. His research included studying the geochemistry of mercury and mercury compounds in river sediments and water.

**Soil Science**

For WALSH, Mr. Buscher is a senior soil scientist and project manager for soil resource inventories and for jurisdictional wetland delineation projects. Most recently he conducted and managed an intensive Order I soil resource inventory and mapping project in Yarnell, Arizona for a major mining company. He interpreted the reclamation potential of the soils and supplied topsoil recommendations. He is currently working on restoration project of wetlands that were destroyed by peat mining. He was a senior field scientist of an environmental assess at an oil production block in Peru where he identified, delineated, and mapped various levels of hydrocarbon contamination in soils at multiple petroleum facilities. Mr. Buscher conducted a soil investigation for a major ski area in Colorado where he mapped and delineated ecological units based on soil type, landform, and plant community. He also assessed the soil hazards with regard to ski area development.

He assisted in an intensive Order 2 soil survey at the California Gulch CERCLA site in Leadville, CO. He also assisted in an Order 3 soil survey at the Anaconda Smelter CERCLA site in Anaconda, MT in support of a vadose zone investigation. His specific tasks for these soil surveys included soil mapping, defining survey map units, classifying soils, describing and sampling representative soil pedons, describing the nature and extent of mine waste material, and compiling and simplifying existing SCS mapping units.

He was a major author for a smelter RI report and for a pre-mining soil geochemistry report. For the smelter RI report, he identified areas impacted with historic smelter emissions based on soil geochemistry. For the pre-mining soil geochemistry report he developed soil-geologic units; described in detail and sampled by soil horizon multiple soil backhoe pits; and evaluated pre-mining metal concentrations of the soil-geologic units by applying the cumulative probability technique to geochemical soil data.

Mr. Buscher is a Certified Associate Soil Scientist and a Certified Professional Geologist of the State of Wyoming.

# CORPORATE CREDENTIALS

Walsh Environmental Scientists and Engineers, Inc. (WALSH) is a full-service, multi-disciplinary environmental consulting firm providing environmental and analytical services nationwide. Founded in 1979 by James P. Walsh, the firm presently employs more than 70 scientists and engineers, including 23 professionals with Master's Degrees and three Ph.D. graduates. With three offices in two states, WALSH has established a reputation for quality and innovation by successfully completing complex environmental projects.

WALSH consists of a diverse group of highly-qualified and experienced professional personnel with advanced expertise in environmental engineering, geology, geochemistry, analytical chemistry, hydrology, soil science, water science, industrial hygiene and safety, and computer technology.

With more than 150 satisfied clients in 21 states, from small business owners to major oil companies, WALSH emphasizes personalized service provided by highly motivated senior professional staff.

## Environmental Science and Engineering

WALSH is dedicated to accurately assessing and resolving complex environmental problems in an efficient and cost-effective manner. Our practical approach to managing the application of remediation technologies maximizes the company's ability to accomplish the goals of its clients.

The company's environmental services include:

- Phase I and Phase II ESAs
- "Superfund" and Hazardous Waste Site Investigations
- UST Removal and Remediation
- Soil Boring, Logging, and Sampling
- Installation of Ground-Water Monitoring Systems
- Ground-Water and Surface Water Sampling
- Laboratory Testing of Soil and Ground-Water Samples
- Contaminant Characterization
- Solid Waste Landfill Permitting and Closure
- Computer Modeling of Environmental Systems
- Environmental Impact Assessments/ Statements
- Expert Witness and Litigation Support

# APPENDIX J

# SITE INSPECTION PRIORITIZATION REPORT