# FINAL
# LANDFILL MONITORING AND MAINTENANCE PLAN
# ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
# PRESENT LANDFILL

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## LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AL | action level |
| CDPHE | Colorado Department of Public Health and Environment |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| DQO | data quality objective |
| EPA | Environmental Protection Agency |
| FML | flexible membrane liner |
| GCL | geosynthetic clay liner |
| GDN | geocomposite drainage net |
| GWIS | Groundwater Interception System |
| IDW | investigation-derived waste |
| IHSS | Individual Hazardous Substance Site |
| IM/IRA | Interim Measure/Interim Remedial Action |
| IMP | Integrated Monitoring Plan |
| Kaiser-Hill | Kaiser-Hill Company L.L.C. |
| LHSU | lower hydrostratigraphic unit |
| ml | milliliter |
| mph | miles per hour |
| PLF | Present Landfill |
| QA | quality assurance |
| QC | quality control |
| RCRA | Resource Conservation and Recovery Act |
| RFCA | Rocky Flats Cleanup Agreement |
| RFETS | Rocky Flats Environmental Technology Site |
| RL | reporting limit |
| SOP | Standard Operating Procedure |
| UHSU | upper hydrostratigraphic unit |

# 1.0 INTRODUCTION

## 1.1 PURPOSE

This Monitoring and Maintenance Plan (Plan) has been prepared for the Present Landfill (Individual Hazardous Substance Site [IHSS] 114) at the Rocky Flats Environmental Technology Site (RFETS) and is designed to meet the following objectives:

1. Describe the procedures to maintain the integrity and effectiveness of the final cover, including making repairs as necessary (Section 3.0),

2. Describe the features to maintain and monitor the groundwater monitoring system (Section 4), and

3. Present the Landfill Seep and East Landfill Pond Environmental Monitoring Plan (Section 5.0).

Under the Final Interim Measure/Interim Remedial Action (IM/IRA) for IHSS 114 and Resource Conservation and Recovery Act (RCRA) Closure for the Present Landfill (Kaiser-Hill Company L.L.C. [Kaiser-Hill] 2004), a RCRA Subtitle C-compliant cover was selected to address closure of the Present Landfill. The designed cover is a geosynthetic composite cover with a rock layer to deter burrowing animals and a 2-foot-thick topsoil layer. The design included installation of perimeter drainage channels to control surface water run-on and runoff around the landfill cover. The design also included modification of the existing landfill seep treatment system. Construction of the landfill cover included removing sediments in the East Landfill Pond, drying the sediments, and placing the dried sediments under the landfill cover. Construction was completed in May 2005, with a minor drainage modification on the landfill's east face completed in August 2005.

## 1.2 FACILITY LOCATION AND UNITS

RFETS is a government-owned facility formerly used for the fabrication of miscellaneous weapons components for national defense. The 6,550-acre site is located in Jefferson County, Colorado, approximately 16 miles northwest of Denver (Figure 1-1). The Present Landfill is centrally located within RFETS, as shown on Figure 1-2.

## 1.3 SITE OPERATIONS

The Present Landfill is located in the No Name Gulch drainage, at the western limit of headward erosion and pediment dissection. Beginning in 1968, a portion of the natural drainage at the headwaters of the No Name Gulch drainage was filled with soil from an on-site borrow area to a thickness of approximately 5 feet to construct a surface on which to begin landfilling operations. The landfill does not have a bottom liner. Waste delivered to the landfill was spread across the work area, compacted, and covered with a daily soil cover, eventually filling the valley to the top of the pediment.

The Present Landfill remained in operation until March 1998, at which time it was placed in a contingent closure status and seeded to stabilize soil and control erosion. The Present Landfill occupies an area of approximately 20 acres. Waste material is generally thinnest along the boundaries and thickest along the east-west axis of the landfill. Thicknesses range from less than 1 foot to approximately 40 feet near the eastern face of the landfill.

Additional information can be found in the IM/IRA for the Present Landfill (Kaiser-Hill 2004).

# 2.0 SITE PHYSICAL DESCRIPTION

This section describes the physical conditions at the Present Landfill site such as topography, hydrology, climate and precipitations, hydrogeology, and site features, which include the final cover, the stormwater management system, the RCRA groundwater monitoring network, the landfill seep, and the East Landfill Pond.

## 2.1 TOPOGRAPHY

The final topography of the Present Landfill is as shown on the post-construction survey (Figure 2-1). The slopes of the landfill cover are generally between 3 to 5 percent in accordance with Environmental Protection Agency (EPA) guidance for landfill covers (EPA 2002). The east face of the landfill has a maximum slope of 4 horizontal to 1 vertical (4H:1V). Perimeter drainage channels were built to control surface water run-on and runoff and are sloped to drain to the east of the landfill below the East Landfill dam. A diversion berm was built at the top of the east face to direct surface water into the perimeter channels. Two additional stormwater drainage channels were built to direct surface water at the toe of the east face.

## 2.2 HYDROLOGY

The Present Landfill is located within the No Name Gulch drainages. Perimeter channels have been constructed around the Present Landfill to route stormwater off the cover and prevent run-on from the surrounding watersheds. On the northern side of the landfill, the western portion of the perimeter channel runs under a perimeter road through a culvert and east into a natural drainage that eventually joins the No Name Gulch drainage below the East Landfill Pond dam. The northeastern portion of the channel empties into the same natural drainage that eventually joins No Name Gulch below the East Landfill Pond dam. On the southern side of the landfill, the perimeter channel runs east above the East Landfill Pond and drops into the No Name Gulch drainage below the dam (Figure 2-1). A diversion berm constructed at the top of the east slope directs surface water from the cover away from the east face and into the perimeter channels. These channels and diversion berms limit runoff into the East Landfill Pond.

The East Landfill Pond covers approximately 2.5 acres. Recharge to the pond occurs from direct precipitation, groundwater discharge, Present Landfill seep flow, and surface water runoff from

the surrounding hillslopes, including surface water discharge from the two riprap channels constructed on the east face of the Present Landfill. Groundwater discharge is likely limited because of the relatively low hydraulic conductivity of the underlying weathered bedrock. The East Landfill Pond discharge occurs by natural evaporation. Normal operation of the pond will be to leave the drain valve near the bottom of the pond open to maintain the water level in the pond. An emergency overflow spillway is provided in the dam, if needed.

## 2.3 CLIMATE AND PRECIPITATION

RFETS is located in the southern Rocky Mountains and has a continental, semiarid climate. The region is noted for large seasonal temperature variations, occasional dramatic short-term temperature changes, and strong, gusty winds that reach 75 miles per hour (mph). Mean annual precipitation is approximately 15.5 inches, with approximately one-half of that amount occurring as snow.

## 2.4 HYDROGEOLOGY

In the area of the Present Landfill, groundwater flows predominantly within the upper hydrostratigraphic unit (UHSU). The UHSU is composed of materials that include the Rocky Flats Alluvium, colluvium, Valley Fill Alluvium, and weathered claystone bedrock. Unweathered bedrock claystones are included as part of the lower hydrostratigraphic unit (LHSU). The thickness of the weathered bedrock material varies considerably in the vicinity of the landfill, ranging from approximately 4 to 35 feet. In the past, the average depth to groundwater ranged from 5 to 15 feet in surficial deposits around the landfill.

## 2.5 SITE FEATURES

Site features at the Present Landfill include the final cover, the stormwater management system, the RCRA groundwater monitoring network, the landfill seep treatment system, and the East Landfill Pond. Each of the site features is discussed in this Plan. Monitoring procedures are provided in subsequent sections.

### 2.5.1 Final Cover

The final cover of the Present Landfill includes the following components, beginning with the top layer:

- A 2-foot-thick soil layer to facilitate vegetation, route surface water, and protect the cover system below;
- A 1-foot-thick rock layer to deter burrowing animals;
- A 10-inch-thick rock cushion soil layer to protect the underlying geosynthetics from rocks;
- Geocomposite drainage net (GDN) to act as a drainage layer to route infiltrating water off of the cover;
- Flexible membrane liner (FML) to act as an impermeable layer and prevent water infiltration to the waste material below;
- Geosynthetic clay liner (GCL) to act as a secondary impermeable layer and also to "heal" punctures in the FML by the swelling of the GCL; and
- A 6-inch-thick GCL cushion soil layer to protect the geosynthetics above. This layer also includes a barometric vent system to equalize atmospheric pressure under the cover.

Inspection and monitoring procedures to maintain the integrity and effectiveness of the final cover are included in Section 3.0.

### 2.5.2 Stormwater Management System

#### 2.5.2.1 Introduction

The stormwater management plan is presented in Appendix H of the Present Landfill Design Submittal (Earth Tech, Inc. 2004). This appendix presents the results of calculations used to determine the stormwater run-on and runoff volumes to adequately design the perimeter channels and culverts. The calculations use a 100-year, 24-hour storm event and check the capacity of this design to handle a 1,000-year, 24-hour storm event. The contributing area for storm events is approximately 54 acres.

#### 2.5.2.2 Applications

Effective stormwater management is achieved in the system by applying the following principles:

- Protect the land surface from erosion,
- Manage run-on and runoff keeping velocities low, and

- Inspect and maintain the erosion and stormwater management practices (discussed in Section 3.0).

2.5.2.3 Erosion Control

At the Present Landfill, stormwater management features have been designed with erosion control features to limit both short-term erosion and long-term erosion (Figure 2-1). Erosion control is any practice that protects soil surfaces and prevents the soil particles from being detached by rainfall or wind. The cover is covered with NAG C125 temporary erosion mat and the cover sideslopes, perimeter channel bottom, perimeter channel sideslopes, and diversion berms are all covered with NAG SC150 temporary erosion control mat. This will limit short-term erosion until vegetation is established. Portions of the perimeter channel with steeper slopes are lined with riprap, a more robust erosion control measure. The diversion berm outfalls to the perimeter channel are also lined with riprap to prevent scouring. The cover of the cap has been seeded, mulched, and covered with erosion matting to limit erosion until vegetation is established. The east face and the portions of the diversion berms have more permanent erosion control mat (NAG C350) since the slope is longer and is more susceptible to erosion. Vegetation will also reduce the erosion on the east face.

2.5.2.4 Run-on and Runoff Control

The system has two purposes for the Present Landfill, which include:

- To collect, route, and discharge storm water run-on and runoff while minimizing unnecessary ponding and subsequent infiltration into the cover; and
- To control erosion and sediment transport.

Run-on stormwater is conveyed from west of the Present Landfill as overland flow and in intermittent, grassed waterways, then enters the perimeter channel. Other run-on is from overland flow from the contributing areas on the non-landfill sides of the perimeter channel.

Runoff enters the perimeter channel from overland flow on the cover as well as grassed waterway flow from the diversion berms constructed on the top of slope at the east face.

### 2.5.3 RCRA Groundwater Monitoring Network

Six RCRA monitoring wells will be used for groundwater monitoring at the Present Landfill as discussed in Section 4.0. These wells will be monitored in accordance with the RFETS Integrated Monitoring Plan (IMP), FY2005 (Rocky Flats 2005). Of the six wells, three are upgradient and three are downgradient of the Present Landfill.

### 2.5.4 Landfill Seep

A seep, known as the Present Landfill seep, exists at the east end of the landfill. A passive seep interception and treatment system was constructed to collect the Present Landfill seep water flowing from the Present Landfill (Kaiser-Hill 2004). This treatment system was replaced with a similar system during construction of the cover system. This new passive treatment system will also treat groundwater from the Groundwater Interception System (GWIS) (if any) and flow from the east face subsurface strip drains. The current concentrations of contaminants in the Present Landfill seep are either below or just slightly above the Rocky Flats Cleanup Agreement (RFCA) surface water action levels (ALs), and below RFCA groundwater Tier II ALs (maximum contaminant levels). Monitoring is discussed in Section 5.0.

### 2.5.5 East Landfill Pond

The East Landfill Pond will remain and receive the treated water from the landfill seep treatment system, surface water from the east face, as well as from precipitation directly into the pond. Monitoring of the pond is discussed in Section 5.0.

### 2.5.6 Access Controls

Access controls will be maintained through a fence around the perimeter of the site, signs at entry points that restrict access to authorized personnel only, and warning signs in accordance with 40 Code of Federal Regulations 265.14. The Department of Energy and the Fish and Wildlife Service may choose additional access controls after Site Closure.

# 3.0 FINAL COVER AND STORMWATER MANAGEMENT SYSTEM INSPECTION AND MONITORING

This section outlines the inspection and monitoring program to be undertaken at the Present Landfill to ensure that the integrity of the cover is not compromised and continues to function as designed. Inspection and monitoring tasks will include monitoring subsidence/consolidation, slope stability, soil cover, vegetation, stormwater management structures, and erosion in surrounding features so that maintenance actions can be taken in a timely manner.

## 3.1 INSPECTION PROCEDURES

In accordance with the IM/IRA (Kaiser-Hill 2004) to maintain integrity and effectiveness of the final cover, site inspections of the area will be conducted on a quarterly basis following construction of the final cover, with the following exceptions:

- The site shall be inspected after a storm event of one inch or more of rain in a 24-hour period, and
- The site shall be inspected after significant melt of a 10-inch or more snow storm assuming 10 inches of snow is equivalent to one inch of water.

Quarterly inspections will continue for five years and will be evaluated at the first Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) review.

Site inspections will be performed using a prescribed form containing a checklist of items that documents the evaluation of site conditions. The inspection form is presented in Appendix A. The findings and observations of the site inspection will be entered on the form and presented in an Annual Present Landfill Monitoring Report. If deficiencies are discovered that require immediate attention, the RFCA parties will be notified.

## 3.2 SUBSIDENCE / CONSOLIDATION

Subsidence and consolidation at the Present Landfill largely depend on how well the waste was compacted when placed, thickness of the waste, age, rate of waste degradation, and waste composition. Waste subsidence or continued consolidation may result in differential settlement which generally occurs when one area of waste settles more readily than another because of differences in waste composition, compaction, thickness, and moisture content. Differential

settlement across the landfill may create cracks on the surface, which would allow precipitation to infiltrate more easily. Differential settlement can also change the topography of the landfill and create areas on the surface where ponding of water can occur. Localized waste subsidence can manifest itself in the form of cracks, depressions, and sinkholes. Construction of the final cover system included placement of engineered fills and repair of unsuitable areas. In addition, the waste was compacted when placed, and decomposition is nearly complete by measurement of landfill gases. Therefore, cover subsidence or consolidation is of little concern. Nevertheless, differential settlement may occur.

### 3.2.1 Monitoring Locations and Procedures

Subsidence/consolidation at the Present Landfill will be monitored by visually inspecting the entire surface of the landfill cover for cracks, depressions, and sinkholes on a quarterly basis. Visual inspections will involve traversing the landfill to gain perspective on regions of the landfill, i.e., every square foot of the landfill is not traversed.

### 3.2.2 Maintenance Action Activities

If differential settlement or localized subsidence appears to be substantial and likely to influence the integrity of the existing cover and surface water drainage over the Present Landfill, the RFCA parties will be consulted and maintenance actions may be taken to mitigate these concerns. Maintenance actions may include, but not be limited to, regrading the affected area to eliminate ponding and/or correct the slope of the surface. A maintenance action plan will be prepared, and the RFCA parties will be consulted prior to any maintenance action.

## 3.3 SLOPE STABILITY

A landfill site may be susceptible to instability due to lateral movement. Slope failures can be caused by the weight of the wastes and cover material, steeply regraded slopes, and seepage forces resulting from water infiltration. Seismic forces can also cause slope failures. Steep slopes produce less stable conditions and are more susceptible to failure. Slope failures can also occur within the waste mass, resulting in downslope sliding of the cover components. The cover system has been designed and constructed with applicable safety factors to guard against slope failure. Nevertheless, slope stability will be monitored.

### 3.3.1 Monitoring Locations and Procedures

Slope stability at the Present Landfill will be monitored by visually inspecting the cover system sideslopes, the perimeter channel sideslopes, and the east face slope for signs of cracks, evidence of block failure, and evidence of circular failure. Visual inspection will involve traversing the slope to gain a perspective of the entire slope.

### 3.3.2 Maintenance Action Activities

Based on the site monitoring data and consultation with RFCA parties, maintenance actions may be taken to address any potential slope stability failure at the site. The actions may include, but not be limited to, regrading affected areas, filling areas, maintaining positive drainage of surface water, creating slopes ranging from 2 to 5 percent on top of the waste, and regrading steep sections to achieve side slopes no greater than 4:1. A maintenance action plan will be prepared, and the RFCA parties will be consulted prior to any maintenance action.

## 3.4 SOIL COVER

The cover system at the Present Landfill is designed to meet the minimum soil erosion requirements from both water and wind erosion. During the post-closure period, it is important to ensure that both temporary and permanent erosion controls are functioning properly. Regardless, the soil cover thickness may change over time due to wind and water erosion. Subsidence due to waste settlement and lateral movement of wastes or slopes may also contribute to changes in differential soil cover thickness.

### 3.4.1 Monitoring Locations and Procedures

Monitoring of the soil cover at the Present Landfill will include the following:

- Visually inspecting the soil cover for erosion or deposition areas on a quarterly basis;
- Visually inspecting the soil cover for signs of burrowing animals on a quarterly basis; and
- Visually inspecting the diversion berm, diversion berm outfalls, and the east face for erosion rills or excessive deposition on a quarterly basis.

Visual inspection will involve traversing the slope to gain perspective of the entire area.

### 3.4.2 Maintenance Action Activities

If monitoring indicates significant loss of soil over time, the RFCA parties will be consulted and maintenance actions may be taken. Action may include, but not be limited to, additional soil placement, regrading the affected areas to maintain the soil cover thickness of 2 feet and a top slope of 3 to 5 percent, and removing and relocating eroded soils (if necessary). The regraded areas will be vegetated to prevent further erosion. Erosion control measures may be implemented to prevent further erosion of cover soils, (e.g., erosion control mat, revegetation), if necessary. A maintenance action plan will be prepared, and the RFCA parties will be consulted prior to any maintenance action.

## 3.5 VEGETATION

Vegetation is important at the Present Landfill to aid with short-term and long-term erosion control although the design calculations have shown that the materials used for construction are resilient to water and wind erosion. Vegetation inspections will ensure that vegetation is established properly.

### 3.5.1 Monitoring Locations and Procedures

The vegetation at the Present Landfill will be monitored quarterly by visual inspection. The vegetation will be monitored by traversing the cover and visually inspecting for the health of the grasses and unwanted vegetation such as weeds or deep rooting trees.

### 3.5.2 Maintenance Action Activities

If visual inspections indicate vegetation concerns on the cover, the RFCA parties will be consulted and maintenance action may be taken. Actions may include, but not be limited to the following:

- Localized reseeding of the soil cover,
- Localized mowing of weeds prior to development of their seeds,
- Spot herbicide applications,
- Fertilization to maintain vitality of the grass cover, and
- Removal of deep-rooting trees and repair of the area.

A maintenance action plan will be prepared, and the RFCA parties will be consulted prior to any maintenance action.

## 3.6 STORMWATER MANAGEMENT STRUCTURES

Stormwater management will be required at the Present Landfill to ensure that existing stormwater control structures (man-made drainage features) are functioning adequately to achieve the following objectives:

- Prevent run-on and runoff from eroding or damaging the cover, and
- Limit transport of sediment from the disturbed areas to off-site drainage ways.

Existing stormwater controls at the Present Landfill include the following (Figure 2-1):

- Diversion berm,
- Diversion berm outfall-north,
- Diversion berm outfall-south,
- Culvert 1,
- Culvert 2,
- Southwest culvert outfall,
- Vegetation-lined perimeter channel-north,
- Vegetation-lined perimeter channel-south,
- Riprap-lined perimeter channel,
- East Face riprap channel-north,
- East Face riprap channel-south, and
- C350-lined East Face.

Details of each type of structure are included on Figure 3-1.

### 3.6.1 Monitoring Locations and Procedures

Stormwater management structures will be monitored visually by walking the structures and examining all components. Problem areas will be noted on the inspection form, graphically depicted, and photographed. At a minimum, these structures will be inspected for signs of excessive erosion, settlement, bank failure, breaching of the diversion berms, subsidence, burrowing animals, and blockage. Signs of potential problems include, but are not limited to, gullying, sediment build-up, and depressions.

The perimeter channel lining will be inspected for evidence of damage, displacement, undermining, scour, or deterioration. Repairs shall be made to re-stabilize the channel in accordance with the design specifications. Permanent erosion control mat lining on the east face will also be inspected. The erosion control mat will be inspected for holes, rips, and separation.

In addition, any evidence of erosion rills or gullies will be monitored during the inspection. Inspections will take place on a quarterly basis.

### 3.6.2 Maintenance Action Activities

If the inspections indicate that the existing stormwater management structures are not adequately controlling surface water run-on and runoff, RFCA parties will be consulted and maintenance actions may be taken.

Routine maintenance of the surface water controls may include removing any blockages, filling eroded areas, replacing erosion control mat, or repairing other disturbances as necessary. Sediment will be removed from the stormwater management structures to restore the design characteristics of the structure. Areas that exhibit excessive erosion may require placement of erosion control material or strengthening of the existing erosion control measures. A maintenance action plan will be prepared, and the RFCA parties will be consulted prior to any maintenance action.

## 3.7 EROSION CONTROL

Erosion control inspections are to take place in natural drainages around the Present Landfill to prevent excess sediment load to the Present Landfill system and to ensure excessive erosion is not problematic. Natural drainages and slopes around the Present Landfill to be inspected for excess erosion as shown on Figure 2-1 include:

- Natural drainage fed by Culvert 1,
- Natural drainage fed by the northeast portion of the perimeter channel,
- Natural drainage fed by the south perimeter channel, and
- Natural area sideslopes of the perimeter channel.

The inspection will include areas where flows from the channels meet the existing land surface.

### 3.7.1 Monitoring Locations and Procedures

The natural drainages will be visually monitored to identify signs of soil erosion that could adversely impact the Present Landfill or conditions that may cause an overload on existing stormwater management structures. Monitoring will take place on a quarterly basis for any changes.

### 3.7.2 Maintenance Action Activities

If inspections indicate soil loss, excessive disturbance in the areas, the presence of erosion gullies, or other evidence of erosion, RFCA parties will be consulted and maintenance action may be taken. The slope areas are more susceptible to water erosion in the event of high intensity rainfall and are of particular concern. Actions may include placing additional soils, regrading, and seeding of the affected areas. Other erosion control measures that may be implemented include placing erosion mat, riprap, straw bale barrier(s), and silt fencing. A maintenance action plan will be prepared, and the RFCA parties will be consulted prior to any maintenance action.

## 3.8 INSTITUTIONAL CONTROLS AND OTHER INSPECTIONS

In addition to the inspection and monitoring activities discussed above, the site inspection will include assessment of other items that may need attention, such as institutional controls, the condition of established monitoring points, and site security.

### 3.8.1 Institutional Controls

Institutional controls are used to control access and restrict activities at the Present Landfill to ensure the effectiveness of the engineered controls and the monitoring systems. Inspection at the Present Landfill will look for evidence that violate the institutional controls or damage the physical controls. On a quarterly basis, an inspection will be conducted to look for evidence of the following activities:

- Excavation(s) of the cover and in the immediate vicinity of the cover,
- Construction of roads, trails or buildings on the cover,
- Drilling of wells or use of groundwater for any purpose other than the accelerated action,
- Disruption or damage of the seep treatment system, and
- Damage or removal of any signage or groundwater monitoring wells at the Present Landfill.

A checklist of these items is included on the inspection form found in Appendix A.

### 3.8.2 Condition of Monitoring Points

All established monitoring locations, such as groundwater wells and the seep treatment system or other items placed to assist inspection efforts, will be evaluated for ongoing integrity. The

inspection will include documentation of any damage to the monitoring points that would impact their usefulness for inspections.

### 3.8.3 Site Conditions

During site inspections, signs, markers, and the overall condition of the Present Landfill site will be checked to determine continuing effectiveness of institutional and physical controls.

### 3.8.4 Reporting and Record Keeping

Inspection reports and findings will be included in the Annual Present Landfill Monitoring Reports discussed in Section 6.0. These annual reports will be submitted to the EPA and the Colorado Department of Public Health and Environment (CDPHE).

# 4.0 GROUNDWATER MONITORING PLAN

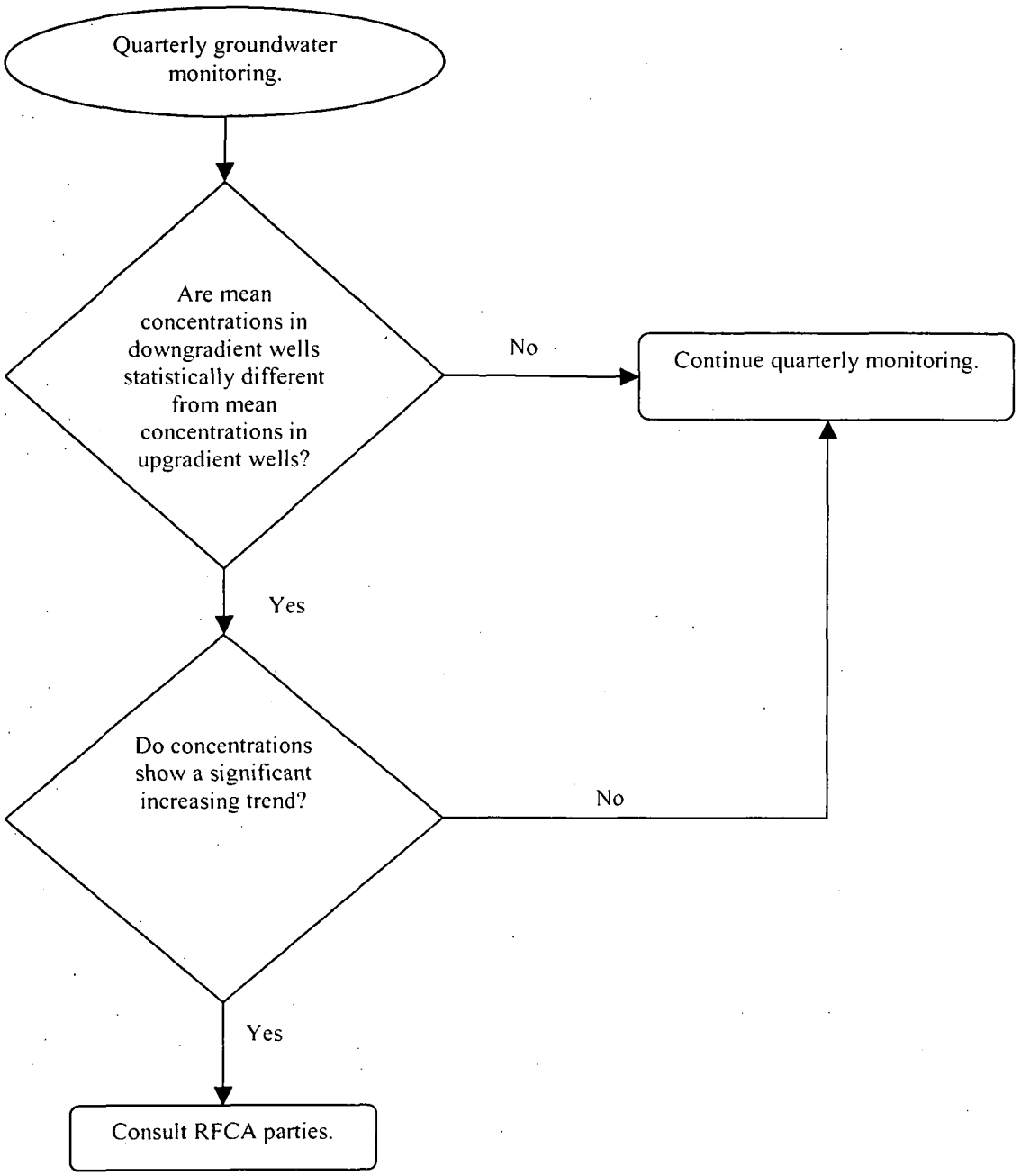
This section presents the plan to maintain and monitor the groundwater monitoring system for the Present Landfill during the post-closure period. This plan establishes consistent monitoring locations and frequencies for the monitoring period.

## 4.1 PURPOSE AND REQUIREMENTS

The Present Landfill groundwater monitoring plan has been implemented to determine groundwater quality impacts of the landfill (IM/IRA [Kaiser-Hill 2004]). The groundwater monitoring system was implemented under the IMP (Rocky Flats 2004) in accordance with 6 Code of Colorado Regulations 1007-3, 265.90[d]. The groundwater monitoring will be used to evaluate upgradient versus downgradient groundwater quality at the Present Landfill.

## 4.2 DATA QUALITY OBJECTIVES

Detailed data quality objective (DQO) information can be found in Section 3.3 of the IMP. The DQO process was generally developed using EPA guidance documents. Groundwater monitoring wells at the Present Landfill are categorized as RCRA monitoring wells under the IMP and undergo a certain decision statement outlined in Section 3.3.10.7 of the IMP. The following flowchart will be used to guide the decision statement:


Quarterly groundwater monitoring.
Are mean concentrations in downgradient wells statistically different from mean concentrations in upgradient wells?
No
Continue quarterly monitoring.
Yes
Do concentrations show a significant increasing trend?
No
Yes
Consult RFCA parties.

## 4.3 WELL LOCATIONS

Well locations have been chosen in compliance with the IMP and include a total of six RCRA groundwater monitoring wells (Figure 4-1). Locations were selected and approved by both CDPHE and EPA. Of these, three are downgradient and three are upgradient.

Upgradient monitoring wells include well numbers 70193, 70393, and 70693. Downgradient monitoring wells include well numbers 73005, 73105, and 73205. Monitoring well details are summarized in Table 4-1. Boring logs are included in Appendix B.

## 4.4 GROUNDWATER QUALITY SAMPLE PARAMETERS

Groundwater samples will be submitted for laboratory analysis of analytes inclusive of those listed in Table 4-2, which were established in the IM/IRA.

## 4.5 SAMPLING PROCEDURES SUMMARY

Groundwater sampling will be conducted in accordance with RFETS Standard Operating Procedures (SOPs). The following sections summarize the groundwater sampling procedures that will be used to monitor groundwater conditions at the Present Landfill. Details include groundwater level measurements, conventional groundwater purging and sampling procedures, quality control (QC) field samples, decontamination procedures, and investigation-derived waste (IDW) management.

### 4.5.1 Groundwater Level Measurement

Water levels are measured to determine groundwater flow patterns, water level fluctuations, and the volume of water in a well for the calculation of purge volumes prior to sampling. Since this plan requires measuring water levels from a group of monitoring wells for hydrologic evaluation, such measurements will be conducted as a complete round, separate from any sampling efforts. The six RCRA monitoring wells will be included during water level measurements. Water levels will be measured in accordance with RFETS SOPs.

### 4.5.2 Conventional Groundwater Purging and Sampling

Monitoring wells will be purged before samples are withdrawn to prevent collection of non-representative stagnant water in a well. Well purging will be sufficient to increase the likelihood



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that the water collected is representative of the groundwater within the formation around the well. All purging and sampling operations will be conducted in accordance with RFETS SOPs.

### 4.5.3 Quality Control Field Samples

During implementation of the field sampling program, field quality assurance (QA)/QC samples will be collected to assess the reproducibility of the field collection techniques, the quality of preservation techniques and sample bottles, and the effectiveness of field decontamination procedures. QA/QC procedures will be conducted in accordance with RFETS SOPs.

### 4.5.4 Decontamination

Equipment used in monitoring and sampling must be properly decontaminated. Decontamination must effectively eliminate the potential for cross-contamination between sampling locations and must be conducted using the appropriate materials to prevent the introduction of external contaminants (such as phosphate from detergents, aromatic hydrocarbons from motor vehicles, or oil and grease from dirty hands). Decontamination will be conducted in accordance with RFETS SOPs.

### 4.5.5 Investigation-Derived Waste (IDW)

IDW that will accumulate during groundwater monitoring includes decontamination and purge water. The management of IDW will be conducted in accordance with RFETS SOPs.

## 4.6 LABORATORY PROCEDURES SUMMARY

Analytical methodologies and reporting limits (RLs), data reporting procedures, laboratory QA/QC procedures, laboratory data validation and contractor validation procedures are to be conducted in accordance with EPA-approved methods. Groundwater samples will be submitted to an EPA-approved analytical laboratory for the following analyses:

- SW-846 Method 8260B – Volatile Organic Compounds
- SW-846 Method 6010B – Metals
- SW-846 Method 7470A – Mercury

Prior to implementing procedures, the laboratory will perform an initial demonstration of proficiency as specified in the method. Once the procedure is properly understood by the analyst

and acceptable quality control data (precision and accuracy) are achieved, the method is placed in the laboratory for use.

Sample results are reported according to laboratory analytical method SOPs or contract specifications. The laboratory will report any analyte of interest detected at or above the RL as a positive value. Any analyte of interest not detectable or detected below the RL will be reported as "not detected" at the RL or an estimated value between the RL and the instrument or method detection limit. Data are generally reported in a tabular format or posted on maps and figures. RLs are adjusted for dilution when necessary.

## 4.7 REPORTING AND SCHEDULE

Groundwater monitoring results will be included in the Annual Present Landfill Monitoring Reports discussed in Section 6.0. Groundwater monitoring will be conducted on a quarterly basis.

# 5.0 PRESENT LANDFILL SEEP AND EAST LANDFILL POND ENVIRONMENTAL MONITORING PLAN

As part of Present Landfill closure, a passive seep interception and treatment system has been installed to treat landfill seep water and GWIS water. Effluent for the treatment system eventually flows to the East Landfill Pond. This section presents the monitoring plan for seep influent and effluent as well as East Landfill Pond sampling if the seep effluent exceeds standards.

## 5.1 PURPOSE AND REQUIREMENTS

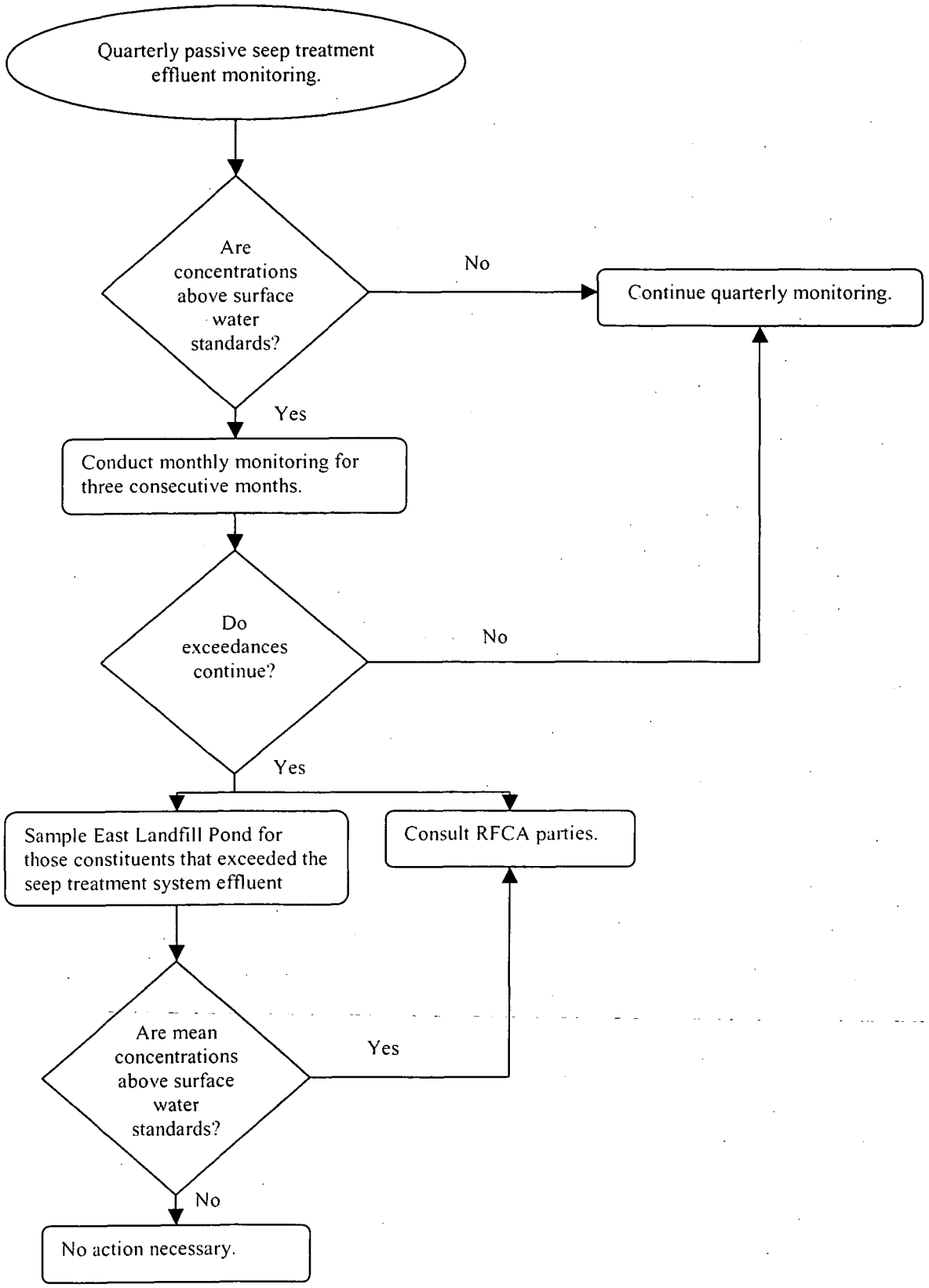
The Present Landfill Seep and East Landfill Pond Monitoring Plan has been implemented to determine surface water quality impacts of the landfill (IM/IRA [Kaiser-Hill 2004]). Applicable surface water standards are listed in the RFCA, Attachment 5, Table 1.

As detailed in the IM/IRA, seep monitoring requirements will consist of quarterly monitoring until the first CERCLA review. A validated exceedance of an effluent limit will trigger monthly monitoring for three consecutive months. Continued exceedances during the three-month period will trigger consultation between the RFCA parties to determine whether a change in the remedy is required, additional parameters need to be analyzed, or a different sampling frequency is required. Continued exceedances will also trigger sampling of the East Landfill Pond for those constituents that exceeded in the effluent. If surface water standards are exceeded in the pond, RFCA parties will be consulted to determine if further sampling is required, if the water in the pond can overflow the East Landfill Pond dam spillway (Figure 5-1), or if another water management strategy should be applied (IM/IRA).

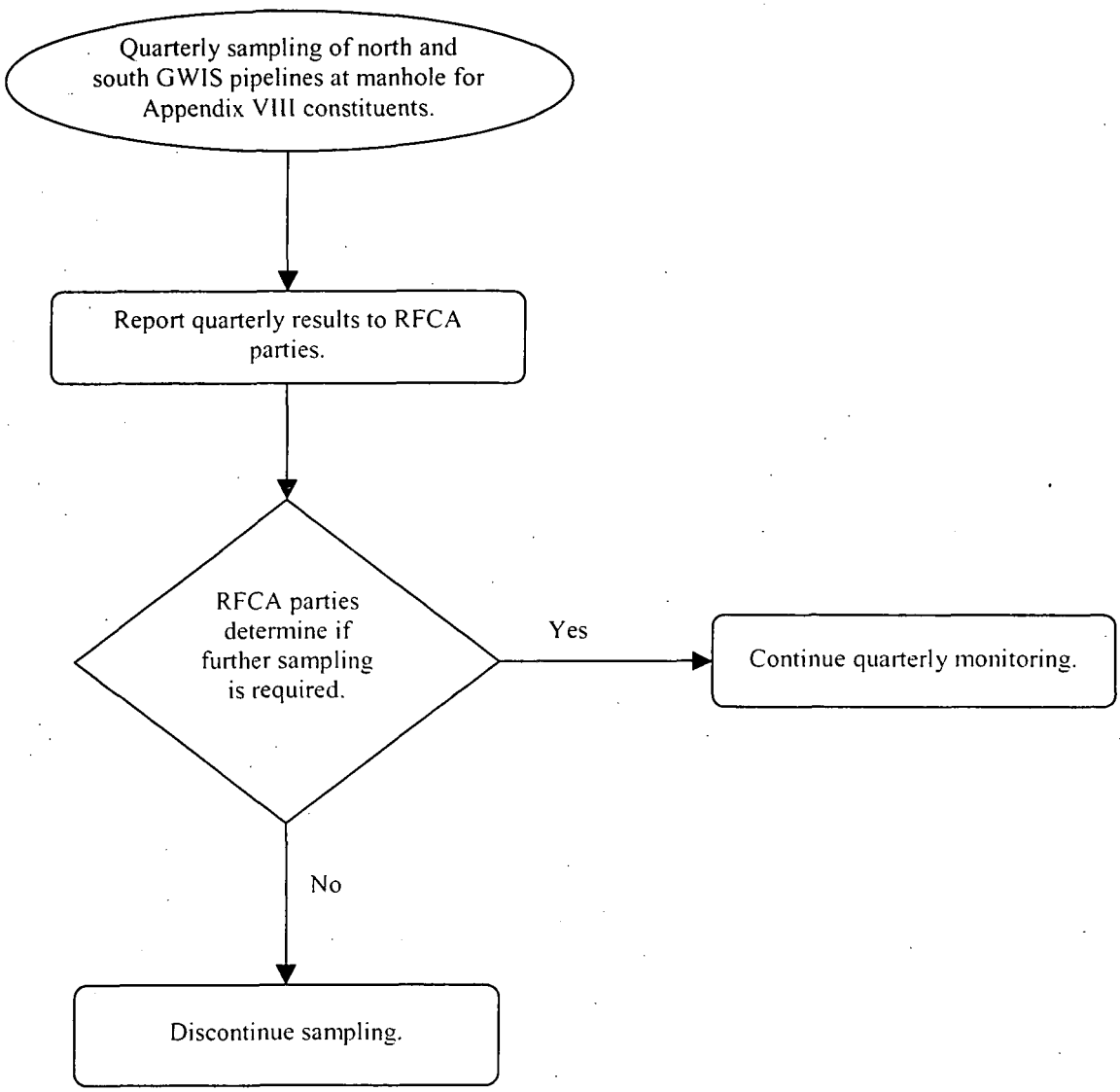
The GWIS influent (if any) into the seep treatment system will also be sampled. The water will be sampled for one year, and the analytical results will be evaluated by the RFCA parties.

## 5.2 DATA QUALITY OBJECTIVES

Surface water monitoring DQO information can be found in the IMP, Section 2 (Rocky Flats 2005). The following flowchart will be used to guide the decision statement for seep and pond sampling.


Quarterly passive seep treatment effluent monitoring.
Are concentrations above surface water standards?
No
Continue quarterly monitoring.
Yes
Conduct monthly monitoring for three consecutive months.
Do exceedances continue?
No
Yes
Sample East Landfill Pond for those constituents that exceeded the seep treatment system effluent
Consult RFCA parties.
Are mean concentrations above surface water standards?
Yes
No
No action necessary.

The following flow chart will be used to guide the decision statement for GWIS sampling:



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## 5.3 SAMPLE LOCATIONS

Sampling will be conducted at both the influent and effluent of the seep treatment system as well as at the GWIS influent flow (Figure 5-1). Flow of the seep will be manually measured (calibrated bucket and stop watch). GWIS influent also enters the manhole at two locations, and both will be sampled at the manhole. The effluent sample will be taken from the base of the treatment unit or after the last step.

If East Landfill Pond sampling is required as discussed in Section 5.1, a sample will be taken near the pond discharge location (Figure 5-1).

## 5.4 LANDFILL SEEP AND EAST LANDFILL POND SAMPLE PARAMETERS

Seep samples will be submitted for laboratory analysis of analytes inclusive of those listed in Table 5-1, which were established in the IM/IRA, Appendix A. If necessary, East Landfill Pond samples will be sampled for those constituents that exceeded in the seep sample as discussed in Section 5.2. GWIS samples will be submitted for analytes listed in 40 Code of Federal Regulations Part 261 Appendix VIII.

## 5.5 SAMPLING PROCEDURES SUMMARY

The following sections detail the sampling procedures that will be used to monitor seep treatment system influent, GWIS influent, and seep treatment system effluent and the East Landfill Pond sampling, if necessary. QC field samples, decontamination procedures, sample identification, and sample handling procedures are identical to those of the groundwater sampling.

### 5.5.1 Sampling Procedures

#### 5.5.1.1 Landfill Seep

When sampling the landfill seep treatment system, samples shall be taken in the following order to prevent disturbances from upgradient samples:

1. Seep treatment system effluent sample,
2. Seep treatment system influent sample, and
3. GWIS influent flow samples (north and south).

When taking effluent samples, direct dipping of the sample containers without preservatives into the water to be sampled is desirable. Effluent samples that are to be preserved with chemical additives shall be collected using a properly decontaminated dipper, filtered if so specified, and poured into the sample container already containing the proper chemical preservative. Teflon® or stainless steel vessels may be used to collect samples from the effluent. The influent samples shall be taken by placing the sample containers directly under discharge location inside the treatment system. Separate GWIS samples will be taken from the north and south manholes.

#### 5.5.1.2 East Landfill Pond

Pond water will be sampled using a pond sampler device. The collection suite will be dependant on effluent exceedances. The pond sampler can be purchased or simply fabricated with the following parts:

- One 250-milliliter (ml) polypropylene beaker (laboratory supply store),
- Adjustable clamp sized for 250-ml beakers (laboratory supply store),
- Aluminum telescoping tube equipped with bolt holes (swimming supply store), and
- Nuts/bolts to attached clamp to telescoping tube (hardware store).

Pond water from the sampler device will be poured directly into the sample containers. The device must be decontaminated in accordance with Section 4.5.4 between samples.

## 5.6 LABORATORY PROCEDURES SUMMARY

Analytical methodologies and RLs, data reporting procedures, laboratory QA/QC procedures, and laboratory data validation and contractor validation procedures are similar to that for groundwater sampling and provided in Section 4.6.

## 5.7 REPORTING AND SCHEDULE

Landfill seep and East Landfill Pond sampling results will be included in the Annual Present Landfill Monitoring Reports discussed in Section 6.0. Sampling will be conducted on a quarterly basis.

## 5.8 SEEP TREATMENT SYSTEM INSPECTIONS

During sampling of the passive seep treatment system, the system components will be inspected to ensure proper operation. The treatment system is shown on Figure 5-1 and includes the following components:

- Previous seep treatment system influent pipe;
- East face strip drain influent pipe;
- Concrete manholes (two);
- GWIS influent pipes (two);
- Treatment unit influent pipes (two);
- Treatment unit, which includes 10 steps; and
- Treatment unit effluent pipe.

The concrete manholes and treatment unit will be inspected for signs of damage as will the piping contained within. The influent and effluent pipes within the manhole and the treatment system effluent pipe will be inspected for signs of blockage.

# 6.0 REPORTING AND CONTACT INFORMATION

## 6.1 REPORTING

The complete Annual Present Landfill Monitoring Report, including inspection results, repairs, groundwater monitoring data, landfill seep monitoring data, and East Landfill Pond monitoring data if applicable, will be submitted to RFCA parties. Any maintenance actions during the year will be detailed in the report. If conditions appear that are of concern and that require immediate attention, RFCA parties will be notified immediately. The Annual Present Landfill Monitoring Report will include at a minimum:

- Quarterly inspection forms, including vegetation information;
- Notations of problems, action taken, maintenance or repairs as a result of the quarterly inspection;
- Any deviations from the Plan and the rationale for such deviations;
- Summary of monitoring locations;
- Tables with depth to water, well elevations, and groundwater elevations;
- Table with groundwater results and associated qualifiers;
- Tables with seep sampling results and associated qualifiers;
- Tables with GWIS sampling results (first year only);
- Tables with East Landfill Pond sampling results if applicable;
- Figures with groundwater monitoring points, East Landfill Pond monitoring points, and location(s) of problems and/or repairs; and
- Groundwater and seep water sampling forms.

## 6.2 CONTACT INFORMATION

The point of contact and contact information for the Present Landfill during the monitoring and maintenance phase is as follows:

Scott Surovchak/Department of Energy
Rocky Flats Project Office
12101 Airport Way, Unit A
Broomfield, CO 80021-2583
303-966-3551

# 7.0 REFERENCES

Earth Tech, Inc. 2004. *Final Design Analysis and Design Calculations, Accelerated Action Design for the Present Landfill.* October.

Environmental Protection Agency. 2002 *Technical Guidance for RCRA/CERCLA Final Covers.* April

Kaiser-Hill Company L.L.C. 2004. *Final Interim Measure/Interim Remedial Action for IHSS 114 and RCRA Closure for the RFETS Present Landfill.* August.

Rocky Flats. 2005. *RFETS Integrated Monitoring Plan FY2005, Revision 1 Background Document.* September.



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# TABLES

TABLE 4-1
GROUNDWATER MONITORING WELLS
PRESENT LANDFILL
1 OF 1

| Well ID | Type | Installation Date | Screen Length (feet) | Borehole Depth (feet bgs) | Well Diameter (inches) | Depth to Top of Screen (feet bgs) | Depth to Bedrock (feet bgs) |
|---|---|---|---|---|---|---|---|
| 70193 | Upgradient | 1/15/93 | 15 | 39.4 | 2 | 22.30 | 19.50 |
| 70393 | Upgradient | 2/2/93 | 15 | 26.0 | 2 | 7.80 | 22.80 |
| 70693 | Upgradient | 12/4/92 | 20 | 30.3 | 2 | 8.50 | 28.50 |
| 73005 | Downgradient | 6/27/05 | 20 | 28.0 | 2 | 4.60 | 0.00 |
| 73105 | Downgradient | 6/27/05 | 20 | 27.7 | 2 | 5.65 | 12.50 |
| 73205 | Downgradient | 6/27/05 | 25 | 32.0 | 2 | 4.55 | 4.20 |

Notes:
bgs below ground surface

**TABLE 4-2**
**GROUNDWATER SAMPLING PARAMETERS**
**PRESENT LANDFILL**


| Parameter ID | Parameter Name |
|---|---|
| **ORGANICS** | |
| | ***Volatile Organic Compounds*** |
| 67-64-1 | Acetone |
| 71-43-2 | Benzene |
| 108-86-1 | Bromobenzene |
| 74-97-5 | Bromochloromethane |
| 75-27-4 | Bromodichloromethane |
| 75-25-2 | Bromoform |
| 74-83-9 | Bromomethane |
| 78-93-3 | 2-Butanone (MEK) |
| 104-51-8 | n-Butylbenzene |
| 135-98-8 | sec-Butylbenzene |
| 98-06-6 | tert-Butylbenzene |
| 75-15-0 | Carbon Disulfide |
| 56-23-5 | Carbon Tetrachloride |
| 108-90-7 | Chlorobenzene |
| 75-00-3 | Chloroethane |
| 67-66-3 | Chloroform |
| 74-87-3 | Chloromethane |
| 95-49-8 | 2-Chlorotoluene |
| 106-43-4 | 4-Chlorotoluene |
| 96-12-8 | 1,2-Dibromo-3-chloropropane |
| 124-48-1 | Dibromochloromethane |
| 106-93-4 | 1,2-Dibromomethane (EDB) |
| 74-95-3 | Dibromomethane |
| 95-50-1 | 1,2-Dichlorobenzene |
| 541-73-1 | 1,3-Dichlorobenzene |
| 106-46-7 | 1,4-Dichlorobenzene |
| 75-71-8 | Dichlorodifluoromethane |
| 75-34-3 | 1,1-Dichloroethane |
| 107-06-2 | 1,2-Dichloroethane |
| 75-35-4 | 1,1-Dichloroethylene |
| 156-59-2 | cis-1,2-Dichloroethylene |
| 156-60-5 | trans-1,2-Dichloroethylene |
| 78-87-5 | 1,2-Dichloropropane |
| 142-28-9 | 1,3-Dichloropropane |
| 594-20-7 | 2,2-Dichloropropane |
| 563-58-6 | 1,1-Dichloropropene |
| 10061-01-5 | cis-1,3-Dichloropropene |
| 10061-02-6 | trans-1,3-Dichloropropene |

TABLE 4-2
GROUNDWATER SAMPLING PARAMETERS
PRESENT LANDFILL


| Parameter ID | Parameter Name |
|---|---|
| 100-41-4 | Ethyl Benzene |
| 87-68-3 | Hexachlorobutadiene |
| 591-78-6 | 2-Hexanone |
| 98-82-8 | Isopropylbenzene |
| 99-87-6 | p-Isopropyltoluene |
| 108-10-1 | 4-Methyl-2-pentanone (MIBK) |
| 75-09-2 | Methylene Chloride |
| 91-20-3 | Napthalene |
| 103-65-1 | n-Propylbenzene |
| 100-42-5 | Styrene |
| 630-20-6 | 1,1,1,2-Tetrachloroethane |
| 79-34-5 | 1,1,2,2-Tetrachloroethane |
| 127-18-4 | Tetrachloroethylene |
| 108-88-3 | Toluene |
| 87-61-6 | 1,2,3-Trichlorobenzene |
| 120-82-1 | 1,2,4-Trichlorobenzene |
| 71-55-6 | 1,1,1-Trichloroethane |
| 79-00-5 | 1,1,2-Trichloroethane |
| 79-01-6 | Trichloroethylene |
| 75-69-4 | Trichlorofluoromethane |
| 96-18-4 | 1,2,3-Trichloropropane |
| 76-13-1 | 1,1,2-Trichlorotrifluoroethane |
| 95-63-6 | 1,2,4-Trimethylbenzene |
| 108-67-8 | 1,3,5-Trimethylbenzene |
| 75-01-4 | Vinyl Chloride |
| 1330-20-7 | Xylenes |
| **INORGANICS** | |
| | ***Metals*** |
| 7429-90-5 | Aluminum |
| 7440-36-0 | Antimony |
| 7440-38-2 | Arsenic |
| 7440-39-3 | Barium |
| 7440-41-7 | Beryllium |
| 7440-43-9 | Cadmium |
| 7440-70-2 | Calcium |
| 7440-47-3 | Chromium |
| 7440-48-4 | Cobalt |
| 7440-50-8 | Copper |
| 7439-89-6 | Iron |
| 7439-92-1 | Lead |
| 7439-93-2 | Lithium |
| 7439-95-4 | Magnesium |

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TABLE 4-2
GROUNDWATER SAMPLING PARAMETERS
PRESENT LANDFILL


| Parameter ID | Parameter Name |
|---|---|
| 7439-96-5 | Manganese |
| 7439-97-6 | Mercury |
| 7439-98-7 | Molybdenum |
| 7440-02-0 | Nickel |
| 7440-09-7 | Potassium |
| 7782-49-2 | Selenium |
| 7440-22-4 | Silver |
| 7440-23-5 | Sodium |
| 7440-24-6 | Strontium |
| 7440-28-0 | Thallium |
| 7440-31-5 | Tin |
| 11-09-6 | Uranium |
| 7440-62-2 | Vanadium |
| 7440-66-6 | Zinc |

TABLE 5-1
SEEP SAMPLING PARAMETERS
PRESENT LANDFILL


| Parameter ID | Parameter Name | RFETS Standard (µg/L) |
|---|---|---|
| **ORGANICS** | | |
| | ***Volatile Organic Compounds*** | |
| 67-64-1 | Acetone | |
| 71-43-2 | Benzene | 2.2 (W+F) Segment 4a & 4b (lowest)<br>5 Segment 5 |
| 108-86-1 | Bromobenzene | |
| 74-97-5 | Bromochloromethane | |
| 75-27-4 | Bromodichloromethane | |
| 75-25-2 | Bromoform | |
| 74-83-9 | Bromomethane | |
| 78-93-3 | 2-Butanone (MEK) | |
| 104-51-8 | n-Butylbenzene | |
| 135-98-8 | sec-Butylbenzene | |
| 98-06-6 | tert-Butylbenzene | |
| 75-15-0 | Carbon Disulfide | |
| 56-23-5 | Carbon Tetrachloride | 0.23 (W+F) Segment 4a & 4b (lowest)<br>5 Segment 5 |
| 108-90-7 | Chlorobenzene | |
| 75-00-3 | Chloroethane | |
| 67-66-3 | Chloroform | 3.4 (W+F) (lowest) |
| 74-87-3 | Chloromethane | |
| 95-49-8 | 2-Chlorotoluene | |
| 106-43-4 | 4-Chlorotoluene | |
| 96-12-8 | 1,2-Dibromo-3-chloropropane | |
| 124-48-1 | Dibromochloromethane | |
| 106-93-4 | 1,2-Dibromomethane (EDB) | |
| 74-95-3 | Dibromomethane | |
| 95-50-1 | 1,2-Dichlorobenzene | |
| 541-73-1 | 1,3-Dichlorobenzene | |
| 106-46-7 | 1,4-Dichlorobenzene | |
| 75-71-8 | Dichlorodifluoromethane | |
| 75-34-3 | 1,1-Dichloroethane | |
| 107-06-2 | 1,2-Dichloroethane | |
| 75-35-4 | 1,1-Dichloroethylene | |
| 156-59-2 | cis-1,2-Dichloroethylene | 70 (WS) |
| 156-60-5 | trans-1,2-Dichloroethylene | |
| 78-87-5 | 1,2-Dichloropropane | |
| 142-28-9 | 1,3-Dichloropropane | |
| 594-20-7 | 2,2-Dichloropropane | |
| 563-58-6 | 1,1-Dichloropropene | |
| 10061-01-5 | cis-1,3-Dichloropropene | |
| 10061-02-6 | trans-1,3-Dichloropropene | |

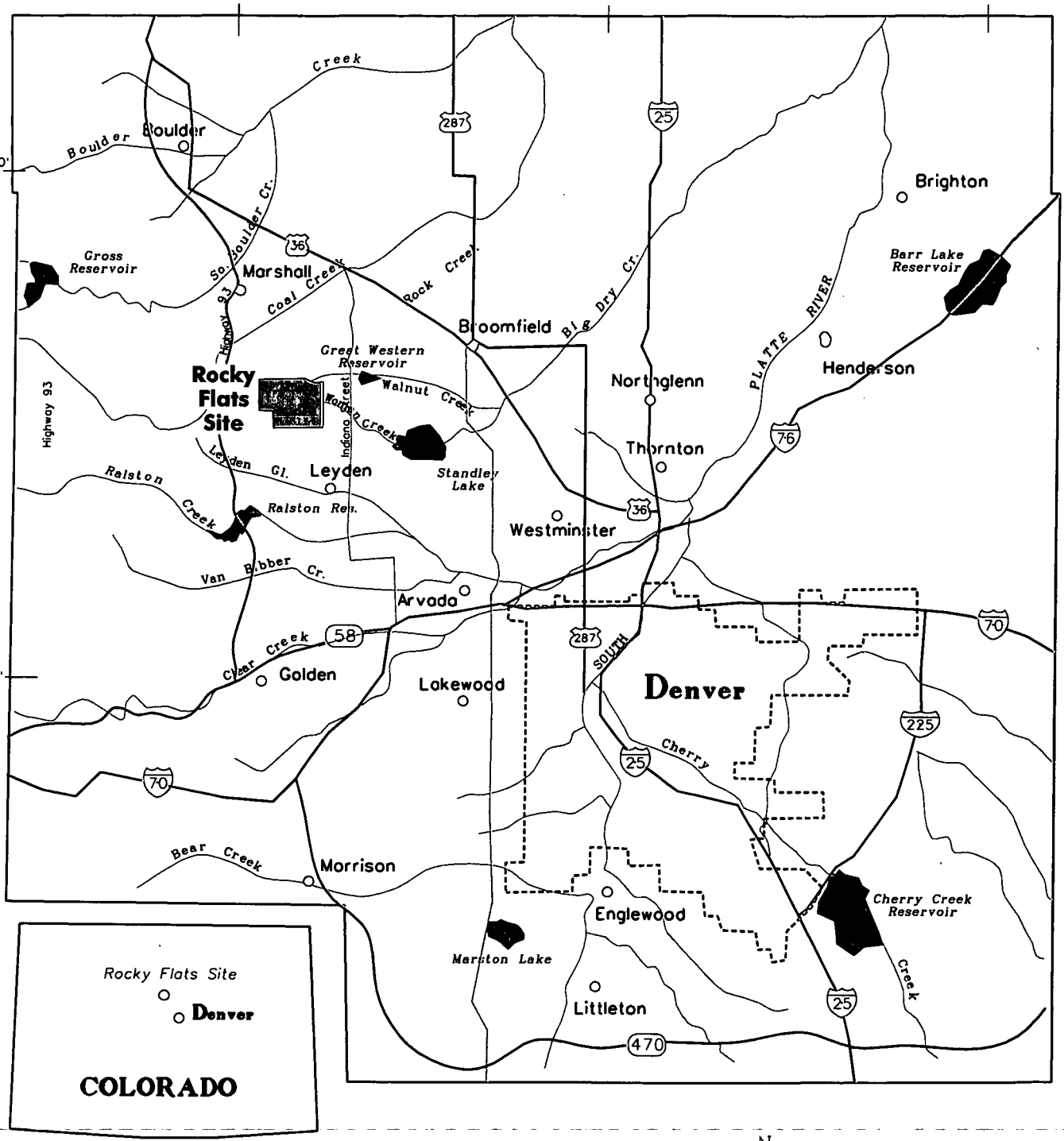
TABLE 5-1
SEEP SAMPLING PARAMETERS
PRESENT LANDFILL


| Parameter ID | Parameter Name | RFETS Standard (µg/L) |
|---|---|---|
| 100-41-4 | Ethyl Benzene | |
| 87-68-3 | Hexachlorobutadiene | |
| 591-78-6 | 2-Hexanone | |
| 98-82-8 | Isopropylbenzene | |
| 99-87-6 | p-Isopropyltoluene | |
| 108-10-1 | 4-Methyl-2-pentanone (MIBK) | |
| 75-09-2 | Methylene Chloride | 4.6 (W+F) (lowest) |
| 91-20-3 | Napthalene | |
| 103-65-1 | n-Propylbenzene | |
| 100-42-5 | Styrene | |
| 630-20-6 | 1,1,1,2-Tetrachloroethane | |
| 79-34-5 | 1,1,2,2-Tetrachloroethane | |
| 127-18-4 | Tetrachloroethylene | 0.69 (W+F) Segment 4a & 4b (lowest)<br>5 Segment 5 |
| 108-88-3 | Toluene | |
| 87-61-6 | 1,2,3-Trichlorobenzene | |
| 120-82-1 | 1,2,4-Trichlorobenzene | |
| 71-55-6 | 1,1,1-Trichloroethane | |
| 79-00-5 | 1,1,2-Trichloroethane | |
| 79-01-6 | Trichloroethylene | 2.5 (W+F) Segment 4a & 4b (lowest)<br>5 Segment 5 |
| 75-69-4 | Trichlorofluoromethane | |
| 96-18-4 | 1,2,3-Trichloropropane | |
| 76-13-1 | 1,1,2-Trichlorotrifluoroethane | |
| 95-63-6 | 1,2,4-Trimethylbenzene | |
| 108-67-8 | 1,3,5-Trimethylbenzene | |
| 75-01-4 | Vinyl Chloride | 0.023 (W+F) (lowest) |
| 1330-20-7 | Xylenes | |
| **INORGANICS** | | |
| | ***Metals*** | |
| 7429-90-5 | Aluminum | None promulgated |
| 7440-36-0 | Antimony | None promulgated |
| 7440-38-2 | Arsenic | 50 (ac) (TREC) |
| 7440-39-3 | Barium | None promulgated |
| 7440-41-7 | Beryllium | 4 (ch) (D) |
| 7440-43-9 | Cadmium | 1.5 (ch) (D) |
| 7440-70-2 | Calcium | |
| 7440-47-3 | Chromium III, Chromium VI | 50 (ac) (TREC), 11 (ch) (D) |
| 7440-48-4 | Cobalt | |
| 7440-50-8 | Copper | 16 (ch) (D) |
| 7439-89-6 | Iron | 1,000 (ch) (TREC) |
| 7439-92-1 | Lead | 6.5 (ch) (D) |

TABLE 5-1
SEEP SAMPLING PARAMETERS
PRESENT LANDFILL


| Parameter ID | Parameter Name | RFETS Standard (µg/L) |
|---|---|---|
| 7439-93-2 | Lithium | |
| 7439-95-4 | Magnesium | |
| 7439-96-5 | Manganese | 1,858 (ch) (D) |
| 7439-97-6 | Mercury | 0.01 (ch) (TOT) |
| 7439-98-7 | Molybdenum | |
| 7440-02-0 | Nickel | 123 (ch) (D) |
| 7440-09-7 | Potassium | |
| 7782-49-2 | Selenium | 4.6 (ch) (D) |
| 7440-22-4 | Silver | 0.6 (ch) (D) |
| 7440-23-5 | Sodium | |
| 7440-24-6 | Strontium | |
| 7440-28-0 | Thallium | |
| 7440-31-5 | Tin | |
| 11-09-6 | Uranium | |
| 7440-62-2 | Vanadium | See IM/IRA |
| 7440-66-6 | Zinc | 141 (ch) (D) |

# FIGURES




EARTH TECH

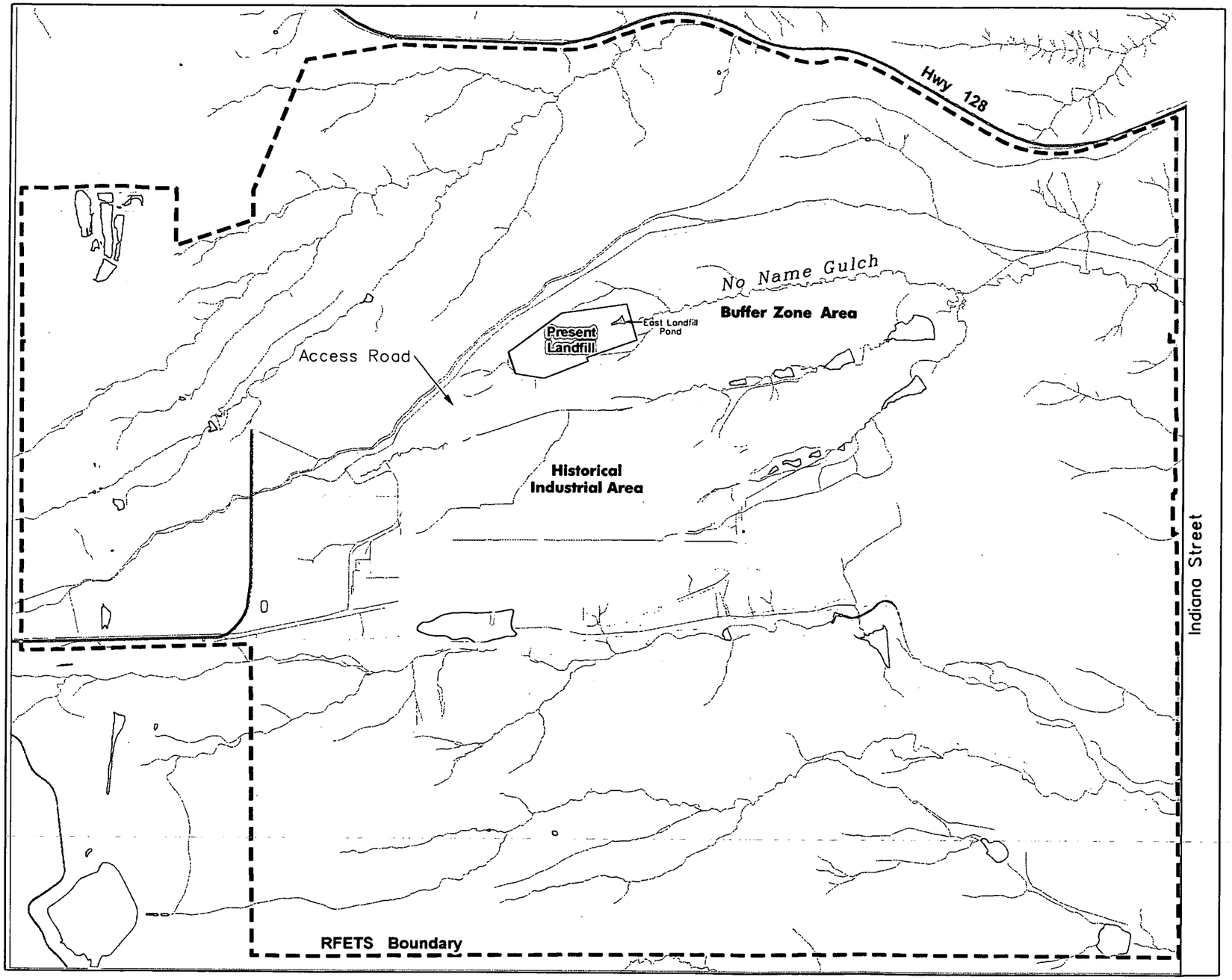
FIGURE 1-1

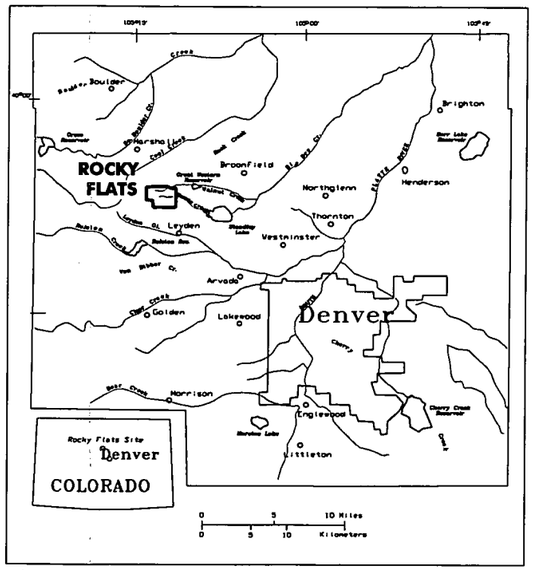
LOCATION MAP

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

CAD FILE: GRO CAD\ROCKY_FLATS\NEWDESIGN_2004\PLFMM\LOCATION.DGN

DATE: 12/8/2004




N

EARTH TECH

FIGURE 1-2

PLF SITE MAP

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

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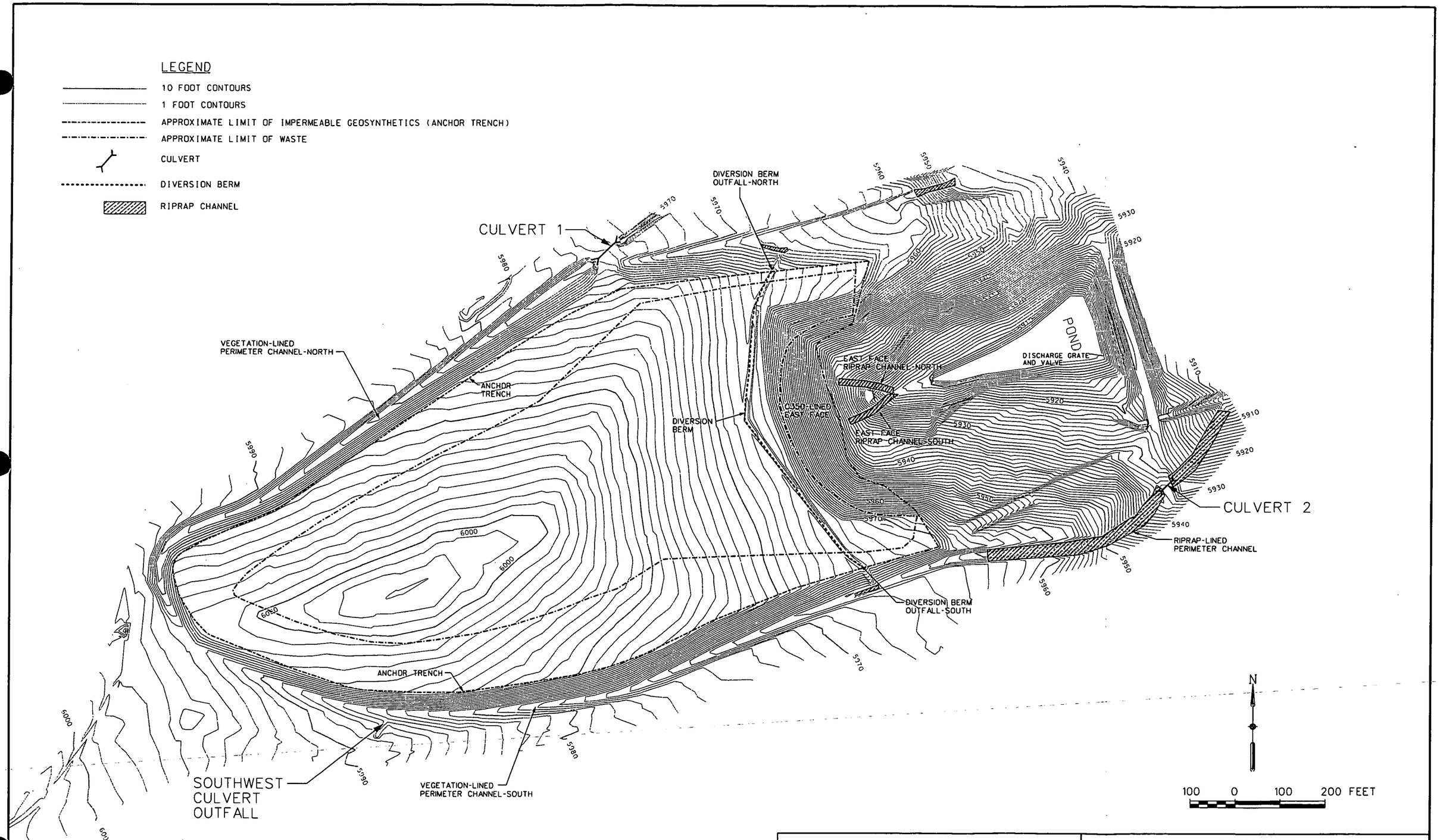


EARTH TECH

FIGURE 2-1

PLF COVER

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

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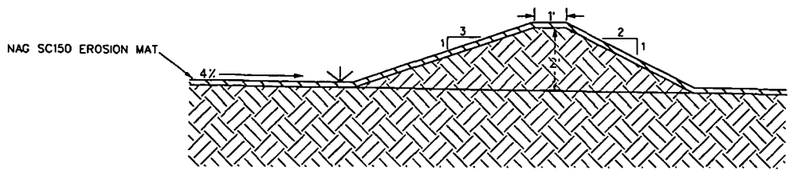
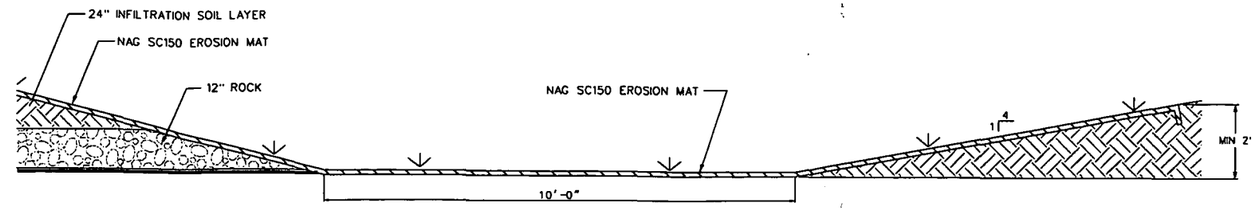
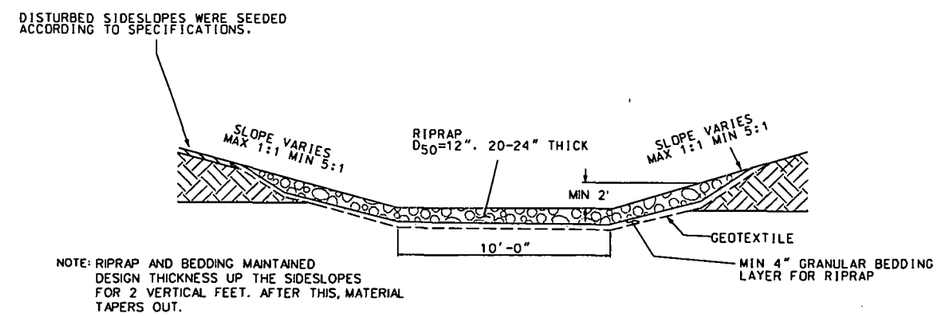


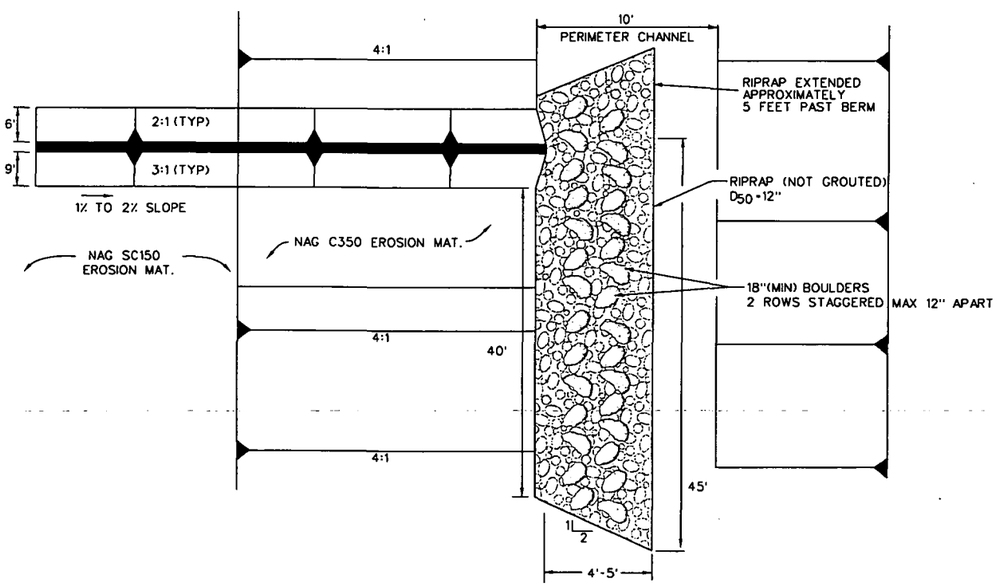

**DIVERSION BERM**
NTS



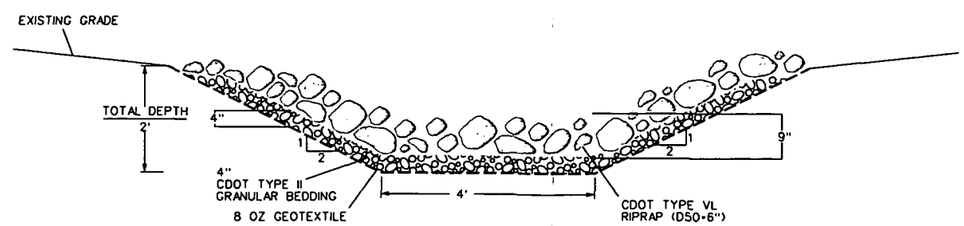

**VEGETATION-LINED PERIMETER CHANNEL**
NTS




**RIPRAP-LINED PERIMETER CHANNEL**
NTS




**DIVERSION BERM OUTFALL**
NTS




**EAST FACE RIPRAP CHANNEL SECTION**
NTS

E A R T H T E C H

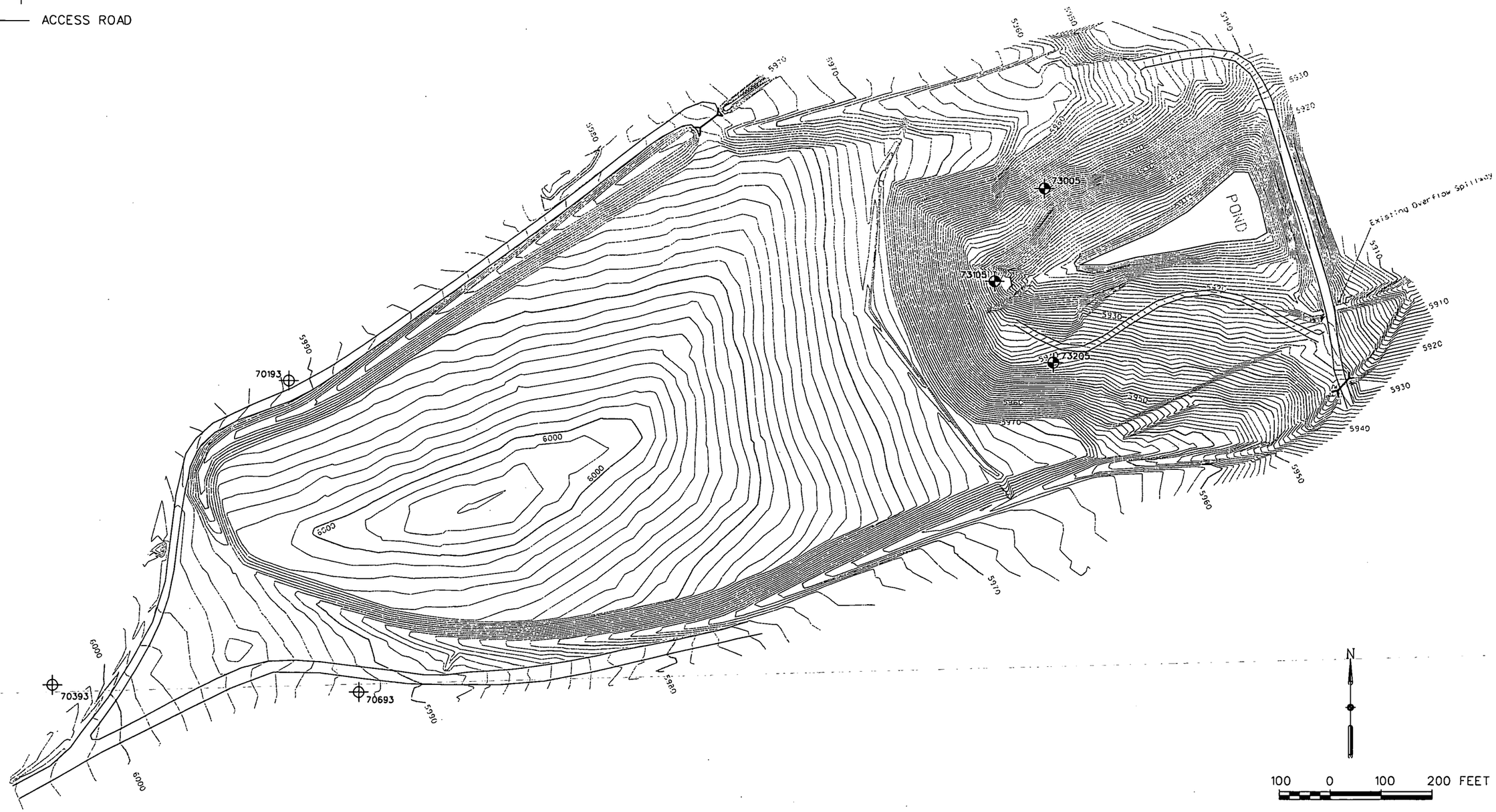
FIGURE 3-1
PLF STORMWATER MANAGEMENT STRUCTURE DETAILS
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

LEGEND

UPGRADIENT MONITORING WELLS

DOWNGRADIENT MONITORING WELLS

ACCESS ROAD




EARTH TECH

FIGURE 4-1

PLF
GROUNDWATER MONITORING WELLS

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

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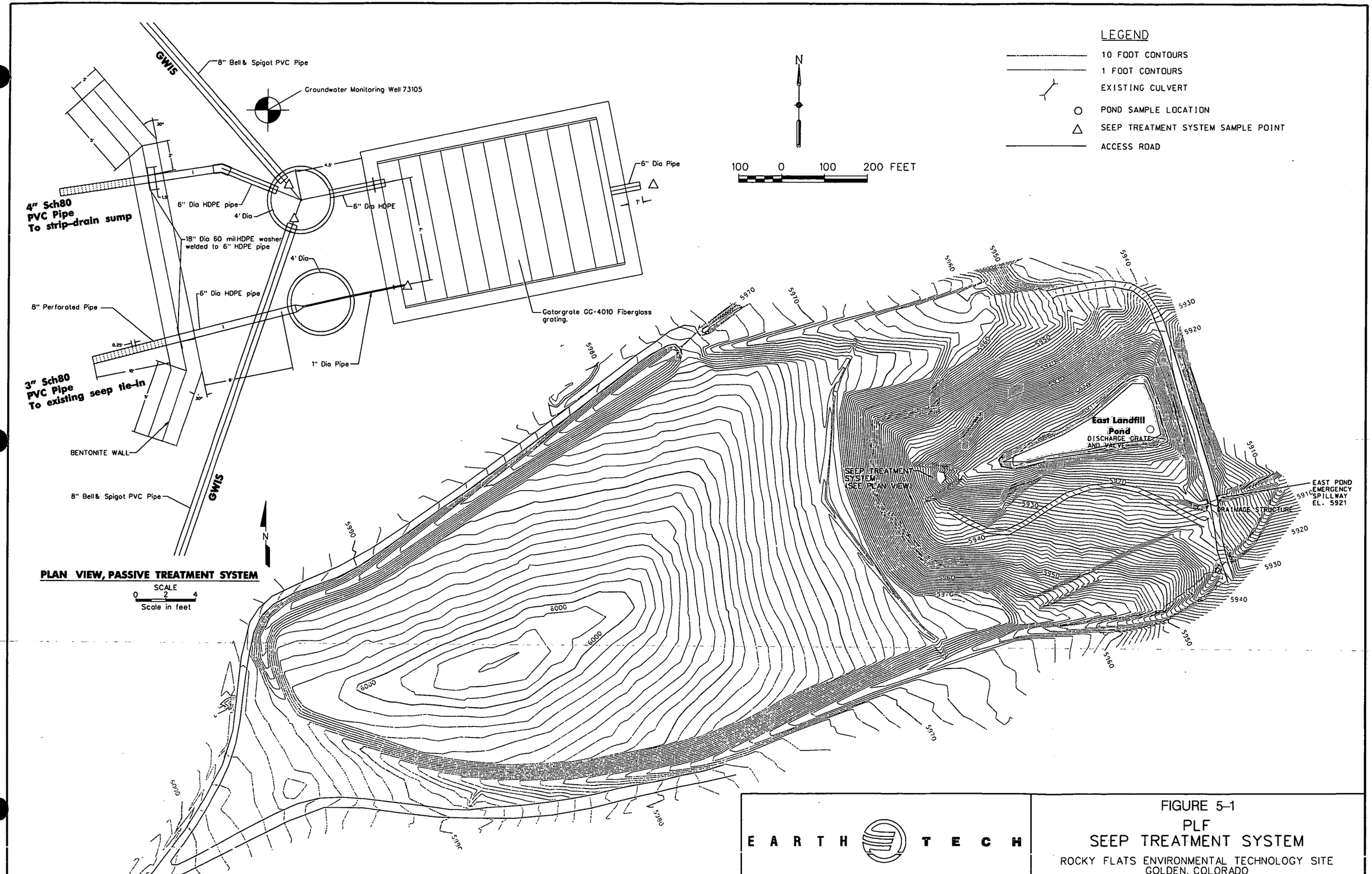


EARTH TECH

FIGURE 5-1
PLF
SEEP TREATMENT SYSTEM
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

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# APPENDIX A

# PRESENT LANDFILL INSPECTION FORM

# PRESENT LANDFILL – MONITORING AND MAINTENANCE PROGRAM

## INSPECTION FORM

INSPECTOR: _____ DATE: _____

TEMPERATURE: _____ WEATHER CONDITIONS: _____

## SUBSIDENCE / CONSOLIDATION

| REGION | EVIDENCE OF CRACKS? | EVIDENCE OF DEPRESSIONS? | EVIDENCE OF SINK HOLES? | OTHER (DESCRIBE BELOW) |
|---|---|---|---|---|
| TOP OF COVER – WEST | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| TOP OF COVER – EAST | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| COVER SIDESLOPE – NORTH | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| COVER SIDESLOPE – SOUTH | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| EAST FACE SLOPE - NORTH | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| EAST FACE SLOPE - SOUTH | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| EAST FACE SLOPE - CENTRAL | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| EAST FACE SLOPE – NORTH SEEP* | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | |

MAINTENANCE REQUIRED / COMMENTS

_____

_____

_____

* AREA OF SEEP IS OUTSIDE OF LANDFILL COVER AND EAST OF THE COVER ANCHOR TRENCH

## SLOPE STABILITY

| REGION | EVIDENCE OF CRACKS? | EVIDENCE OF BLOCK OR CIRCULAR FAILURE? | OTHER (DESCRIBE BELOW) |
|---|---|---|---|
| COVER SIDESLOPE – NORTH | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| COVER SIDESLOPE – SOUTH | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| PERIMETER CHANNEL OUTER SLOPE – NORTH | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| PERIMETER CHANNEL OUTER SLOPE – SOUTH | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| EAST FACE SLOPE - NORTH | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| EAST FACE SLOPE - SOUTH | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| EAST FACE SLOPE - CENTRAL | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| EAST FACE SLOPE – NORTH SEEP* | ☐ Yes ☐ No | ☐ Yes ☐ No | |

MAINTENANCE REQUIRED / COMMENTS

* AREA OF SEEP IS OUTSIDE OF LANDFILL COVER AND EAST OF THE COVER ANCHOR TRENCH

## SOIL COVER

| REGION | EVIDENCE OF SOIL DEPOSITION OR EROSION? | EVIDENCE OF EROSION RILLS/GULLIES? | EVIDENCE OF BURROWING ANIMALS? | OTHER (DESCRIBE BELOW) |
|---|---|---|---|---|
| TOP OF COVER – WEST | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| TOP OF COVER – EAST | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| COVER SIDESLOPE – NORTH | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| COVER SIDESLOPE – SOUTH | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| EAST FACE SLOPE - NORTH | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| EAST FACE SLOPE - SOUTH | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| EAST FACE SLOPE - CENTRAL | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | |

MAINTENANCE REQUIRED / COMMENTS

## VEGETATION

| REGION | CONDITION OF GRASS | UNWANTED VEGETATION PRESENT*? | OTHER (DESCRIBE BELOW) |
|---|---|---|---|
| TOP OF COVER- WEST | | ☐ Yes ☐ No | |
| TOP OF COVER - EAST | | ☐ Yes ☐ No | |
| EAST FACE SLOPE - NORTH | | ☐ Yes ☐ No | |
| EAST FACE SLOPE - SOUTH | | ☐ Yes ☐ No | |
| EAST FACE SLOPE - CENTRAL | | ☐ Yes ☐ No | |
| COVER SIDESLOPE – NORTH | | ☐ Yes ☐ No | |
| COVER SIDESLOPE – SOUTH | | ☐ Yes ☐ No | |
| VEGETATION-LINED PERIMETER CHANNEL – NORTH | | ☐ Yes ☐ No | |
| VEGETATION-LINED PERIMETER CHANNEL – SOUTH | | ☐ Yes ☐ No | |

* Unwanted vegetation includes weeds and deep-rooting trees.

MAINTENANCE REQUIRED / COMMENTS

## SEEP TREATMENT SYSTEM

| REGION | EVIDENCE OF PLUGGING, OBSTRUCTIONS, OR EXCESS DEBRIS? | EVIDENCE OF CRACKS OR DETERIORATION? | OTHER (DESCRIBE BELOW) |
|---|---|---|---|
| GWIS INLET PIPES | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| STRIP DRAIN INLET PIPE | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| NORTH MANHOLE OUTLET PIPE | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| SOUTH MANHOLE OUTLET PIPE | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| TREATMENT UNIT | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| TREATMENT UNIT OUTLET PIPE | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| NORTH MANHOLE | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| SOUTH MANHOLE | ☐ Yes ☐ No | ☐ Yes ☐ No | |
| TREATMENT UNIT GRATING | NA | ☐ Yes ☐ No | |

MAINTENANCE REQUIRED / COMMENTS

# STORMWATER MANAGEMENT STRUCTURES

## CHANNELS / LINING

| STRUCTURE | EVIDENCE OF EXCESSIVE EROSION, GULLYING, SCOUR, OR UNDERMINING? | EVIDENCE OF SETTLEMENT/ SUBSIDENCE OR DEPRESSIONS? | EVIDENCE OF BREACHING OR BANK FAILURE? | EVIDENCE OF BURROWING ANIMALS? | EVIDENCE OF SEDIMENT BUILD-UP OR OTHER BLOCKAGE? | EVIDENCE OF LINING DETERIORATION, HOLES, RIPS, OR SEPARATION? | EVIDENCE OF LINING DISPLACEMENT? |
|---|---|---|---|---|---|---|---|
| DIVERSION BERM | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No |
| VEGETATION-LINED PERIMETER CHANNEL – NORTH | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No |
| VEGETATION-LINED PERIMETER CHANNEL – SOUTH | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No |
| RIPRAP-LINED PERIMETER CHANNEL | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No |
| C350-LINED EAST FACE | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No |
| EAST FACE RIPRAP CHANNEL – NORTH | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No |
| EAST FACE RIPRAP CHANNEL – SOUTH | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | ☐ Yes ☐ No | |

OTHER DEFICIENCIES?

MAINTENANCE REQUIRED / COMMENTS

# STORMWATER MANAGEMENT STRUCTURES (CONTINUED)

## OUTFALLS

CHECK EACH STRUCTURE FOR EXCESSIVE EROSION AND SEDIMENT DEPTH. IF SEDIMENT DEPTH IS COMPROMISING THE DESIGN CHARACTERISTICS, REMOVE SEDIMENT.

| STRUCTURE | CONDITION / SEDIMENT DEPTH |
|---|---|
| DIVERSION BERM OUTFALL - NORTH | |
| DIVERSION BERM OUTFALL - SOUTH | |
| CULVERT 1 OUTFALL | |
| CULVERT 2 OUTFALL | |
| SOUTHWEST CULVERT OUTFALL | |

## CULVERTS

CHECK EACH STRUCTURE FOR BLOCKAGE, SURROUNDING CONDITIONS, BREACHING, SEDIMENT BUILD-UP, AND INLET/OUTLET CONDITIONS.

| STRUCTURE | CONDITION |
|---|---|
| CULVERT 1 | |
| CULVERT 2 | |
| SOUTHWEST CULVERT | |

MAINTENANCE REQUIRED

## EROSION CONTROL

| AREA | ADVERSELY AFFECTING PLF? | | |
|---|---|---|---|
| RUN-ON INTO PERIMETER CHANNEL – NORTH | ☐ Yes | ☐ No | COMMENT: |
| RUN-ON INTO PERIMETER CHANNEL – SOUTH | ☐ Yes | ☐ No | COMMENT: |
| NATURAL DRAINAGE FED BY CULVERT 1 | ☐ Yes | ☐ No | COMMENT: |
| NATURAL DRAINAGE FED BY NORTHEAST PERIMETER CHANNEL | ☐ Yes | ☐ No | COMMENT: |
| NATURAL DRAINAGE FED BY RIPRAP | ☐ Yes | ☐ No | COMMENT: |

MAINTENANCE REQUIRED

## INSTITUTIONAL CONTROLS

| ITEM | | | |
|---|---|---|---|
| EVIDENCE OF EXCAVATION(S) OF COVER AND IMMEDIATE VICINITY OF COVER? | ☐ Yes | ☐ No | COMMENT: |
| EVIDENCE OF CONSTRUCTION OF ROADS, TRAILS ON COVER OR BUILDINGS? | ☐ Yes | ☐ No | COMMENT: |
| EVIDENCE OF DRILLING OF WELLS OR USE OF GROUNDWATER? | ☐ Yes | ☐ No | COMMENT: |
| DISRUPTION OR DAMAGE OFSEEP TREATMENT SYSTEM? | ☐ Yes | ☐ No | COMMENT: |
| DAMAGE OR REMOVAL OF ANY SIGNAGE OR GROUNDWATER MONITORING WELLS? | ☐ Yes | ☐ No | COMMENT: |

OTHER DEFICIENCIES?

## ACTION ITEMS

| DEFICIENCY | DATE NOTED | ACTION | DATE COMPLETED | COMMENTS |
|---|---|---|---|---|
| | | | | |
| | | | | |
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SIGNATURE: _____ DATE: _____

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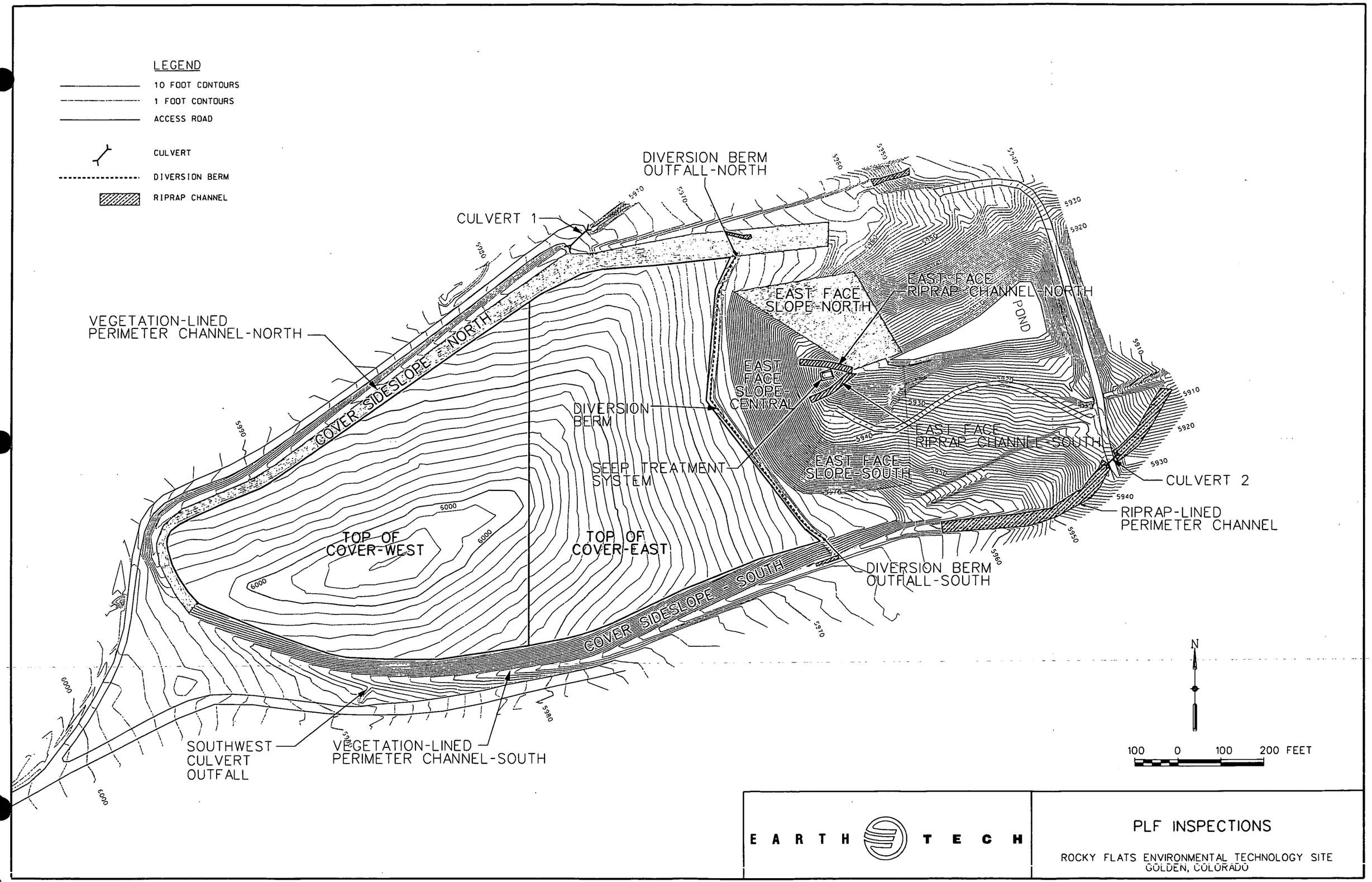


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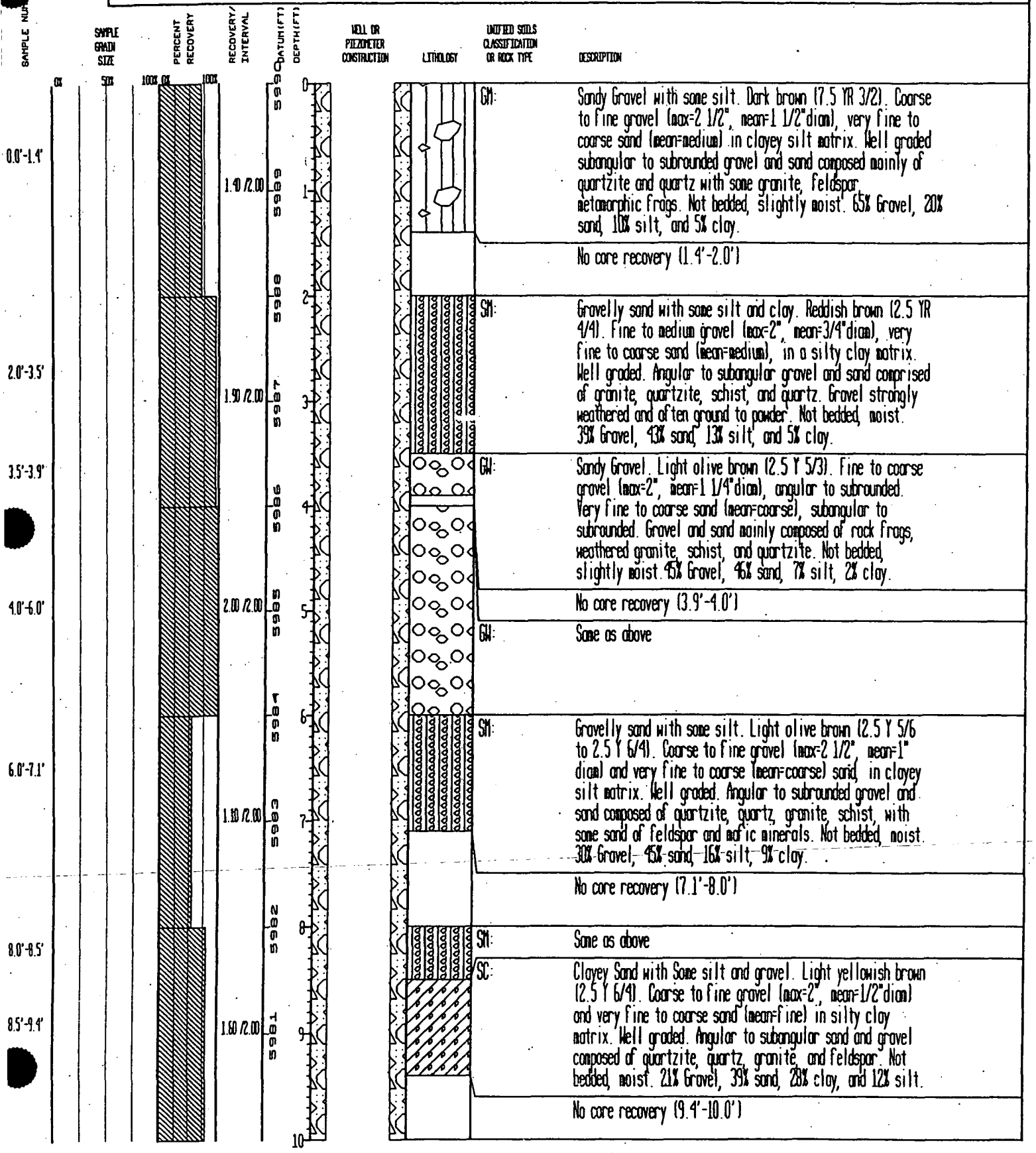
# APPENDIX B

# GROUNDWATER WELL BORING LOGS / CONSTRUCTION SUMMARIES

| | | | | | | |
|---|---|---|---|---|---|---|
| STATE PLANE COORDINATE: | TOTAL DEPTH (FT): 39.4 | GROUND ELEVATION (FT): | 5990.00 | PROJECT NUMBER: | 989073 | LOG OF BORING NUMBER: |
| NORTH: 752688 | AREA: 007 PRESENT LANDFILL | CASING DIAMETER (IN): | 2 | GEOLOGIST: | JAB/KJT | 70193 |
| EAST: 2082674 | LOCATOR NUMBER: 12J | BOREHOLE DIAMETER (IN): | 10.25 | DATE DRILLED: | 01/15/93 | |

REMARKS: MOBIL DRILL B-57; HSA, CEMENT GROUT 0.0'-19.5', BENTONITE SEAL 19.5'-21.5', SAND 21.5'-37.6', NATURAL BACK-FILL 37.6'-39.4'; CENTRALIZERS PLACED 18.5' AND 38.55'; HOLE DIAMETER 10.25" 0.0'-37.5' AND 3.0" 37.5'-39.4'; 2.0' SUMP 37.3'-39.3' DEPTH TO BEDROCK 19.5'.



| STATE PLANE COORDINATE: | | TOTAL DEPTH (FT): 39.4 | GROUND ELEVATION (FT): | 5990.00 | PROJECT NUMBER: | 989073 | LOG OF BORING NUMBER: |
|---|---|---|---|---|---|---|---|
| NORTH: | 752688 | AREA: OU7 PRESENT LANDFILL | CASING DIAMETER (IN): | 2 | GEOLOGIST: | JAB/KJT | 70193 |
| EAST: | 2082674 | LOCATOR NUMBER: 12J | BOREHOLE DIAMETER (IN): | 10.25 | DATE DRILLED: | 01/15/93 | |

REMARKS: MOBIL DRILL B-57; HSA, CEMENT GROUT 0.0'-19.5', BENTONITE SEAL 19.5'-21.5', SAND 21.5'- 37.6', NATURAL BACK- FILL 37.6'-39.4'; CENTRALIZERS PLACED 18.5' AND 38.55'; HOLE DIAMETER 10.25" 0.0'- 37.5' AND 3.0" 37.5' - 39.4'; 2.0' SUMP 37.3'- 39.3' DEPTH TO BEDROCK 19.5'.

| SAMPLE NUM. | SAMPLE GRAIN SIZE | PERCENT RECOVERY | RECOVERY/INTERVAL | DATUM (FT) | DEPTH (FT) | WELL OR PIEZOMETER CONSTRUCTION | LITHOLOGY | UNIFIED SOILS CLASSIFICATION OR ROCK TYPE | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 10 | | | | No core recovery (9.4'-10.0') |
| 10.0'-11.3' | | | 1.30 /2.00 | | 11 | | | GC: | Sandy Gravel with some clay. Light yellowish brown (2.5 Y 6/4). Coarse to fine gravel (max=2 1/2", mean=1 1/4" diam) and very fine to coarse sand (mean=fine) in silty clay matrix. Well graded. Angular to rounded gravel, some broken by drilling, subangular to subrounded sand. Gravel composed of quartzite, granite, and some schist. Sand composed of quartz, rock fragments, feldspars and micas. Not bedded, moist. 44% Gravel, 39% sand, 12% clay, and 5% silt. |
| | | | | | 12 | | | | No core recovery (11.3'-12.0') |
| 12.0'-13.9' | | | 1.90 /2.00 | | 13 | | | GC: | Sandy Gravel with some clay. Strong brown (7.5 YR 5/6). Very coarse to fine gravel (max=3", mean=1" diam) and very fine to coarse sand (mean=coarse) in silty clay matrix. Well graded angular to subrounded gravel and subangular to subrounded sand. Gravel composed of quartzite, quartz, granite, schist; sand composed of quartz, feldspar, quartzite, granite, micas and mafic minerals. Moist to wet. 45% Gravel, 32% sand, 15% clay, and 8% silt. |
| | | | | | 14 | 01/28/93 ▽ | | | No core recovery (13.9'-14.0') |
| 14.0'-15.1' | | | 1.60 /2.00 | | 15 | | | GC: | Same as above |
| 15.1'-15.6' | | | | | 15 | | | SM: | Silty Gravelly Sand. Light yellowish brown (2.5 Y 6/4) to light brown (7.5 YR 6/4). Coarse to fine gravel (max=2 1/2", mean=3/4" diam) and very fine to coarse sand (mean=coarse) in clayey silt matrix. Well graded. Angular to subrounded gravel and sand composed of quartzite, quartz, granite, and schist with some sand of feldspar, micas, mafic minerals. Not bedded, saturated. 18.5% Gravel, 55.5% sand, 20% silt, and 6% clay. |
| 16.0'-16.5' | | | | | 16 | | | | |
| 16.5'-17.7' | | | 1.70 /2.00 | | 17 | | | | No core recovery (15.6'-16.0') |
| | | | | | | | | SM: | Same as above |
| | | | | | | | | GC: | Sandy Gravel with some clay. Same as interval from 12.0' to 15.1'. |
| | | | | | 18 | | | | No core recovery (17.7'-18.0') |
| 18.0'-19.0' | | | | | | | | GC: | Same as above. Saturated. |
| 19.5' | | | 1.60 /2.00 | | 19 | | | SC: | Clayey Gravelly Sand. Light brownish gray (2.5 Y 6/2) to dark brown (7.5 YR 4/4). Fine gravel and very fine to coarse sand (mean=medium) composed of same composition as above. Decreasing sand and gravel with depth - transition to bedrock clay. Clay is of low plasticity. Crudely bedded at boundary with reworked bedrock. Moist. 10% Gravel, 45% sand, 35% clay, and 10% silt. |
| | | | | | 20 | | | | |

2

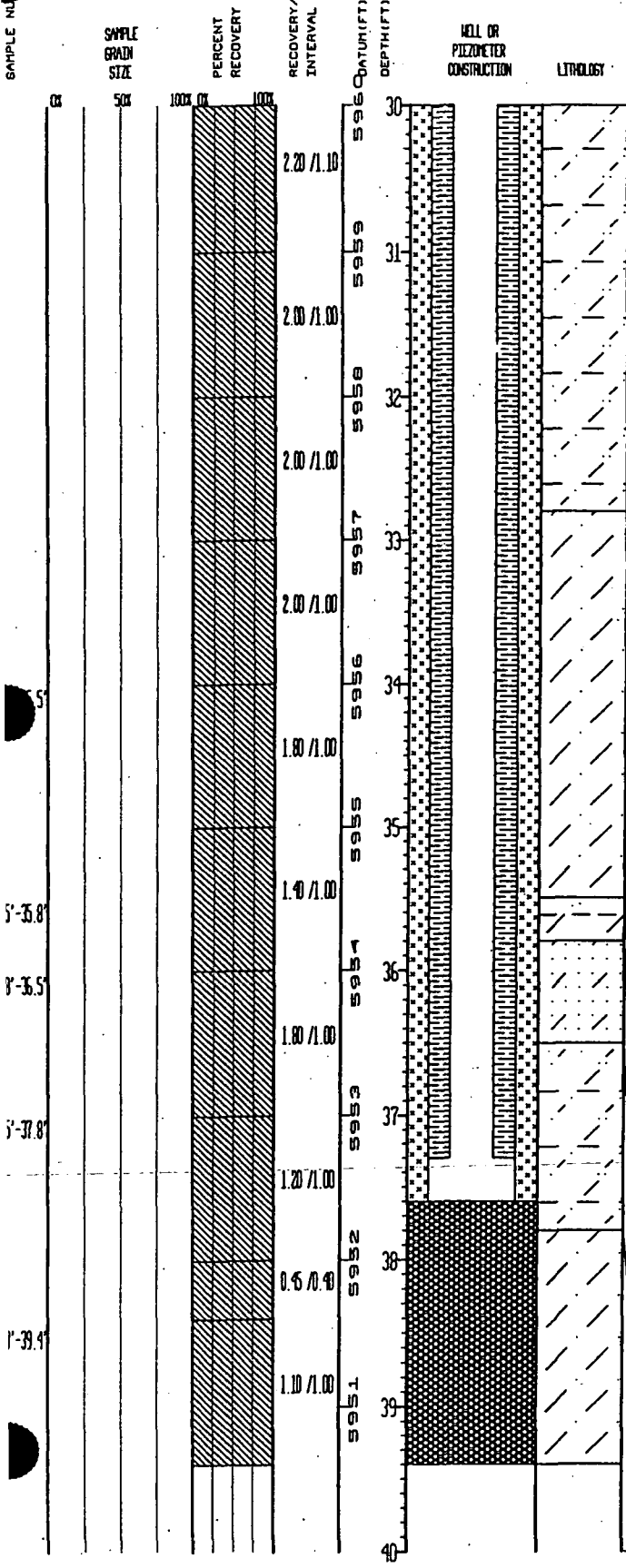
| STATE PLANE COORDINATE: | TOTAL DEPTH (FT): 39.4 | GROUND ELEVATION (FT): 5990.00 | PROJECT NUMBER: 989073 | LOG OF BORING NUMBER: |
|---|---|---|---|---|
| NORTH: 752688 | AREA: 007 PRESENT LANDFILL | CASING DIAMETER (IN): 2 | GEOLOGIST: JAB/KJT | 70193 |
| EAST: 2082674 | LOCATOR NUMBER: 12J | BOREHOLE DIAMETER (IN): 10.25 | DATE DRILLED: 01/15/93 | |

REMARKS: MOBIL DRILL B-57; HSA, CEMENT GROUT 0.0'-19.5', BENTONITE SEAL 19.5'-21.5', SAND 21.5'- 37.6', NATURAL BACK- FILL 37.6'-39.4'; CENTRALIZERS PLACED 18.5' AND 38.55'; HOLE DIAMETER 10.25" 0.0'- 37.5' AND 3.0" 37.5' - 39.4'; 2.0' SUMP 37.3'- 39.3' DEPTH TO BEDROCK 19.5'.

| SAMPLE NO. | SAMPLE GRAIN SIZE | PERCENT RECOVERY | RECOVERY/INTERVAL | DATUM (FT) | DEPTH (FT) | WELL OR PIEZOMETER CONSTRUCTION | LITHOLOGY | UNIFIED SOILS CLASSIFICATION OR ROCK TYPE | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| | 0% 50% 100% | 0% 100% | | | | | | | |
| | | | | 5970 | 20 | 01/15/93 | | SILTY CLAYSTONE | Silty Claystone with trace of very fine sand. Light olive gray (5 Y 6/2) to olive yellow (2.5 Y 6/8) where stained by fe-oxides, moderately sorted, porosity=18%, no cement, moderately to highly friable, massive claystone with mottled coloring due to weathering, increasing silt content with depth. Moist. 20% Silt and 80% clay. |
| | | | 2.00 /2.00 | 5969 | 21 | | | | |
| | | | | 5968 | 22 | | | CLAYEY SILTSTONE | Clayey Siltstone with some very fine sand. Gray (5 Y 6/1) to light yellowish brown (2.5 Y 6/4) and olive yellow (2.5 Y 6/8), moderately sorted, porosity=20%-25%, no cement, highly to moderately friable, composed of varying proportions of clay and silt, siltstone often contains up to 10% of very fine sand, mottled coloring due to weathering, thin and irregular subparallel bedding to disturbed bedding, not fractured, moist to wet. 5% Sand, 65% silt, and 30% clay. |
| | | | 2.20 /2.00 | 5967 | 23 | | | | |
| | | | | 5966 | 24 | | | | |
| | | | 1.00 /1.00 | 5965 | 25 | | | | |
| | | | 1.00 /1.00 | 5964 | 26 | | | | |
| | | | 1.40 /0.90 | 5963 | 27 | | | CLAYEY SILTSTONE | Clayey Siltstone. Light olive brown (2.5 Y 5/6) to olive yellow (2.5 Y 6/8), variable porosity 10%-25%, no cement, highly friable, silt and clay vary throughout interval but bedding is not apparent, much of core heavily damaged during drilling, mottled due to fe-oxide staining, weathered not fractured (except where damaged), moist to wet (saturated) bottom 0.5' of interval stained bright olive yellow (fe-hydroxide stain). Carbonaceous fragments present, especially from 30.0'-31.0'. 60% Silt and 40% clay. |
| | | | 1.70 /1.00 | 5962 | 28 | | | | |
| | | | 1.10 /1.00 | 5961 | 29 | | | | |
| | | | 1.70 /1.00 | | 30 | | | | |

| STATE PLANE COORDINATE: | TOTAL DEPTH (FT): 39.4 | GROUND ELEVATION (FT): 5990.00 | PROJECT NUMBER: 989073 | LOG OF BORING NUMBER: |
|---|---|---|---|---|
| NORTH: 752588 | AREA: OUT PRESENT LANDFILL | CASING DIAMETER (IN): 2 | GEOLOGIST: JAB/KJT | 70193 |
| EAST: 2082674 | LOCATOR NUMBER: 12J | BOREHOLE DIAMETER (IN): 10.25 | DATE DRILLED: 01/15/93 | |

REMARKS: MOBIL DRILL B-57; HSA, CEMENT GROUT 0.0'-19.5', BENTONITE SEAL 19.5'-21.5', SAND 21.5'- 37.6', NATURAL BACK- FILL 37.6'-39.4'; CENTRALIZERS PLACED 18.5' AND 38.55'; HOLE DIAMETER 10.25" 0.0'- 37.5' AND 3.0" 37.5' - 39.4'; 2.0" SUMP 37.3'- 39.3' DEPTH TO BEDROCK 19.5'.




**CLAYEY SILTSTONE:** Clayey Siltstone. Light olive brown (2.5 Y 5/6) to olive yellow (2.5 Y 6/8), variable porosity 10%-25%, no cement, highly friable, silt and clay vary throughout interval but bedding is not apparent, much of core heavily damaged during drilling, mottled due to Fe-oxide staining, weathered not fractured (except where damaged), moist to wet (saturated) bottom 0.5' of interval stained bright olive yellow (Fe-hydroxide stain). Carbonaceous fragments present, especially from 30.0'-31.0'. 60% Silt and 40% clay.

**SILTSTONE:** Siltstone with some clay. Light olive brown (2.5 Y 5/4) to olive yellow (2.5 Y 6/8), porosity = 20%-25%, no cement, highly to moderately friable, clay content varies, subhorizontal bedding occurs in siltiest intervals, not fractured but damaged during drilling, moist. 85% Silt and 15% clay.

**SILTY CLAYSTONE:** Silty Claystone. Dark grayish brown (2.5 Y 4/2), porosity = 10%-15%, no cement, slightly to moderately friable, grades into overlying siltstone, not bedded, not fractured but broken during drilling, slightly moist. 70% Clay and 30% sand.

**SILTY SANDSTONE:** Silty Sandstone. Light gray (5 Y 6/1) to olive yellow (2.5 Y 6/6), very fine sand, moderately sorted, porosity = 25%, no cement, highly friable, intermixed with claystone and siltstone but not bedded. 70% Sand, 25% silt, and 5% clay.

**CLAYEY SILTSTONE:** Clayey Siltstone. Dark gray (5 Y 4/1) to dark grayish brown (2.5 Y 4/2), porosity varies from 10% to 25%, no cement, slightly to moderately friable, Fe-oxide stains present but limited, thin irregular planar bedding. 60% Silt and 40% clay.

**SILTSTONE:** Siltstone with some clay. Light olive brown (2.5 Y 5/4) to gray (5 Y 5/1), porosity=20%-25%, no cement, moderately friable, clay content varies (max=25%) in thin 1" intervals within siltstone, irregular bedding, subhorizontal, not fractured, moist. 85% Silt and 15% clay.
Total Depth 39.4'.

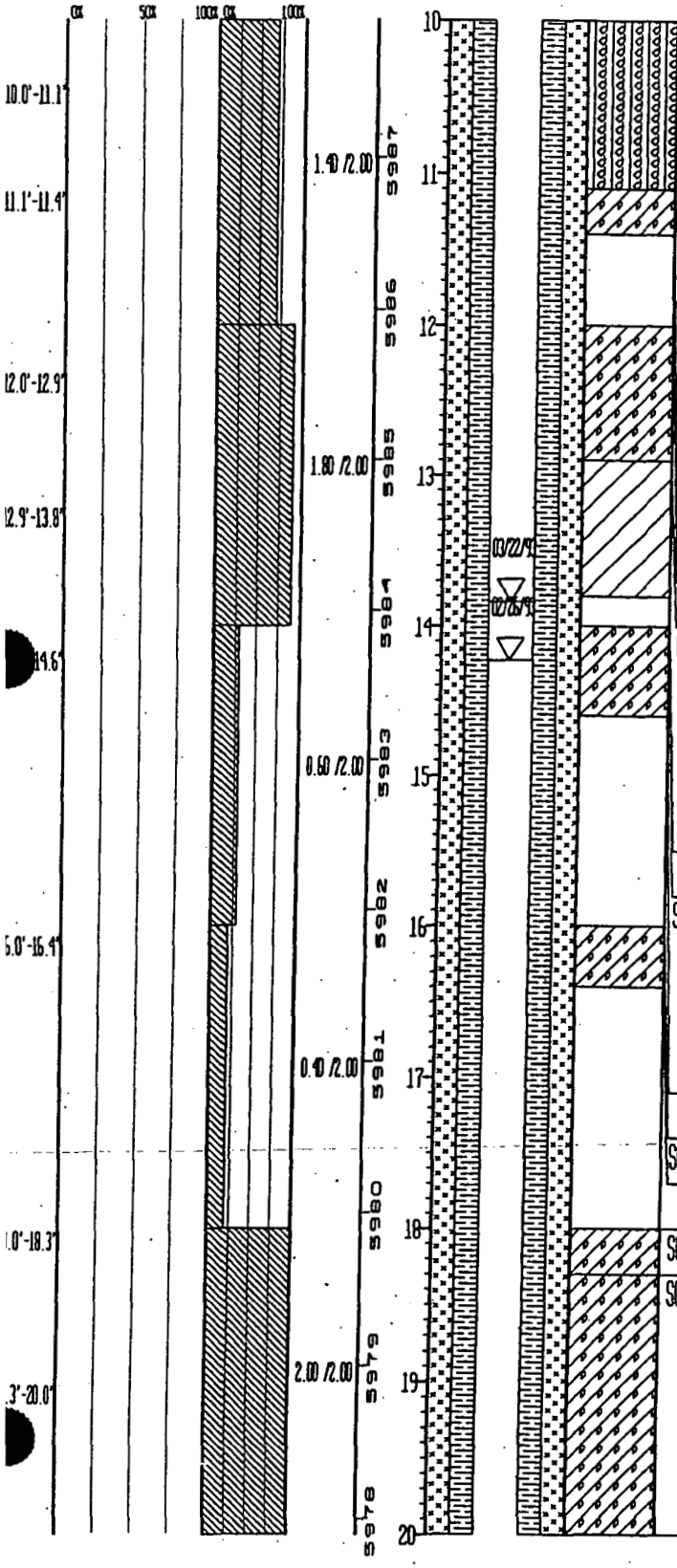
| STATE PLANE COORDINATE: | TOTAL DEPTH (FT): 26.00 | GROUND ELEVATION (FT): 5997.90 | PROJECT NUMBER: 989073 | LOG OF BORING NUMBER: |
|---|---|---|---|---|
| NORTH: 752090 | AREA: OU7 PRESENT LANDFILL | CASING DIAMETER (IN): 2 | GEOLOGIST: J. BOYLAN | 70393 |
| EAST: 2082389 | LOCATOR NUMBER: 12J | BOREHOLE DIAMETER (IN): 7 | DATE DRILLED: 02/02/93 | |

REMARKS: MOBIL DRILL B-57; HSA; CEMENT GROUT 0.0'-4.25', BENTONITE SEAL 4.25'-6.5', SAND 6.5'-24.5', NATURAL BACKFILL 24.5'-26'; CENTRALIZERS PLACED AT 3.8' AND 24.2'; 2' SUMP 22.8'-24.8'; DEPTH TO BEDROCK 22.8'.

| SAMPLE NO. | SAMPLE GRAIN SIZE | PERCENT RECOVERY | RECOVERY/INTERVAL | DATUM (FT) | DEPTH (FT) | WELL OR PIEZOMETER CONSTRUCTION | LITHOLOGY | UNIFIED SOILS CLASSIFICATION OR ROCK TYPE | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| 1'-.7' | 0% 50% 100% | 0% 100% | 0.70 /2.00 | 5997 5996 | 0 1 | | | SC: | Gravelly Sand with silt and clay. Very dark grayish brown (10 YR 3/2). Coarse to fine sand (mean=fine) with coarse to fine gravel (max=3", mean=0.5" diam). Sand subangular to subrounded comprised of quartz, trace of dark minerals. Gravel subangular to subrounded, comprised of quartzite and igneous rock frags. Not bedded, well graded. Slightly moist. 19% Gravel, 67% sand, 7% clay, and 7% silt. |
| | | | | | | | | | No core recovery (0.7'-2.0'). |
| 1'-2.9' | | | 0.90 /2.00 | 5995 5994 | 2 3 4 | | | SC: | Gravelly Clayey Sand. Grayish brown (2.5 Y 5/2), dark grayish brown (2.5 Y 4/3) and dark reddish gray (2.5 YR 4/6) staining. Coarse to fine sand (mean=fine) with coarse to fine gravel. Sand subangular to subrounded, comprised of quartz and a trace of dark minerals and rock frags. Gravel subangular to subrounded, comprised of igneous rock frags and quartzite. Not bedded, poorly sorted. Slightly moist. 15% Gravel, 63% sand, 14% clay, and 8% silt. |
| | | | | | | | | | No core recovery (2.9'-4.0'). |
| 6.0' | | | 2.00 /2.00 | 5993 5992 | 5 6 | | | SM: | Gravelly Sand. Light olive brown (5 Y 5/3) to olive brown (5 Y 5/3), becoming dark yellowish brown (10 YR 4/6) at base. Sand coarse to fine (mean=fine). Gravel coarse to fine (max=3", mean=1" diam). Sand subangular to subrounded, comprised of quartz with a trace of dark minerals and rock frags. Gravel subangular to subrounded comprised of quartzite and igneous rock frags. Not bedded, poorly sorted. Slightly moist. 32% Gravel, 50% sand, 7% clay, and 11% silt. |
| 1'-7.1' | | | 1.10 /2.00 | 5991 5990 | 7 8 | | | GC: | Sandy Gravel. Dark yellowish brown (10 YR 4/4) with very dark gray (2.5 YR N3) cobbles. Coarse to fine gravel (max=3", mean= 2" diam), fractured; subangular to subrounded; comprised of igneous frags with some smaller granite and quartzite frags. Sand coarse to fine; subangular to subrounded; comprised of quartz, trace of dark minerals, and rock frags. ~~Fines upward, possibly two graded (Fining up) sequences.~~ Slightly moist. 50% Gravel, 35% sand, and 15% fines. |
| | | | | | | | | | No core recovery (7.1'-8.0'). |
| 1'-8.8' | | | 0.80 /2.00 | 5989 5988 | 9 10 | | | GC: | Same as above. See description 6.0'-7.1'. |
| | | | | | | | | | No core recovery (8.8'-10.0'). |

| STATE PLANE COORDINATE: | TOTAL DEPTH (FT): 26.00 | GROUND ELEVATION (FT): 5997.90 | PROJECT NUMBER: 989073 | LOG OF BORING NUMBER: |
|---|---|---|---|---|
| NORTH: 752090 | AREA: OU7 PRESENT LANDFILL | CASING DIAMETER (IN): 2 | GEOLOGIST: J. BOYLAN | 70393 |
| EAST: 2082389 | LOCATOR NUMBER: 12J | BOREHOLE DIAMETER (IN): 7 | DATE DRILLED: 02/02/93 | |

REMARKS: MOBIL DRILL B-57; HSA; CEMENT GROUT 0.0'-4.25', BENTONITE SEAL 4.25'-6.5', SAND 6.5'-24.5', NATURAL BACKFILL 24.5'-26'; CENTRALIZERS PLACED AT 3.8' AND 24.2'; 2' SUMP 22.8'-24.8'; DEPTH TO BEDROCK 22.8'.




| UNIFIED SOILS CLASSIFICATION OR ROCK TYPE | DESCRIPTION |
|---|---|
| SM: | Gravelly Sand. Dark yellowish brown (10 YR 4/4) to olive gray (5 Y 5/2) with reddish brown (5 YR 4/4) staining. Fine to coarse sand (mean=fine) and coarse to fine gravel (max=2", mean=0.5" diam). Sand subangular to subrounded, comprised of quartz with a trace of mica and dark minerals. Gravel subangular to subrounded, comprised of igneous rock frags and pegmatitic quartzite. No bedding. Slightly moist. 30% Gravel, 50% sand, and 20% fines. |
| SC: | Sand with some gravel and clay. Light olive brown (5 Y 5/4) to brown (10 YR 5/3). Coarse to fine (mean=fine) sand and coarse to fine gravel (max=2", mean=0.5" diam). Sand subangular to subrounded, comprised of quartz with a trace of mica and dark minerals. Gravel subangular to subrounded, comprised of granitic, mafic, igneous, arkosic, and quatzite rock frags. No bedding. Slightly moist. 14% Gravel, 71% sand, and 10% clay, and 5% silt. |
| | No core recovery (11.4'-12.0'). |
| SC: | Same as above. See description 11.0'-11.4'. |
| CL: | Sandy Clay with some gravel and silt. Mottled dark yellowish brown (10 YR 4/6) and light olive gray (5 Y 6/2). Coarse to fine gravel (max=2.5", mean=0.5" diam) and coarse to fine (mean=medium) sand. Gravel and sand angular to subrounded, comprised mainly of quartzite and schist. Low to moderate plasticity. Moderately well graded. No bedding. Slightly moist. 15% Gravel, 35% sand, 35% clay, and 15% silt. |
| | No core recovery (13.8'-14.0'). |
| SC: | Gravel, sand, clay mixture. Strong brown (7.5 YR 5/6) to yellowish brown (10 YR 5/4). Gravels broken during drilling (>3" diam) and very coarse to very fine sand (mean=medium). Sand angular to subrounded. Poorly to moderately graded. Igneous and metamorphic gravels, sand is predominantly quartz. No bedding. Slightly moist. 20% Gravel, 50% sand, and 30% fines. |
| | No core recovery (14.6'-16.0'). |
| SC: | Same as above See description 14.0'-14.6'. |
| | No core recovery (16.4'-18.0'). |
| SC: | Same as above See description 14.0'-14.6'. |
| SC: | Sand with gravel and clay. Light yellowish brown (2.5 Y 6/3) dominates to 20.0'. Fine to coarse gravel (max=2", mean= .25"-.5") and very fine to very coarse sand (mean=fine to medium). Grains subangular to subrounded, comprised of quartz and quarztitic metamorphic rock frags with abundant Fe-oxide grains below 20.0'. Moderately well graded, no bedding. Coarser below 21.0'. Slightly moist. 7% Gravel, 82% sand, 4% silt, and 7% clay. |

1

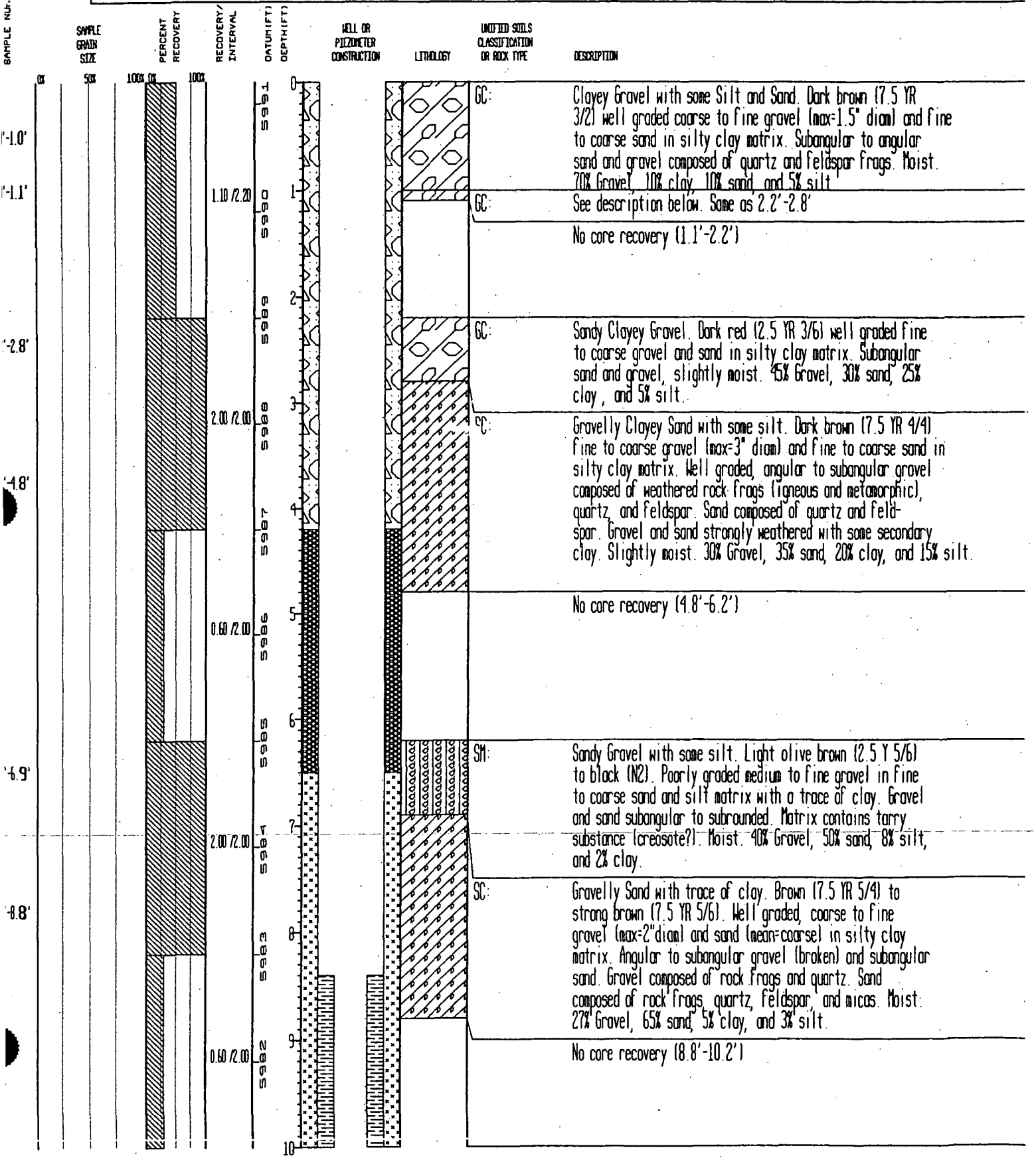
| STATE PLANE COORDINATE: | TOTAL DEPTH (FT): 26.00 | GROUND ELEVATION (FT): 5997.90 | PROJECT NUMBER: 989073 | LOG OF BORING NUMBER: |
|---|---|---|---|---|
| NORTH: 752090 | AREA: OU7 PRESENT LANDFILL | CASING DIAMETER (IN): 2 | GEOLOGIST: J. BOYLAN | 70393 |
| EAST: 2082389 | LOCATOR NUMBER: 12J | BOREHOLE DIAMETER (IN): 7 | DATE DRILLED: 02/02/93 | |

REMARKS: MOBIL DRILL B-57; HSA; CEMENT GROUT 0.0'-4.25', BENTONITE SEAL 4.25'-6.5', SAND 6.5'-24.5', NATURAL BACKFILL 24.5'-26'; CENTRALIZERS PLACED AT 3.8' AND 24.2'; 2' SUMP 22.8'-24.8'; DEPTH TO BEDROCK 22.8'.

| SAMPLE NUMBER | SAMPLE GRAIN SIZE | PERCENT RECOVERY | RECOVERY/INTERVAL | DATUM (FT) | DEPTH (FT) | WELL OR PIEZOMETER CONSTRUCTION | LITHOLOGY | UNIFIED SOILS CLASSIFICATION OR ROCK TYPE | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| | 0% 50% 100% | 0% 100% | | | 20 | | | SC: | Same as above. See description 18.3'-20.0', with a color change to strong brown (7.5 YR 5/6, 4/6) to reddish yellow (7.5 YR 6/6). Coarsens below 21.0'. |
| | | | 1.30 /2.00 | 5977 | 21 | | | | |
| 20.0'-22.8' | | | | 5976 | 22 | | | | |
| | | | 0.90 /2.00 | 5975 | 23 | | | CLAYSTONE: | Claystone. Top of bedrock 22.8'. See description below. |
| | | | | | | | | | No core recovery (22.9'-24.0'). |
| | | | | 5974 | 24 | | | CLAYSTONE: | Claystone. Light brownish gray (2.5 Y 6/2) above 25.0' to light olive brown (2.5 Y 5/3), yellowish brown (10 YR 5/6, 5/8) and dark yellowish brown (10 YR 4/6, 3/6). Core is thin, extruded due to gravel clast pushed by auger. Trace to some silt. Porosity=5%-10%. Argillaceous cement plus Fe-oxide in yellowed areas. Non- to slightly- friable. No apparent bedding. Slightly moist. 95% Clay and 5% silt. Total Depth 26.0'. |
| 24.9'-26.0' | | | 2.40 /2.00 | 5973 | 25 | | | | |
| | | | | 5972 | 26 | | | | |
| | | | | 5971 | 27 | | | | |
| | | | | 5970 | 28 | | | | |
| | | | | 5969 | 29 | | | | |
| | | | | 5968 | 30 | | | | |

| STATE PLANE COORDINATE: | | TOTAL DEPTH (FT): 30.3 | GROUND ELEVATION (FT): | 5991.20 | PROJECT NUMBER: | 989073 | LOG OF BORING NUMBER: |
|---|---|---|---|---|---|---|---|
| NORTH: | 752070 | AREA: 007 PRESENT LANDFILL | CASING DIAMETER (IN): | 2 | GEOLOGIST: | JAB/KJT | 70693 |
| EAST: | 2082799 | LOCATOR NUMBER: 11J | BOREHOLE DIAMETER (IN): | 10.25 | DATE DRILLED: | 12/04/92 | |

REMARKS: MOBIL DRILL B-57; HSA; CEMENT GROUT 0.0'-4.2', BENTONITE SEAL 4.2'-6.5', SAND 6.5'-30.5', NO BACKFILL; NO CENTRALIZERS PLACED; BOREHOLE DIAMETER 10.25" 0'-28.5' AND 3" 28.5'-30', 2.1' SUMP 28.4'- 30.5'; DEPTH TO BEDROCK 28.5'.



| STATE PLANE COORDINATE: | TOTAL DEPTH (FT): 30.3 | GROUND ELEVATION (FT): 5991.20 | PROJECT NUMBER: 989073 | LOG OF BORING NUMBER: |
|---|---|---|---|---|
| NORTH: 752070 | AREA: OU7 PRESENT LANDFILL | CASING DIAMETER (IN): 2 | GEOLOGIST: JAB/KJT | 70693 |
| EAST: 2082799 | LOCATOR NUMBER: 11J | BOREHOLE DIAMETER (IN): 10.25 | DATE DRILLED: 12/04/92 | |

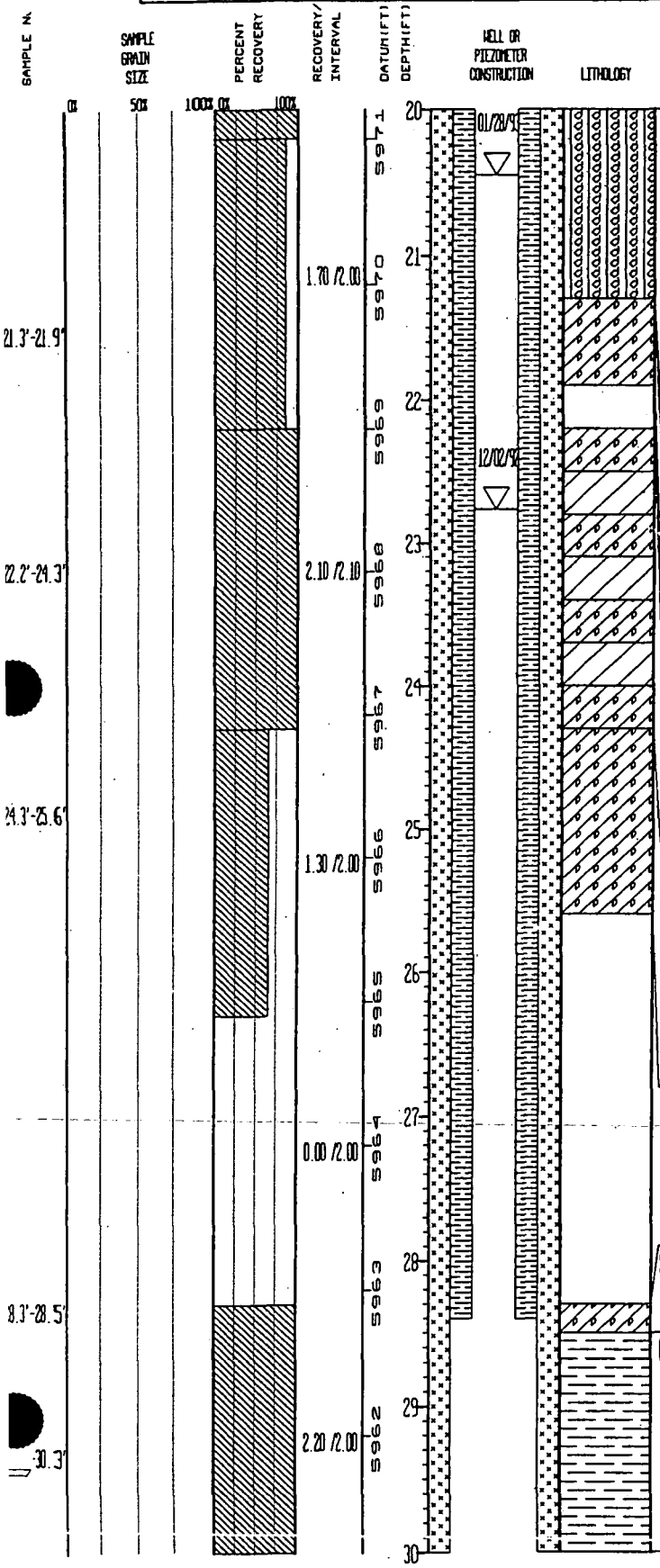
REMARKS: MOBIL DRILL B-57; HSA; CEMENT GROUT 0.0'-4.2', BENTONITE SEAL 4.2'-6.5', SAND 6.5'-30.5', NO BACKFILL; NO CENTRALIZERS PLACED; BOREHOLE DIAMETER 10.25" 0'-28.5' AND 3" 28.5'-30', 2.1' SUMP 28.4'- 30.5'; DEPTH TO BEDROCK 28.5'.

| SAMPLE NO. | SAMPLE GRAIN SIZE (0% 50% 100%) | PERCENT RECOVERY (0% 100%) | RECOVERY/INTERVAL | DATUM (FT) | DEPTH (FT) | WELL OR PIEZOMETER CONSTRUCTION | LITHOLOGY | UNIFIED SOILS CLASSIFICATION OR ROCK TYPE | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 10 | | | | No core recovery (8.8'-10.2') |
| | | | 2.00 /2.00 | 5986 | 11 | | | SC: | Same as above |
| 2'-12.6' | | | | 5985 | 12 | | | | |
| | | | | 5984 | | | | | |
| | | | 2.00 /2.00 | 5983 | 13 | | | ML: | Sandy Silt with some clay. Reddish yellow (7.5 YR 6/8). Very fine to fine sand in clayey silt matrix. Low plasticity. Poorly graded. Subangular to subrounded sand, composed of quartz, micas - including biotite, rock frags, trace of black stained material throughout (not identified). Moist. 50% Silt, 30% sand, and 15% clay. |
| 6'-14.3' | | | | 5982 | 14 | | | | |
| | | | | 5981 | | | | SC: | Gravelly Sand. Reddish yellow (7.5 YR 6/6) fine to medium gravel and very fine to coarse sand (mean=coarse) in clay and silt matrix. Well graded. Subangular to angular sand and gravel composed of rock frags and quartz. Moist. 23% Gravel, 56% sand, 11% clay, and 10% silt. |
| 3'-15.4' | | | 1.40 /2.00 | 5980 | 15 | | | | |
| | | | | 5979 | | | | | No core recovery (15.4'-16.2'). |
| | | | | 5978 | 16 | | | | |
| 2'-16.5' | | | | 5977 | | | | SC: | Same as above. |
| 5'-17.6' | | | 2.00 /2.00 | 5976 | 17 | | | SC: | Clayey Sand with some silt. Light brownish gray (2.5 Y 6/2) to reddish yellow (7.5 YR 6/8). Very fine to fine sand in silty clay matrix. Subangular to subrounded sand composed of quartz, micas, rock frags, and feldspar. Moist. 50% Sand, 40% clay, and 10% silt. |
| | | | | 5975 | 18 | | | SM: | Silty Sand with some gravel and trace of clay. Light brownish gray (2.5 Y 6/2) to reddish yellow (7.5 Y 6/8). Heterogeneous mix of gravelly clayey sand, silty sand, and clayey silty sand. Gravel concentrated between 18.0'-18.5' (damaged core). Fine to medium gravel (max=0.5" diam) and very fine to fine sand in silty clay matrix. Well graded, sub-angular to subrounded gravel and sand composed of rock frags and quartz with some feldspar, micas, and clays. Moist to wet. Grades into underlying clay. 7% Gravel, 50% Sand, 30% silt, and 13% clay. |
| | | | 2.00 /2.00 | 5974 | 19 | | | | |
| -21.3' | | | | | 20 | | | | |

70

| STATE PLANE COORDINATE: | TOTAL DEPTH (FT): 30.3 | GROUND ELEVATION (FT): 5991.20 | PROJECT NUMBER: 989073 | LOG OF BORING NUMBER: |
|---|---|---|---|---|
| NORTH: 752070 | AREA: OUT PRESENT LANDFILL | CASING DIAMETER (IN): 2 | GEOLOGIST: JAB/KJT | 70693 |
| EAST: 2082799 | LOCATOR NUMBER: 11J | BOREHOLE DIAMETER (IN): 10.25 | DATE DRILLED: 12/04/92 | |

REMARKS: MOBIL DRILL B-57; HSA; CEMENT GROUT 0.0'-4.2', BENTONITE SEAL 4.2'-6.5', SAND 6.5'-30.5', NO BACKFILL; NO CENTRALIZERS PLACED; BOREHOLE DIAMETER 10.25" 0'-28.5' AND 3" 28.5'-30', 2.1' SUMP 28.4'-30.5'; DEPTH TO BEDROCK 28.5'.




| UNIFIED SOILS CLASSIFICATION OR ROCK TYPE | DESCRIPTION |
|---|---|
| SM: | Silty Sand with some gravel and trace of clay. Light brownish gray (2.5 Y 6/2) to reddish yellow (7.5 Y 6/8). Heterogeneous mix of gravelly clayey sand, silty sand, and clayey silty sand. Gravel concentrated between 18.0'-18.5' (damaged core). Fine to medium gravel (max=0.5" diam) and very fine to fine sand in silty clay matrix. Well graded, sub-angular to subrounded gravel and sand composed of rock frags and quartz with some feldspar, micas, and clays. Moist to wet. Grades into underlying clay. 7% Gravel, 50% Sand, 30% silt, and 13% clay. |
| SM: | Same as above |
| SC: | Clayey Sand with some gravel. Strong brown (7.5 Y 5/8). Fine gravel and fine to coarse sand in silty clay matrix. Sub-rounded sand and gravel. Moist to wet. 5% Gravel, 60% sand, 20% clay, and 15% silt. |
| | No core recovery (21.9'-22.2') |
| SC: | Clayey Sand to Sandy Clay. Light olive brown (2.5 Y 5/3) to light brownish gray (2.5 Y 6/2). Interbedded sand and clay layers (thick). Very fine to medium sand in clay and silt matrix. Subangular to subrounded sand composed of quartz, felspar, micas, rock frags, and trace of carbonaceous material. Some Fe-oxide stains within clay and sand. Wet. 50% Sand, 38% clay, and 12% silt, to 72% clay, 10% silt, and 18% sand. |
| SC: | Gravelly Silty Sand. Strong brown (7.5 Y 5/6). Coarse to fine gravel (max=1 3/4" diam) and fine to coarse sand in clayey silt matrix. Subangular gravel but angular where broken with angular to subrounded sand. Well graded. Gravel composed mainly of quartz, quartzite, and rock frags with some meta-morphic rocks. Sand composed of quartz, rock frags, mafic minerals, and feldspar. Wet/saturated. 25% Gravel, 59% sand, 10% silt, and 6% clay. |
| | No core recovery (25.6'-28.3') |
| SC: | Same as above<br>Top of bedrock 28.5' |
| CLAYSTONE: | Claystone with trace of silt. Grayish brown (2.5 Y 5/2) to light olive brown (2.5 Y 5/6). Clay with trace of silt (4%) Well sorted, porosity=10%, no cement, slightly friable, slightly weathered, mottled gray appearance with some ir-regular patches of Fe-oxide stains, massive, not fractured Moist. 96% Clay and 4% silt. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| STATE PLANE COORDINATE: | | TOTAL DEPTH (FT): 30.3 | GROUND ELEVATION (FT): | 5991.20 | PROJECT NUMBER: | 989073 | LOG OF BORING NUMBER: |
| NORTH: | 752070 | AREA: 007 PRESENT LANDFILL | CASING DIAMETER (IN): | 2 | GEOLOGIST: | JAB/KJT | 70693 |
| EAST: | 2082799 | LOCATOR NUMBER: 11J | BOREHOLE DIAMETER (IN): | 10.25 | DATE DRILLED: | 12/04/92 | |

REMARKS: MOBIL DRILL B-57; HSA; CEMENT GROUT 0.0'-4.2', BENTONITE SEAL 4.2'-6.5', SAND 6.5'-30.5', NO BACKFILL; NO CENTRALIZERS PLACED; BOREHOLE DIAMETER 10.25" 0'-28.5' AND 3" 28.5'-30', 2.1' SUMP 28.4'- 30.5'; DEPTH TO BEDROCK 28.5'.

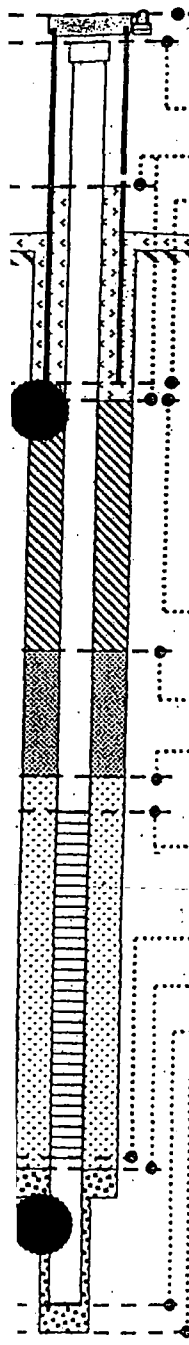
| GEOTECHNICAL DEPTH | SAMPLE NO. | SAMPLE GRAIN SIZE | PERCENT RECOVERY | RECOVERY/INTERVAL | DATUM (FT) | DEPTH (FT) | WELL OR PIEZOMETER CONSTRUCTION | LITHOLOGY | UNIFIED SOILS CLASSIFICATION OR ROCK TYPE | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 0% 50% 100% | 0% 100% | | 5961 | 30 | | | CLAYSTONE: | Same as above. Total Depth 30.3' |
| | | | | | 5960 | 31 | | | | |
| | | | | | 5959 | 32 | | | | |
| | | | | | 5958 | 33 | | | | |
| | | | | | 5957 | 34 | | | | |
| | | | | | 5956 | 35 | | | | |
| | | | | | 5955 | 36 | | | | |
| | | | | | 5954 | 37 | | | | |
| | | | | | 5953 | 38 | | | | |
| | | | | | 5952 | 39 | | | | |
| | | | | | | 40 | | | | |

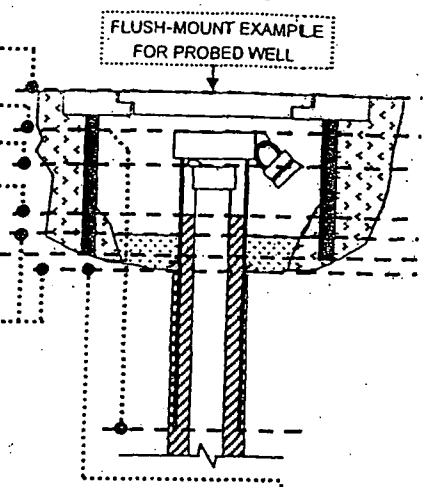
# MONITORING WELL INSTALLATION REPORT: Form PRO.118

LOCATION CODE: 73005 PROJECT NAME: CY05 Well Installation PROGRAM: Present Landfill
SCREENED FORMATION: Bdrk. DRILLING CONTRACTOR: Layne BORING METHOD: Hollow Stem Auger
DATE DRILLED: 6/22/05 DATE COMPLETED: 6/27/05 TOTAL DEPTH: 28.0' COMPLETED DEPTH: 25.0'
ESTIMATED DEPTH TO BEDROCK: 0.0' RIG GEOLOGIST: E. Warp LOGGING GEOLOGIST: E. Warp
BOREHOLE DIAMETER IN SCREENED INTERVAL: 8" QUANTITY OF FLUIDS LOST DURING DRILLING: N/A
INITIAL WATER LEVEL (FT, DATE): Dry, 6/22/05 COMPLETED WATER LEVEL (FT, DATE): Dry, 6/27/05
DIAMETER & TYPE OF INSTALLATION (WELL/PIEZOMETER/WELL POINT/ETC.): 2" PVC Well
TYPE OF PROTECTION (FLUSH-MOUNT VS. ABOVE GROUND, ASEPTIC, ETC.): Above Ground Steel Protective Casing

**ALL MEASUREMENTS WILL BE MADE IN FEET FROM GROUND SURFACE**

* DENOTES ITEMS THAT MAY NOT BE APPLICABLE, DEPENDING ON BORING METHOD, WELL PROTECTION & PURPOSE






PROTECTIVE CASING TOP (STICKUP OR FLUSH-MOUNT): 3.1' a.g.s.
*SECONDARY CASING TOP: N/A BOTTOM: N/A TYPE: N/A
SURFACE CASING TOP: 2.7' ags ID (IN): 2.0
SURFACE SEAL TOP: 1.35' ags BOTTOM: 0.2' bgs TYPE: Concrete
PROTECTIVE CASING BOTTOM, ID (IN), TYPE: 1.9', 5" x 5" Square Steel
*WELL PAD DIMENSIONS, TYPE: 3' x 3' square, Concrete
*ADD'L CASING FILL TOP: N/A BOTTOM: N/A TYPE: N/A
*SURFACE ISOLATION CASING TOP: N/A BOTTOM: N/A
*SURFACE ISOLATION CASING ID (IN): N/A TYPE: N/A
*OTHER (E.G., ASEPTIC) CASING TOP: N/A BOTTOM: N/A
*OTHER CASING ID (IN): N/A TYPE, PURPOSE: N/A
*CENTRALIZER(S) OD (IN): N/A NUMBER USED: N/A TYPE: N/A
*CENTRALIZER(S) DEPTH(S): N/A
*GROUT TOP: N/A MEASURED DENSITY (LBS/GAL): N/A TYPE: N/A
*GRANULAR BENTONITE TOP: N/A TYPE: N/A
*BENTONITE SEAL TOP: 0.2' TYPE: 1/4" Bentonite pellets - Baroid and Pel-Plug } Hydrated w/ 5 gall. of Distilled $H_2O$
BENTONITE SEAL OR GRANULAR BENTONITE BOTTOM (= FILTER PACK TOP): 4.0'
FILTER PACK TYPE: 16/40 Silica Sand BRAND: C.S.S.I.
SURFACE CASING BOTTOM (=SCREEN TOP): 4.6' TYPE: Sch. 40-PVC
SCREEN ID (IN): 2.0" SLOT SIZE (IN): 0.01 TYPE: Sch. 40-PVC
SCREEN BOTTOM (= SUMP, TOP): 24.65' SUMP TYPE: Threaded End Cap - Sch. 40 PVC
FILTER PACK BOTTOM (= *BACKFILL TOP): 25.0' *BACKFILL TYPE: 1/4" bentonite pellets - Pel-plug
SUMP BOTTOM (= WELL COMPLETED DEPTH): 25.0' *PILOT HOLE TOP, DIAMETER: 26.0', 2.5"
TOTAL BOREHOLE DEPTH (= *PILOT HOLE AND *BACKFILL BOTTOM): 28.0'

REMARKS: Routine well installation on 6/22/05. Top 2' of bentonite seal and protective casing installed on 6/23/05. Concrete well pad installed on 6/27/05

COMPLETED BY: Ellen S. Warp Ellen S. Warp DATE: 6/27/05
CHECKED BY: J. Boylan DATE: 6/30/05

U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT

FORM PRO.101A

# ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG



Borehole Number: 73005
Location - North: East:
Date: 6/22/05
Geologist: E. WARP
Drilling Equip.: CME-750 Hollow Stem Auger

Surface Elevation:
Area: Present Landfill
Total Depth: 28.0'
Company: URS/Layne
Project No.: ~~WAD51300~~ 6R201400 SW 6/22/05
Sample Type: Continuous Core - Split Spoon

RMRS LOGGING SUPERVISOR APPROVAL _____ DATE _____

| TOP/BOTTOM OF CORE IN BOX | TOP/BOTTOM OF INTERVAL | FEET OF CORE IN INTERVAL (FIELD MEASUREMENT) | SAMPLE NUMBER | FRACTURE ANGLE | BEDDING ANGLE | GRAIN SIZE DISTRIBUTION | USCS SYMBOL | DEPTH IN FEET | SOIL LITHOLOGIC LOG | SAMPLE DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | | | | | | 0.0 | | 0.0-0.1'- Clayey SILTSTONE - Lt. yell'sh Brn (10YR6/4) massive texture. Tr roots. Dry 6/29/05 w/ tr-some sand in pockets (rip up?) |
| | Run #1 | Rec. = 0.8' | | | | | | 0.1 | | |
| | | | | | | | | 0.7 | | 0.1-0.7'- Clayey SILTSTONE - Brn'sh yellow (10YR6/6) w/some Lt. gry (10YR7/1) mottling. Wk to mod. perv. FeOx'n. w/some un-oxd mottling. massive texture. Wk. to moderately friable. Tr roots. Sl. MOIST. Tr-some sand (vfg). 6/29/05 |
| | | | | | | | | 0.8' | | |
| | | | | | | | | 1 | | |
| | 2.0' | | | | | | | | | 0.7-0.8- Silty CLAYSTONE - Lt. Brn'sh Gry (10YR6/2). Decr. FeOxn to Tr. Strongly friable. Crumbly. Tr roots. Sl. MOIST. |
| | | | | | | | | 2 | | |
| | | | | | | | | 2.5 | | 0.8-2.0 = No recovery |
| | Run #2 | Rec. = 1.8' | | | | | | 2.8 | | 2.0-2.5'- Clayey SILTSTONE Lt. yell'sh brn. (10YR6/4) to Lt. brn'sh gry. (10YR6/2). Wk. perv. FeOxn fm. 2.0-2.1'. Massive texture. Increasing clay @ base of interval. Moderately friable. Sl. MOIST. |
| | | | | | | | 6/29/05 (continue lithlog to 3.8') | 3 | | |
| | | | | | | | | 3.8 | | |
| | 4.0' | | | Misc. high angle | | | | 4 | | 2.5-3.8 6/29/05 CLAYSTONE w/some silt. Lt. Brn'sh Gry (10YR6/2). Tr wk. FeOxn predominately along bedding planes (sub-horizontal) & fracture surfaces. Tr wht. caliche stringers and blebs. Massive texture. Moderately friable. Sl. MOIST. 6/29/05 |
| | | | | | | | | 4.8' | | |
| | | | | | | | | 5 | | |
| | Run #3 | Rec. = 1.9' | | | | | | | | 3.8 4.0 = No recovery |
| | 6.0' | | | | | | | 5.9' | | 4.0-4.8'- CLAYSTONE w/some silt. Pale Brn. (10YR6/3) w/some Gry (10YR5/1) mottling. Wk. perv. FeOx'n fm. 4.0-4.4'. Gry mottling fm. 4.4-4.8' w/FeOx'n on internal fracture surfaces. Massive texture. Sl. moist fm. 4.0-4.4', increase to moist fm. 4.4 to 4.8'. Friable. |
| | | | | | | | | 6 | | |
| | | | | | | | | 6.7 | | |
| | Run #4 | Rec. = 1.9' | | | | | | 7 | | |
| | 8.0' | | | | | | | 7.9' | | 4.8-5.9'- CLAYSTONE w/some silt. Gry (10YR5/1) to Gry'sh brn. (10YR5/2). Wk. FeOxn along bedding planes. Massive texture. Wk. to moderately friable. Sl. MOIST. |
| | | | | | | | | 8 | | |
| | | | | | | | | | | 5.9-6.0'- No recovery |
| | Run #5 | Rec. = 1.9' | | | | | | | | 6.0-6.7- CLAYSTONE w/Tr silt. Same as above fm. 4.8-5.9'. Sl. moist. |
| | | | | | | | | 9 | | |
| | | | | | | | | | | 6.7-7.9'- CLAYSTONE - Gry (10YR6/1) (Predominately un-oxd). Faint undulating bedding planes. Tr blk organic stringers throughout. Wk. to mod. friable. Tr FeOx'n stringers fm. 10.3-10.5'. |
| | 10.0' | | | | | | | 9.9 | | |
| | | | | | | | | 10.0' | | |

Box #1 (0.0 → 10.0')

NOTES: General: USCS is modified for this log as follows: No recovery 9.9-10.0' Sl. MOIST. 6/29/05
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO. 101
Revision 0
Date effective: 12/31/98



(4011-930-0134-930)(Form GT.1A)(03/01/92)

7.9-8.0' = No recovery
8.0-9.9 = CLAYSTONE (same as 6.7-7.9').

U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT

FORM PRO.101A

# ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG



Borehole Number: 73005
Location - North: _____ East: _____
Date: 6/22/05
Geologist: E. WARP
Drilling Equip.: CME-750-Hollow Stem Auger

Surface Elevation: _____
Area: Present Landfill
Total Depth: 28.0'
Company: URS/Layne
Project No.: ~~HA051300~~ GR201400
Sample Type: Continuous Core-Split Spoon ESW 6/22/05

RMRS LOGGING SUPERVISOR APPROVAL _____ DATE 6/29/05

| TOP/BOTTOM OF CORE IN BOX | TOP/BOTTOM OF INTERVAL | FEET OF CORE IN INTERVAL (FIELD MEASUREMENT) | SAMPLE NUMBER | FRACTURE ANGLE | BEDDING ANGLE | GRAIN SIZE DISTRIBUTION | USCS SYMBOL | DEPTH IN FEET | SOIL LITHOLOGIC LOG | SAMPLE DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|
| Box #2 (10.0→ | Run #6 | Rec. = 2.0' | | | | | | 10.0 | | 10.0-10.5-CLAYSTONE - Same as fm. 8.0-9.9'. |
| | | | | | | | | 10.5 | | 10.5-11.6' CLAYSTONE - Brn. (10YR5/3) Sl. color change. Faint laminations (bedding planes) visible w/ Tr to some blk organic stringers on planes. Tr to some FeOxn stringers along bedding and fracture planes. Wk. to moderately friable. Sl. MOIST. |
| | | | | | | | | 11 | | |
| | | | | ~20° ~80° | | | | 11.6 | | |
| | | | | | | 2.4 29 05 | | 12 | | |
| | Run #7 | Rec. = 2.0' | | subhor. to ~70° | | | | | | |
| | | | | | | | | 13 | | 11.6-13.6-CLAYSTONE-Gry (10YR5/1 to 6/1), Wk. FeOxn along bedding planes @ 11.6' and fm. 12.2 to 13.0'. Fissile and moderately friable. Sl. MOIST. Fe-ox along fracture surfaces, especially @ 11.6-11.8', 12.2-13.0' 6/29/05 |
| | | | | | | | | 13.6 | | |
| | | | | | | | | 14 | | 13.6-22.0-Clayey SILTSTONE to silty claystone - Pale Brn. (10YR6/3) to Lt. brish gry. (10YR6/2). Wk. FeOxn on subhorizontal bedding planes (approximately 4 to 6 FeOxd bedding planes per ft.) & frac surfaces. Tr blk organic stringers. Noticeable FeOxn coating 80° fracture fm. 18.9' to 19.2'. Color of FeOxn is strong brn. (7.5YR5/6). FeOxn on 20° fracture fm. 19.5 to 19.6'. Moisture decreasing to Tr. Occ. Fe-Ox replaced organic debris fragments. Some intervals to silty claystone, but predominantly clayey siltstone. 6/30/05 |
| | Run #8 | Rec. = 2.0' | | | ~20-30° 6/29/05 | | | 15 | | |
| | | | | | | | | 16 | | |
| | Run #9 | Rec. = 2.0' | | | | | | 17 | | |
| | | | | | | | | 18 | | |
| | Run #10 | Rec. = 2.0' | | 80° ~20° | | | | 19 | | |
| | | | | | | | | 20.0 | | |

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO.101
Revision 0
Date effective: 12/31/98

# ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

Borehole Number: 73005
Location - North: _____ East: _____
Date: 6/22/05
Geologist: E. Warp
Drilling Equip.: CME-750-Hollow Stem Auger

Surface Elevation: _____
Area: Present Landfill
Total Depth: 28.0'
Company: URS/Layne
Project No.: ~~HAT5T300~~ GR201400
Sample Type: Continuous Core-Split Spoon

RMRS LOGGING SUPERVISOR APPROVAL _____ DATE _____

| TOP/BOTTOM OF CORE IN BOX | TOP/BOTTOM OF INTERVAL | FEET OF CORE IN INTERVAL (FIELD MEASUREMENT) | SAMPLE NUMBER | FRACTURE ANGLE | BEDDING ANGLE | GRAIN SIZE DISTRIBUTION | USCS SYMBOL | DEPTH IN FEET | SOIL/LITHOLOGIC LINE | SAMPLE DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|
| | 20.0' Run #11 22.0' | Rec. = 2.0' | | | | | | 20.0 21 22 | | 20.0-22.0 - Clayey SILTSTONE - silty claystone (described on pg. 2). 6/30/05 6/30/05 to silty claystone |
| | Run #12 24.0' | Rec. = 2.0' | | ~80° | | | | 22.7' 23 | | 22.0-22.7 - Clayey SILTSTONE Gry (10YR5/1) Notable color change. Decrease Fe Ox'n to R as minor fracture coating. Massive texture. Moderately friable. Increase moisture to SL. MOIST. |
| | | | | | | | | 24 | | 22.7-24.0 - CLAYSTONE w/ some silt. Yellowish brn. (10YR5/6) and gry (10YR5/1) mottled throughout. Fe Oxide coating - 80° fracture @ 22.9'. Moderate perv. Fe Ox'n fm. 23.9 to 23.8'. Moderately friable fm. 23.8 to 24.0', corresponding with increased moisture zone. SL. MOIST fm. 22.7 to 23.1', MOIST fm. 23.1 → 24.0' |
| | Run #13 26.0' | Rec. = 2.0' | | ~80° 10-30° | | | | 25 | | 24.0-28.0' - CLAYSTONE w/ R Silt. Gry (10YR5/1) to Lt. brn'sh gry (10YR6/2). Decr. Fe Ox'n to R along bedding planes and frac surfaces. Massive textured, moderately friable. Clay-rich fm. 24.0-24.2 and slightly darker color (dark gry - 10YR4/1). SL. MOIST. Decr. moisture to V. slightly moist fm. 24.2 to 26.0'. Fissile between 24.5 to 25.7'. R blk organic material. 6/30/05 |
| | Run #14 28.0' | Rec. = 1.8' | | | | | | 26 27 27.1 27.8' 28 | | 26.0-27.1' - CLAYSTONE - Gry'sh brn. (10YR5/2). Massive texture. Wkly. friable. Fe Ox'n along internal fractures @ 26.3 and 27.0'. V. SL. moist. 27.1-27.8 - CLAYSTONE - Dk Gry (10YR4/1). Noteable color change. Fissile and friable. R moisture. 27.8-28.0' = No recovery |
| | | | | | | | | 29 30.0 | | T.D. @ 28.0' |

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO.101
Revision 0
Date effective: 12/31/98



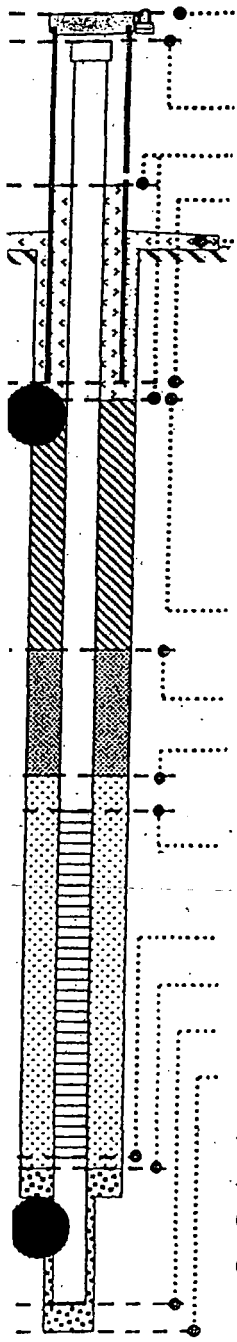
(4011-930-01 34-930)(Form CT.1A)(03/01.V2)

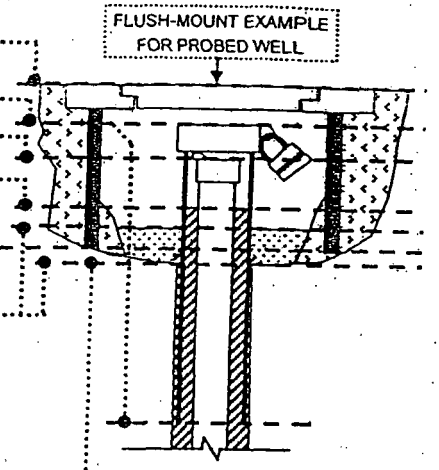
## MONITORING WELL INSTALLATION REPORT: Form PRO.118

LOCATION CODE: 73105 PROJECT NAME: CY05 Well Installation PROGRAM: Present Landfill
SCREENED FORMATION: Al/Blk. DRILLING CONTRACTOR: Layne BORING METHOD: Hollow Stem Auger
DATE DRILLED: 6/23/05 DATE COMPLETED: 6/27/05 TOTAL DEPTH: 27.7' COMPLETED DEPTH: 26.0
ESTIMATED DEPTH TO BEDROCK: 12.5' RIG GEOLOGIST: E. Warp LOGGING GEOLOGIST: E. Warp
BOREHOLE DIAMETER IN SCREENED INTERVAL: 8" QUANTITY OF FLUIDS LOST DURING DRILLING: N/A
INITIAL WATER LEVEL (FT, DATE): Dry, 6/23/05 COMPLETED WATER LEVEL (FT, DATE): 25.33', 6/27/05 - Possibly $H_2O$ used to hydrate Seal.
DIAMETER & TYPE OF INSTALLATION (WELL/PIEZOMETER/WELL POINT/ETC.): 2.0" PVC Well
TYPE OF PROTECTION (FLUSH-MOUNT VS. ABOVE GROUND, ASEPTIC, ETC.): Above Ground Steel Protective Casing

**ALL MEASUREMENTS WILL BE MADE IN FEET FROM GROUND SURFACE**

* DENOTES ITEMS THAT MAY NOT BE APPLICABLE, DEPENDING ON BORING METHOD, WELL PROTECTION & PURPOSE






PROTECTIVE CASING TOP (STICKUP OR FLUSH-MOUNT): 3.35' ags
*SECONDARY CASING TOP: N/A BOTTOM: N/A TYPE: N/A
SURFACE CASING TOP: 2.7' ags ID (IN): 2.0
SURFACE SEAL TOP: 0.4' ags BOTTOM: 0.1' bgs TYPE: concrete
PROTECTIVE CASING BOTTOM, ID (IN), TYPE: 1.65', 5"x5" square steel
*WELL PAD DIMENSIONS, TYPE: 3'x3', concrete
*ADD'L CASING FILL TOP: N/A BOTTOM: N/A TYPE: N/A
*SURFACE ISOLATION CASING TOP: N/A BOTTOM: N/A
*SURFACE ISOLATION CASING ID (IN): N/A TYPE: N/A
*OTHER (E.G., ASEPTIC) CASING TOP: N/A BOTTOM: N/A
*OTHER CASING ID (IN): N/A TYPE, PURPOSE: N/A
*CENTRALIZER(S) OD (IN): N/A NUMBER USED: N/A TYPE: N/A
*CENTRALIZER(S) DEPTH(S): N/A
*GROUT TOP: N/A MEASURED DENSITY (LBS/GAL): N/A TYPE: N/A
*GRANULAR BENTONITE TOP: N/A TYPE: N/A
*BENTONITE SEAL TOP: 0.1' TYPE: 1/4" bentonite pellets - BAROID - Hydrated with 5 gall. of distilled $H_2O$.
BENTONITE SEAL OR GRANULAR BENTONITE BOTTOM (= FILTER PACK TOP): 4.5'
FILTER PACK TYPE: 16/40 Silica Sand BRAND: C.S.S.I.
SURFACE CASING BOTTOM (=SCREEN TOP): 5.65' TYPE: Sch. 40 PVC
SCREEN ID (IN): 2.0 SLOT SIZE (IN): 0.01 TYPE: Sch. 40 PVC
SCREEN BOTTOM (= SUMP, TOP): 25.65' SUMP TYPE: Threaded End Cap - Sch. 40 PVC
FILTER PACK BOTTOM (= *BACKFILL TOP): 26.0' *BACKFILL TYPE: 1/4" bentonite pellets - BAROID
SUMP BOTTOM (= WELL COMPLETED DEPTH): 26.0' *PILOT HOLE TOP, DIAMETER: 26.0', 2.5"
TOTAL BOREHOLE DEPTH (= *PILOT HOLE AND *BACKFILL BOTTOM): 27.7'

REMARKS: Routine well installation on 6/23/05. Concrete well pad installed on 6/27/05.

COMPLETED BY: Ellen S. Warp Ellen S. Warp DATE: 6/27/05
CHECKED BY: J. Baylor DATE: 6/30/05

# ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG



Borehole Number: 73105
Location - North: _____ East: _____
Date: 6/23/05
Geologist: E. WARP
Drilling Equip.: CME-750-Hollow Stem Auger

Surface Elevation: _____
Area: Present Landfill
Total Depth: 27.7'
Company: URS/Layne
Project No.: ~~HAD51300~~ GR201400 6/23/05
Sample Type: Continuous Core- Split Spoon

RMRS LOGGING SUPERVISOR APPROVAL _____ DATE 6/29/05

| TOP/BOTTOM OF CORE IN BOX | TOP/BOTTOM OF INTERVAL | FEET OF CORE IN INTERVAL (FIELD MEASUREMENT) | SAMPLE NUMBER | FRACTURE ANGLE | BEDDING ANGLE | GRAIN SIZE DISTRIBUTION | USCS SYMBOL | DEPTH IN FEET | SOIL LITHOLOGIC LOG | SAMPLE DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | | | | | GP | 0.0 | | 0.0-0.2'- GRAVEL(FILL) - Pea gravel (1/4" dia, sub-rounded to sub-ang) composed of granite and qtzite. Poorly graded. Dry. |
| | | | | | | | CL | 0.2 | | |
| | | | | | | | CL/SC | 0.4' | | 0.2-0.4'- CLAY w/ sand and gravel. Grysh brn. (10YR 6/2 to Gry (10YR5/1). Reworked claystone. Thin, blk. organic stringers commen. MOIST. |
| | | | | | | | | 0.8' | | 0.4-0.8'- Gravelly, sandy CLAY (1) Strong brn. (7.5YR5/6). Imported fill (Qal$_{rf}$). 60% clay-med. plasticity. 30% sand (m.g. to c.g., sub-rounded to sub-ang.). 10% gravel (1/4" dia., sub-rounded to sub-ang.) V. MOIST |
| | | | | | | | | 6/29/05 | | |
| | 2.0' | Run #1 Rec. = 0.8' | | | | | | 2 | | 0.8-2.0' = No recovery |
| | | | | | | | CL/SC | 2.9' | | 2.0-2.9'- Gravelly, sandy CLAY (1) Strong brn. (7.5YR4/6). Imported fill (Qal$_{rf}$). V. similar to above fm. 0.4' to 0.8'; 65% clay (med.+ plasticity). 20-25% sand (m.g. to c.g., sub-ang. to sub-rounded). 10-15% gravel (1/8" to 1/4" dia., sub-rounded, predominately granite and qtzite.). SATURATED but not flowing. |
| | | | | | | | | 3 | | |
| | 4.0' | Run #2 Rec. = 0.9' | | | | | | | | 2.9-4.0' = No recovery |
| | | | | | | | | 4 | | 4.0-5.2'- Gravelly, sandy CLAY (1) Strong brn. (7.5YR 4/6). Imported fill (Qal$_{rf}$). V. similar to above fm. 2.0' to 2.9'. 60% clay (med.+ plasticity). 25% sand. (m.g. to c.g., sub-ang. to sub-rounded). 15% gravel (1/4 to 1/2" dia., sub-ang., composed of granite, qtzite and schist). SATURATED |
| | | | | | | | CL/SC | 6/29/05 | | |
| | | | | | | | | 5 | | |
| | | | | | | | | 5.2' | | 5.2-6.0' = No recovery |
| | 6.0' | Run #3 Rec. = 1.2' | | | | | | 6 | | 6.0-6.35'- GRAVEL w/ sandy clay. Strong brn. (7.5YR4/6) clay. Appears to be pea-gravel (possible slough?) Gravel (1/4-3/4" dia., sub-rounded to sub-ang). Poorly graded. Decrease moisture fm. Saturated to MOIST. |
| | | | | | | | GP | 6.35 | | |
| | | | | | | | CL GC | 6.9 | | 6.35-6.9'- Gravelly, sandy CLAY and shattered qtzite cobble mixture. 45% gravelly, sandy CLAY (Lt. brn. 7.5YR 6/4) w/ 45% shattered cobbles (1/2" to 1 1/2" dia., ang.). MOIST. |
| | | | | | | | | 7 | | |
| | 8.0' | Run #4 Rec. = 0.9' | | | | | | 8 | | 6.9-8.0' = No recovery |
| | | | | | | | CL GC | 9 | | 8.0-9.6'- Sandy CLAY/GRAVEL mixture. Strong brn. (7.5YR5/6) clay. 60-70% gravel and cobbles. 20-30% clay (med. plasticity). 5-10% sand (c.g., sub-ang.) Shattered qtzite. cobble fm. 8.4-8.6' (2" dia.) and fm. 9.2-9.5' (2-3" dia). MOIST. |
| | 10.0' | Run #5 Rec. = 1.6' | | | | | | 9.6' | | |
| | | | | | | | | 10.0' | | |

Box #1 (0.0 → 15.1')

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

# ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG



Borehole Number: 73105
Location - North: East:
Date: 6/23/05
Geologist: E. WARP
Drilling Equip.: CME-750 - Hollow Stem Auger

Surface Elevation:
Area: Present Landfill
Total Depth: 27.7'
Company: URS/Layne
Project No.: ~~HA051300~~ GR201400 ESO 6/29/05
Sample Type: Continuous Core - Split Spoon

RMRS LOGGING SUPERVISOR APPROVAL: [signature] DATE 6/29/05

| TOP/BOTTOM OF CORE IN BOX | TOP/BOTTOM OF INTERVAL | FEET OF CORE IN INTERVAL (FIELD MEASUREMENT) | SAMPLE NUMBER | FRACTURE ANGLE | BEDDING ANGLE | GRAIN SIZE DISTRIBUTION | USCS SYMBOL | DEPTH IN FEET | SOIL LITHOLOGIC LOG | SAMPLE DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.0 Run #6 12.0 | Rec = 1.9' | | | | | CL, GC | 10.0, 11, 11.9, 12 | | 10.0-11.9'-Sandy CLAY/GRAVEL mixture. Strong brn. (7.5YR5/6). 50% clay (med. plasticity). 30% gravel (1/8-3/4" dia., sub-ang). ~20% sand (c.g.). Cobbles of qtzite (1-2" dia.) @ 11.2' and 11.7'. MOIST. |
| | | | | | | | | | | 11.9-12.0' = No recovery |
| | | | | | | | CL/GC | 12.15 | | 12.0-12.15'-Sandy CLAY/GRAVEL mixture. Same as above fm. 10.0-11.9'. |
| | Run #7 14.0' | Rec = 0.3' | | Bdrk Contact @ 12.5" (estimated) | | | CL | 12.3, 12.5, 13 | | 12.15-12.3'-Silty CLAY. Gry. (10YR 6/1). Reworked silty claystone. Poor recovery due to clogged split spoon sampler producing "ribbons" of claystone. MOIST. Probable cobble lodged in sampler. |
| | | | | | | | | | | 12.3-14.0' = No recovery. |
| | | | | | | | | | | Bedrock contact (estimated) @ 12.5' (Bdrk. contact estimated by drilling conditions/changes in penetration) |
| | Run #8 16.0' | Rec = 1.3' | | | | | | 14, 15, 15.3 | | 14.0-15.3'-Silty CLAYSTONE (Weathered Bedrock). Gry'sh brn. (10YR5/2) w/some yellowish brn (10YR5/6) mottling. Massive texture. Firm and cohesive. Wk. to moderately friable. Wk. FeOxn mottled throughout. Tr blk. organic material. MOIST. |
| | | | | | | | | | | 15.3-16.0' = No recovery |
| | Run #9 18.0 | Rec = 1.8' | | | | | | 16, 16.2, 16.3, 16.6, 17, 17.8 | | 16.0-16.6'-Silty CLAYSTONE - FeOxd - Yell'sh brn. (10YR5/4) grading to Gry (10YR5/1) @ base of interval. Mod. perv. FeOxn fm. 16.0-16.3' then decreasing @ base. Massive texture. Wk. to moderately friable. SATURATED fm. 16.0-16.2' decreasing to moist fm. 16.2-16.3'. w/silt (<10% clay/silt) |
| | | | | | | | | | | 16.6-17.0'-CLAYSTONE - FeOxd - Yell'sh brn. (10YR5/8). Strong perv. FeOxn. Firm and dense. Blk. organic material common as stringers and along undulating bedding planes. MOIST. w/silt (<10% clay/silt) |
| | Run #10 20.0' | Rec = 1.7' | | | | | | 19, 19.7, 20.0 | | 17.0-17.8-CLAYSTONE - Gry'sh brn. (10YR5/2) w/some yell'sh brn. (10YR5/6) mottling. Decr. overall FeOxn to wk.-mottled. Firm. Wkly. friable. Blk organic stringers common. Faint bedding visible. MOIST. |

17.8-18.0' = No recovery

18.0 → 20.0 logged on page 3.

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

# ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG



Borehole Number: 73105
Location - North: _____ East: _____
Date: 6/23/05
Geologist: E. Warp
Drilling Equip.: CME-750 - Hollow Stem Auger

Surface Elevation: _____
Area: Present Landfill
Total Depth: 27.7'
Company: RMRS/Layne
Project No. 6R201400 HAD51300 6/23/05
Sample Type: Continuous Core - Split Spoon

RMRS LOGGING SUPERVISOR APPROVAL _____ DATE 6/29/05

| TOP/BOTTOM OF CORE IN BOX | TOP/BOTTOM OF INTERVAL | FEET OF CORE INCHES (VAL FIELD MEASUREMENT) | SAMPLE NUMBER | FRACTURE ANGLE | BEDDING ANGLE | GRAIN SIZE DISTRIBUTION | USCS SYMBOL | DEPTH IN FEET | SOIL/LITHOLOGIC UNIT | SAMPLE DESCRIPTION w/tr-some silt 6/29/05 |
|---|---|---|---|---|---|---|---|---|---|---|
| | 20.0 | | | | | | | 20.0 | | 18.0-19.7' - CLAYSTONE, Gry (10YR 5/1) with Yellish brn. (10YR 5/4) mottling. Wk. FeOxin mottled throughout. Firm/dense. Wkly. friable. Blk. organic stringers common. Blk. carbonaceous material coating bedding planes @ 18.9' and 19.0'. MOIST. |
| | Run #11 | Rec = 2.0' | | | | | | 21 | | 19.7-20.0' = No recovery |
| | 22.0' | | | | | | | 22 | | 20.0-22.3 - CLAYSTONE, Lt. brnish gry. (10YR 6/2) to gry (10YR 6/1). Massive texture. Firm/dense. Tr overall FeOxin. Wk. FeOxin fm. 21.7-22.0'. Tr blk. organic stringers. Decrease moisture to SL. MOIST. |
| | Run #12 | Rec = 2.0' | | | | | | 22.3' | | |
| | 24.0' | | | | | | | 23 | | 22.3-24.0' - CLAYSTONE. Gry (10YR 5/1) to Dk. Gry (10YR 4/1). Un-oxidized bedrock. Notable color change. Massive texture. Firm/dense. Tr blk. organic material. Decrease moisture to V. slightly MOIST. Abrupt color change @ base. |
| | Run #13 | Rec = 1.7' | | | | | | 24 | | 24.0 → 27.7' - CLAYSTONE. Dk. Gry (10YR 4/1) to V. dk. gry (10YR 3/1). Un-oxidized, un-weathered bedrock. Fissile/friable. Blk. carbonaceous material common. Abundant blk. carbonaceous material fm. 27.0' to 27.7'. Decr. moisture to Tr. 6/29/05 |
| | 26.0' | | | | | | | 25 | | |
| | Run #14 | Rec = 1.7' | | | | | | 25.7' | | No recovery fm. 25.7 → 26.0'. |
| | 27.7' | | | | | | | 26 | | |
| | | | | | | | | 27 | | REFUSAL @ 27.7' |
| | | | | | | | | 27.7' | | T.D. @ 27.7' |
| | | | | | | | | 28 | | |
| | | | | | | | | 29 | | |
| | | | | | | | | 30.0 | | |

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO.101
Revision 0
Date effective: 12/31/98

# MONITORING WELL INSTALLATION REPORT: Form PRO.118

LOCATION CODE: 73205 PROJECT NAME: CY05 WELL INSTALLATION PROGRAM: PRESENT LANDFILL

SCREENED FORMATION: Cl/Bdrk. DRILLING CONTRACTOR: Layne BORING METHOD: Hollow Stem Auger

DATE DRILLED: 6/21/05 DATE COMPLETED: 6/27/05 TOTAL DEPTH: 32.0' COMPLETED DEPTH: 30.0'

ESTIMATED DEPTH TO BEDROCK: 4.2' RIG GEOLOGIST: E. WARP LOGGING GEOLOGIST: E. WARP

BOREHOLE DIAMETER IN SCREENED INTERVAL: 8" QUANTITY OF FLUIDS LOST DURING DRILLING: N/A

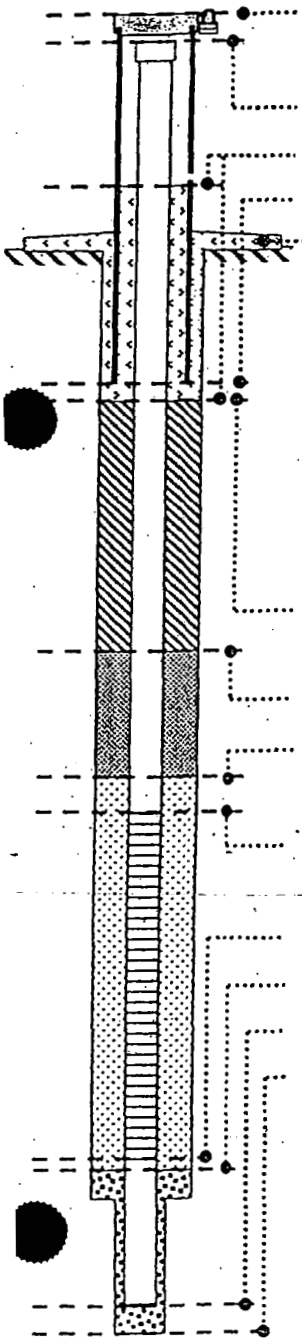
INITIAL WATER LEVEL (FT, DATE): Dry, 6/21/05 COMPLETED WATER LEVEL (FT, DATE): Dry, 6/27/05

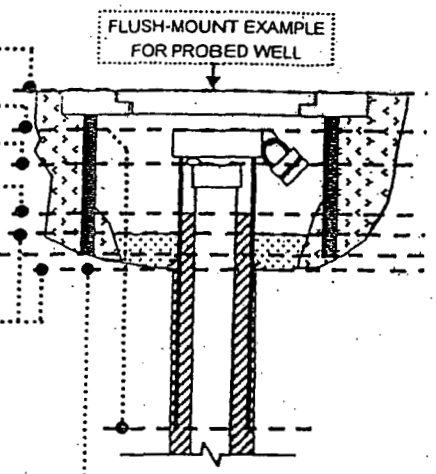
DIAMETER & TYPE OF INSTALLATION (WELL/PIEZOMETER/WELL POINT/ETC.): 2.0" PVC WELL

TYPE OF PROTECTION (FLUSH-MOUNT VS. ABOVE GROUND, ASEPTIC, ETC.): ABOVE GROUND STEEL PROTECTIVE CASING

**ALL MEASUREMENTS WILL BE MADE IN FEET FROM GROUND SURFACE**

* DENOTES ITEMS THAT MAY NOT BE APPLICABLE, DEPENDING ON BORING METHOD, WELL PROTECTION & PURPOSE






PROTECTIVE CASING TOP (STICKUP OR FLUSH-MOUNT): 3.1' ags.

*SECONDARY CASING TOP: N/A BOTTOM: N/A TYPE: N/A

SURFACE CASING TOP: 2.3' a.g.s. ID (IN): 2.0

SURFACE SEAL TOP: 0.3' ags BOTTOM: 0.2' bgs TYPE: CONCRETE

PROTECTIVE CASING BOTTOM, ID (IN), TYPE: 1.9', 5"x5" square steel

*WELL PAD DIMENSIONS, TYPE: 3'x3' square, Concrete

*ADD'L CASING FILL TOP: N/A BOTTOM: N/A TYPE: N/A

*SURFACE ISOLATION CASING TOP: N/A BOTTOM: N/A

*SURFACE ISOLATION CASING ID (IN): N/A TYPE: N/A

*OTHER (E.G., ASEPTIC) CASING TOP: N/A BOTTOM: N/A

*OTHER CASING ID (IN): N/A TYPE, PURPOSE: N/A

*CENTRALIZER(S) OD (IN): N/A NUMBER USED: N/A TYPE: N/A

*CENTRALIZER(S) DEPTH(S): N/A

*GROUT TOP: N/A MEASURED DENSITY (LBS/GAL): N/A TYPE: N/A

*GRANULAR BENTONITE TOP: N/A TYPE: N/A

*BENTONITE SEAL TOP: ~~0.5~~ 0.2' TYPE: Med. bentonite chips - Enviroplugs } Hydrated with 5 gall. of dist. $H_2O$

BENTONITE SEAL OR GRANULAR BENTONITE BOTTOM (= FILTER PACK TOP): 4.0'

FILTER PACK TYPE: 14/40 Silica Sand BRAND: C.S.S.I.

SURFACE CASING BOTTOM (=SCREEN TOP): 4.55 TYPE: SCH. 40-PVC

SCREEN ID (IN): 2.0 SLOT SIZE (IN): 0.01 TYPE: SCH. 40-PVC

SCREEN BOTTOM (= SUMP, TOP): 29.65 SUMP TYPE: THREADED END CAP - SCH. 40 - PVC

FILTER PACK BOTTOM (= *BACKFILL TOP): 30.0 *BACKFILL TYPE: Med. bentonite pellets

SUMP BOTTOM (= WELL COMPLETED DEPTH): 30.0' *PILOT HOLE TOP, DIAMETER: 30.0', 2.5"

TOTAL BOREHOLE DEPTH (= *PILOT HOLE AND *BACKFILL BOTTOM): 32.0'

REMARKS: Routine well installation (6/21/05). Concrete pad installed on 6/27/05.

COMPLETED BY: Ellen S. Warp Ellen S. Warp DATE: 6/27/05

CHECKED BY: J. Baylor DATE: 6/30/05

U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT

FORM PRO.101A

# ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

PAGE 1 OF 4

Borehole Number: 73205
Location - North: East:
Date: 6/21/05
Geologist: E. WARP
Drilling Equip.: CME-750-Hollow Stem Auger

Surface Elevation:
Area: Present Landfill
Total Depth: 32.0'
Company: URS/Layne
Project No.: ~~HAD 51300~~ GR201400 ESW 6/21/05
Sample Type: Cont. core - split spoon

RMRS LOGGING SUPERVISOR APPROVAL

DATE 6/29/05

| TOP/BOTTOM OF CORE IN BOX | TOP/BOTTOM OF INTERVAL | FEET OF CORE IN INTERVAL (FIELD MEASUREMENT) | SAMPLE NUMBER | FRACTURE ANGLE | BEDDING ANGLE | GRAIN SIZE DISTRIBUTION | USCS SYMBOL | DEPTH IN FEET | SOIL LITHOLOGIC LOG | SAMPLE DESCRIPTION (silt, JAE 6/29/05) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | | | | | | 0.0 | | 0.0-1.5' - CLAY w/ Tr gravel and Tr sand. Brn. (7.5YR 4/3). Med. plasticity and firm. Tr-3% diss. caliche. Tr roots. Cobble of schist (3/4" dia., sub-ang) @ 0.3'. Sl. moist to moist. |
| | Run #1 | Rec.=1.5' | | | | | CL | 1 | | 1.5-2.0' = No recovery (silt, JAE 6/29/05) |
| | 2.0' | | | | | | | 1.5' | | 2.0-2.4' - CLAY w/ Tr gravel and Tr sand. Brn. (7.5YR 4/4 to 7.5YR 4/2). Med. plasticity and firm. (Same as 0.0-1.5'). Sl. moist |
| | | | | | | | CL | 2 | | |
| | Run #2 | Rec.=1.2' | | | | | GC CL | 2.4' | | 2.4-3.2' - Sandy GRAVEL/CLAY Mixture. Brn. (7.5YR 4/4). ~75% sandy GRAVEL and ~25% clay. Gravel (1/4-1" dia., sub-ang. to sub-rounded, predominately qtzite). Sand (c.g., sub-ang.). Wk. FeOxn diss. throughout clay and as coating on 1/4" gravel clasts. Tr diss. caliche. 2" dia. qtzite cobble at 2.4'. Shattered qtzite cobble fm. 3.0-3.2'. Poor recovery due to cobbles. Sl. moist. |
| | 4.0' | | | Bedrock Contact @ 4.2' | | | | 3 | | |
| | | | | | | | | 3.2' | | 3.2-4.0' = No recovery |
| | Run #3 | Rec.=1.7' | | | | | CL | 4 | | |
| | | | | | | | | 4.2' | | 4.0-4.2' - Sandy, gravelly CLAY. Brn. (7.5YR 4/4). 5-10% gravel (1/4-1/2" dia., sub-rounded to sub-ang. pred. qtzite). 5-7% sand (c.g., sub-ang.). Clay has med. plasticity. Incr'd moisture fm. Sl. moist to moist. Bedrock Contact @ 4.2' |
| | | | | | | | | 4.7' | | |
| | 6.0' | | | | | | | 5 | | |
| | | | | | | | | 5.7' | | |
| | | | | | | | | 6 | | 4.2-4.7' - CLAYSTONE (Bedrock). Grysh Brn. (10YR 5/2) to Gry. (10YR 5/1). Firm/dense. Blk. organic stringers common on undulating bedding planes. 1/4" Caliche lense at base of interval. MOIST. Sharp basal contact, color change. (JAE 6/29/05) |
| | Run #4 | Rec.=1.7' | | | | | | 6.8' | | |
| | | | | | | | | 7 | | 4.7-5.0' - CLAYSTONE - FeOxd/weathered. Yellsh brn. (10YR 4/6). Mod. to strng. perv. FeOxn. Mod. friable. 1/4" caliche lense @ top of interval and as blebs throughout. MOIST. |
| | 8.0' | | | | | | | 7.7' | | |
| | | | | | | | | 8 | | 5.0-5.7' - ~~CLAYSTONE~~ SILT (ESW 6/21/05) Silty CLAYSTONE. Gry (10YR 6/1). Distinct color change. Massive texture. Caliche mottled throughout. Friable. Decrease moisture to V. slightly moist. |
| | | | | | | | | 8.3 | | |
| | Run #5 | Rec.=2.0' | | | | | | 9 | | 5.7-6.0' = No recovery |
| | 10.0' | | | | | | | 10.0' | | 6.0-7.0' - CLAYSTONE - FeOxd/weathered. Yellsh Brn. (10YR 5/6 to 5/4). Wk. perv. FeOxn. Wk. to moderately friable. Tr wht. caliche stringers. |

Box #1 (0.0 → 10.0')

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
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Procedure No. RMRS/OPS-PRO.101
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(4011-930-0134-930)(Form GT.1A)(03/01/97)

Thin caliche lense @ 6.8'. Sl. MOIST.
(see page 2 for 7.0'-10.0' description).

U.S. DEPARTMENT OF ENERGY ROCKY FLATS PLANT

FORM PRO.101A

# ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG



Borehole Number: 73205
Location - North: _____ East: _____
Date: 6/21/05
Geologist: E. WARP
Drilling Equip. CME-750 Hollow Stem Auger

Surface Elevation: _____
Area: Present Landfill
Total Depth: 32.0'
Company: URS/Layne
Project No.: ~~HA051300~~ 6R201400 6/21/05
Sample Type: Cont. core split spoon

RMRS LOGGING SUPERVISOR APPROVAL _____ DATE 6/29/05

| TOP/BOTTOM OF CORE IN BOX | TOP/BOTTOM OF INTERVAL | FEET OF CORE IN INTERVAL (FIELD MEASUREMENT) | SAMPLE NUMBER | FRACTURE ANGLE | BEDDING ANGLE | GRAIN SIZE DISTRIBUTION | USCS SYMBOL | DEPTH IN FEET | SOIL/ LITHOLOGIC LOG | SAMPLE DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|
| Box #2 (10.0→18.0') | 10.0' Run #6 12.0' | Rec. = 2.0' | | | | | | 10.0 | | 7.0-7.7 - CLAYSTONE, Gry'sh Brn. (10YR5/2). Decr. FeOxn to Tr as stringers. Mod. friable. Massive texture. Sl. moist. 7.7-8.0 = No recovery 8.0-8.3' - Silty CLAYSTONE - FeOxd. Yell'sh Brn. (10YR5/4). Wk to mod. perv. FeOxn. Massive texture. Wk. to moderately friable. Blk. MnOx (possible organics) bleb @ 8.2'. Sl. moist. |
| | Run #7 14.0' | Rec. = 2.0' | | | | | | 11 12 13 13.3 | | 8.3-12.0' - CLAYSTONE - Gry (10YR5/1). Decr. FeOxn to Tr. Massive texture. Firm yet wkly. friable. Tr blk. organic stringers throughout. Blk. organic lense (1/8" thick) @ 11.2'. Tr FeOxn stringers fm. 11.2 to 12.0. Decr. moisture to V. sl. moist. Hard. Cryptocrystalline calcareous clast ~3/8" dia. 6/29/05 |
| | Run #8 16.0' | Rec. = 2.0' | | | | | | 14 15 | | 12.0-13.3 - CLAYSTONE - Gry (10YR6/1). Massive texture. Dense/firm, wkly friable. Tr to some FeOxn. Abundant blk. organic material fm. 12.8 to 13.0'. V. sl. moist. 6/29/05 13.3-15.0' - CLAYSTONE - Wh'sh Gry (10YR6/1). Massive texture as above fm. 12.0-13.3'. Un-old bedrock. Tr blk. organic stringers. Firm/dense. Thin caliche lense along internal bedding plane @ 13.7'. V. sl. moist. |
| | Run #9 18.0' | Rec. = 2.0' | | | | | | 16 17 | | 15.0-20.8' - Silty CLAYSTONE, Gry (10YR6/1). Wk. FeOxn along horizontal bedding planes. Predominately massive texture. Tr blk. organic stringers and blebs. Firm/dense. Wk. to mod. perv. FeOxn fm. 17.3 to 17.7'. Near vertical fracture (~80°) fm. 18.9 to 19.5' with FeOx coating. 1/4" horizontal lense of carbonate (druse) @ 19.7'. Interval Sl. MOIST. Occ. sandy intervals, as at 17.1', 17.6-17.7' and claystone intervals, as at 18.8-19.1'. Rip-up clasts, FeOx. replaced organic debris present. Sand is vfg-fg. |
| 18.0' | Run #10 | Rec. = 2.0' | | ~80° | | | | 18 19 20.0 | | 6/29/05 |

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO.101
Revision 0
Date effective: 12/31/98

# ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG

Borehole Number: 73205
Location - North: _____ East: _____
Date: 6/21/05
Geologist: E. Warp
Drilling Equip.: CME-150 - Hollow Stem Auger

Surface Elevation: _____
Area: Present Landfill
Total Depth: 32.0'
Company: URS/Layne
Project No.: ~~HAN5T30A~~ GR201400 6/21/05
Sample Type: Continuous Core - Split spoon

RMRS LOGGING SUPERVISOR APPROVAL _____ DATE 6/29/05

| TOP/BOTTOM OF CORE IN BOX | TOP/BOTTOM OF INTERVAL | FEET OF CORE IN INTERVAL (FIELD MEASUREMENT) | SAMPLE NUMBER | FRACTURE ANGLE | BEDDING ANGLE | GRAIN SIZE DISTRIBUTION | USCS SYMBOL | DEPTH IN FEET | SOIL/ LITHOLOGIC LOG | SAMPLE DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|
| Box #3 (18.0–26.8') | Run #11 22.0' | Rec. = 2.0' | | ~60° | | | | 20.0 | | 20.0-20.8 - See previous page for description. Silty CLAYSTONE |
| | | | | | | | | 20.8 | | 20.8-21.6' - CLAYSTONE - Grysh Brn. (10YR5/2) Wk. FeOxn as stringers and along bedding planes. Blk. organic material along bedding planes. Poss. MnOx associated w/ FeOxn along bedding surfaces planes. Dense/firm. Sl. moist. |
| | Run #12 24.0 | Rec. = 2.0' | | ~50° | | | | 21.6 | | 21.6-23.1 - CLAYSTONE - Gry (10YR 6/1 to 5/1). To Wk. FeOxn as stringers and along bedding surfaces planes, FeOxn as fracs. (~50°) coating @ 22.6. Interval wk-moderately friable. Massive texture. Slightly moist. |
| | Run #13 26.0' | Rec. = 1.6' | | ~80° | | | | 23.1 | | 23.1-30.4 - CLAYSTONE - Dk. Gry (10YR 4/1) Firm/Dense. To FeOxn along bedding planes. Bedding planes are faintly visible. To Blk. organic material along bedding and as clasts (to 1/2" diam.). Wk. perv. FeOxn fm. 29.1-29.3. Slightly moist fm. 23.1-24.2', decr. to To moisture fm. ~~23.1~~ 24.2' to 30.4'. 6/21/05 |
| Box #4 (26.8'–32.0') | Run #14 28.0' | Rec. = 2.0' | | ~70° | | | | 26.8' | | |
| | Run #15 30.0' | Rec. = 2.0' | | ~70° | | | | 30.0 | | |

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO.101
Revision 0
Date effective: 12/31/98
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# ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE BOREHOLE LOG



Borehole Number: 73205
Location - North: _____ East: _____
Date: 4/21/05
Geologist: E. WARP
Drilling Equip.: CME-750-Hollow Stem Auger

Surface Elevation: _____
Area: Present Landfill
Total Depth: 32.0'
Company: URS/Layne Project No. GR201400
Sample Type: Continuous Core - Split Spoon

RMRS LOGGING SUPERVISOR APPROVAL _____ DATE 6/29/05

| OF CORE IN BOX | TOP/BOTTOM OF INTERVAL | FEET OF CORE IN INTERVAL (FIELD MEASUREMENT) | SAMPLE NUMBER | FRACTURE ANGLE | BEDDING ANGLE | GRAIN SIZE DISTRIBUTION | USCS SYMBOL | DEPTH IN FEET | SOIL/ LITHOLOGIC LOG | SAMPLE DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|
| | 30.0' | | | | | | | 30.0' | | 30.0-30.4 - CLAYSTONE - SEE PREVIOUS PAGE FOR DESC. |
| (26.8-32.0') | | Rec = 2.0' Run #16 | | | | | | 30.4 | | 30.4'-32.0' - CLAYSTONE - Un-Fe Ox'd/Un-weathered. V. Dk Gry (10YR 3/1); Firm and dense. Tr Fe Ox stringers @ 31.8-31.9'. Distinct color change. Sub-horizontal, undulatory bedding faint ~1/4" visible. Blk. organic material / commch along bedding planes and as clasts to 1/2" diam. Tr moisture. T.D. @ 32.0' |
| | 32.0' | | | T.D.@32.0' | | | | 32.0' | | |

6/29/05

NOTES: General: USCS is modified for this log as follows:
Materials amounts are estimated by % volume instead of % weight.
(1) Badly broken core, accurate footage measurements not possible.
(2) Core breaks cannot be matched, accurate footage measurements not possible.

Procedure No. RMRS/OPS-PRO.101
Revision 0
Date effective: 12/31/98



01 34-910) Form GT.1A(03/01, V2)

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