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ROCKWELL INTERNATIONAL
NORTH AMERICAN SPACE OPERATIONS
ROCKY FLATS PLANT

INTERIM REMEDIAL ACTION PLAN FOR 881 HILLSIDE AREA

MAY, 1989

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado

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ADMIN RECORD

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INTERIM ACTION PLAN FOR THE 881 HILLSIDE AREA

Rockwell International
U.S.D.O.E.
Rocky Flats Plant

May 5, 1989

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SECTION 1

INTRODUCTION

The Department of Energy (DOE) wishes to pursue an Interim Remedial Action (IRA), at the High Priority Sites (881 Hillside Area) at the Rocky Flats Plant (RFP). This interim action is to be conducted to minimize the release of hazardous substances from this Area that pose a potential long-term threat to the public health and environment. Although this is considered a "non-time-critical" interim action, DOE would like to implement this action because of the length of time it typically takes to finalize the Remedial Investigation/Feasibility Study (RI/FS) and Record of Decision (ROD), and to implement remedial action under the CERCLA process.

Rockwell International has prepared this IRA plan to identify, screen, and evaluate appropriate remedial action technologies, and select the preferred remedial action for the Area. This IRA Plan has been prepared to conform with the requirements for an Engineering Evaluation/Cost Analysis (EE/CA) as defined in the proposed National Contingency Plan [40 CFR 300.415(b)(4)].

In March 1987, a remedial investigation under the Environmental Restoration (ER) Program [formerly known as the Comprehensive Environmental Assessment and Response Program (CEARP)] began at the twelve sites comprising the 881 Hillside Area. The investigation consisted of the preparation of detailed topographic maps, radiometric and organic vapor screening surveys, surface geophysical surveys, a soil gas survey, a boring and well completion program, soil sampling and ground and surface water sampling. The results of this remedial investigation are presented in the Draft Final Remedial Investigation Report for High Priority Sites (Rockwell

International, 1988a). A feasibility study was also conducted for the 881 Hillside Area, the results of which are presented in the Draft Feasibility Study Report for High Priority Sites (Rockwell International, 1988b). Rockwell has also prepared a detailed response to EPA comments on the RI and FS reports (Rockwell International, 1989). Section 2.0 (Site Characterization) of this IRA plan describes the results of previous investigations of the 881 Hillside. Most of the information included in Section 2.0 has been derived from the RI report, although chemical data has been updated to include all data collected through December 1988.

Section 3.0 identifies the objectives of the IRA. The objectives will define criteria used to identify and evaluate IRA options.

Section 4.0 identifies technically feasible ground water treatment technologies, screens these technologies based on implementability, effectiveness, and costs, integrates the preferred ground water treatment technology into alternative IRA options that address the objectives, and screens these alternatives based on implementability, effectiveness, and costs. Most of the information included in Section 4.0 has been derived from the FS report.

Section 5.0 summarizes the detailed analysis performed in Section 4.0, and Section 6 presents the preferred IRA.

SECTION 2.0

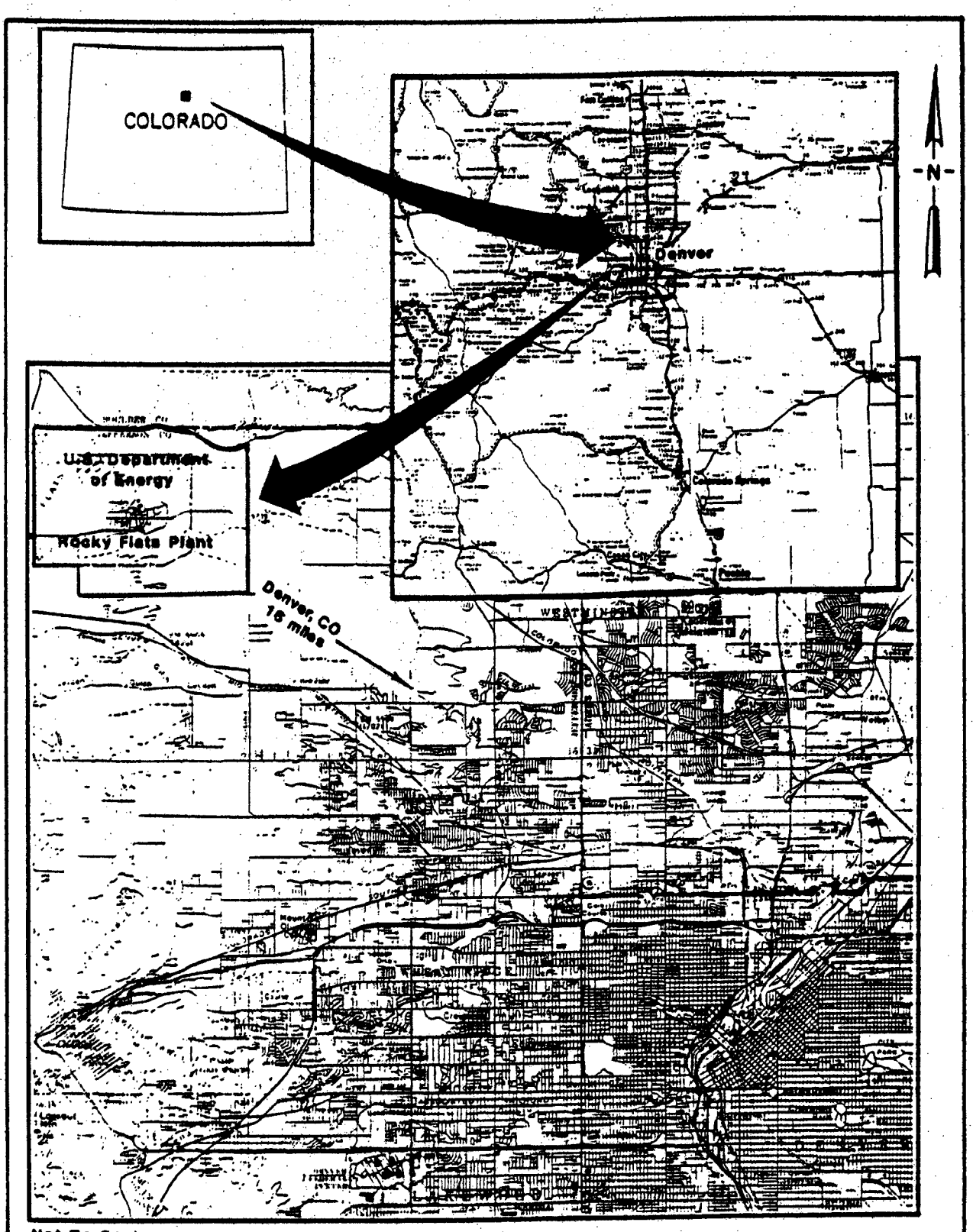
SITE CHARACTERIZATION

2.1 SITE DESCRIPTION AND BACKGROUND

2.1.1 Location and Facility Type

The Rocky Flats Plant (RFP) is located in northern Jefferson County, Colorado, approximately 16 miles northwest of downtown Denver (Figure 2-1). The Plant site consists of approximately 6,550 acres of federally-owned land in Sections 1 through 4, and 9 through 15, of T2S, R70W, 6th principal meridian. Major buildings are located within an area of approximately 400 acres, known as RFP security area. The security area is surrounded by a buffer zone of approximately 6,150 acres.

The RFP is a government-owned, contractor-operated (GOCO) facility. It is part of a nation-wide nuclear weapons research, development, and production complex administered by the Albuquerque Operations Office of the U.S. Department of Energy. The operating contractor for the Rocky Flats Plant is Rockwell International. The facility manufactures components for nuclear weapons and has been in operation since 1951. RFP fabricates components from plutonium, uranium, beryllium, and stainless steel. Production activities include metal fabrication, machining, and assembly. Both radioactive and nonradioactive wastes are generated in the process. Current waste handling practices involve on-site and off-site recycling of hazardous materials and off-site disposal of solid radioactive materials at another DOE facility.



Not To Scale

Figure 2-1 : Location of Rocky Flats Plant

The RFP is currently an interim status Resource Recovery and Conservation Act (RCRA) hazardous waste treatment/storage facility. In the past, both storage and disposal of hazardous and radioactive wastes occurred at on-site locations. Preliminary assessments conducted under Phase 1 of the ER Program identified some of the past on-site storage and disposal locations as potential sources of environmental contamination.

2.1.2 881 Hillside Area Description

There are twelve sites, designated as solid waste management units (SWMUs), which comprise the 881 Hillside Area. These sites were investigated as high priority sites because of elevated concentrations of volatile organic compounds in the ground water and the close proximity of the sites to a surface drainage. The 881 Hillside Area is located at the southeast corner of RFP (Figure 2-2). A brief description of each site in the 881 Hillside Area is presented below.

1. **Oil Sludge Pit (SWMU 102)** -- A small pond located south of Building 881 was used for disposal of oil sludges in the late 1950s.

2. **Chemical Burial Site (SWMU 103)** -- A small pit was used for disposal of liquid wastes southeast of Building 881 in the early 1960s.

3. **Liquid Dumping (SWMU 104)** -- An area east of Building 881 was reportedly used for disposal of unknown liquids prior to 1969.

4,5. **No. 6 Fuel Oil Tanks (SWMUs 105.1 & 105.2)** -- Two fuel oil tanks are located south of Building 881; they are out of service and filled with concrete.

6. **Outfall Site (SWMU 106)** -- An overflow line from the sanitary sewer sump south of Building 881 daylights on the slope below the Building.

7. **Hillside Oil Leak (SWMU 107)** -- Oil was discovered flowing from the Building 881 footing drain in early 1973. The source of the oil was never positively identified but the oil was collected in a skimming pond and transported off site. There is an ongoing discharge of water from the footing drain.

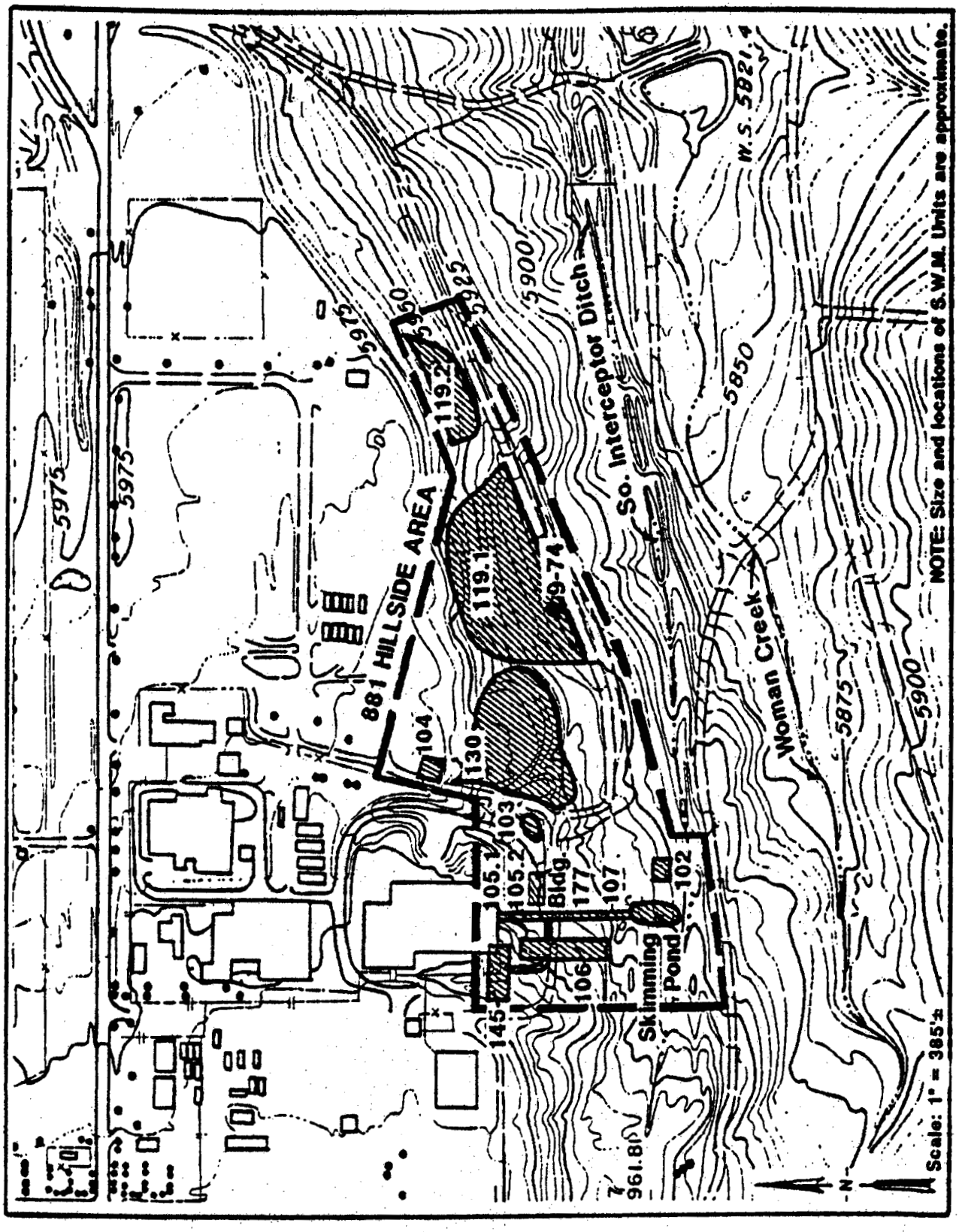


Figure 2-2: 881 HILLSIDE AREA SITE MAP

8,9. **Multiple Solvent Spills (SWMUs 119.1 & 119.2)** -- Two areas east of Building 881 were used for barrel storage between 1969 and 1972.

10. **Radioactive Site (SWMU 130)** -- Soils contaminated with low levels of radionuclides were placed on the hillside east of Building 881 and covered with soil between 1969 and 1972.

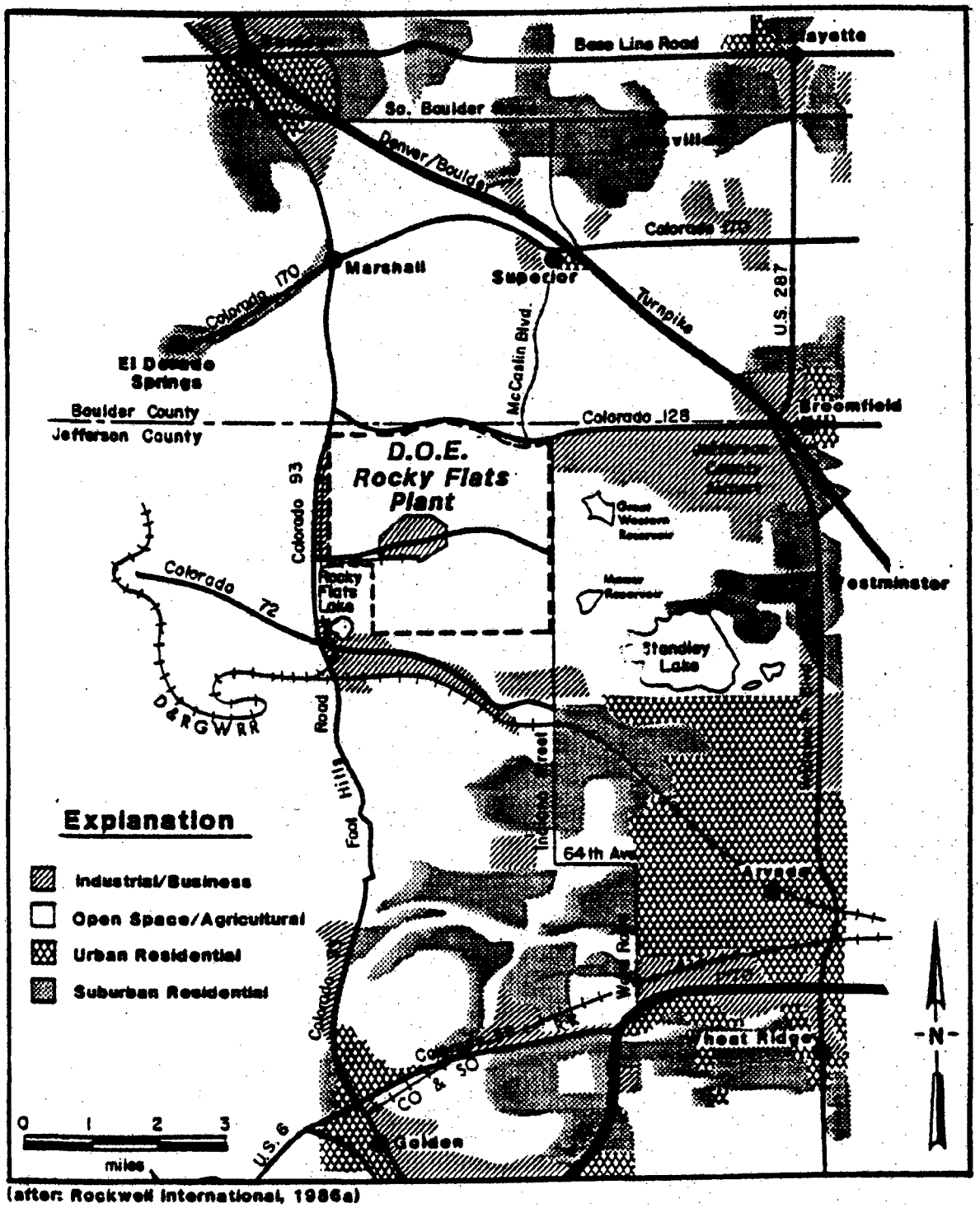
11. **Sanitary Sewer Line Leak (SWMU 145)** -- The sanitary sewer line leaked on the hillside southwest of Building 881 in early 1981.

12. **Drum Storage Area (SWMU 177)** -- Building 885 is currently used for satellite collection and 90-day accumulation of RCRA-regulated wastes. The building will be closed and soil remediation addressed under RCRA Interim Status (6 CCR 1007-3). Ground-water contamination will be addressed as part of the 881 Hillside Area RI/FS performed under CERCLA.

2.1.3 Surrounding Land Use and Population Density

The Rocky Flats Plant is located in a rural area (Figure 2-3). There are no public facilities or institutions such as schools, prisons, or hospitals within five miles of RFP. The nearest educational facility is the Sierra Elementary School, which is six miles southeast of RFP. Other schools are located in the same general area, but somewhat farther from RFP. The closest hospital to RFP is Boulder Memorial Hospital, 10 miles northwest. The closest park and recreational area is the Standley Lake area, which is approximately 5 miles from RFP site. Boating, picknicking, and limited overnight camping are permitted. Several other small parks exist in communities within 10 miles of RFP. The closest major park, Golden Gate Canyon State Park, located approximately 15 miles to the southwest, provides 8,400 acres of general camping and outdoor recreation. Other national and state parks are located in the mountains west of RFP, but all are more than 15 miles away.

Some of the land adjacent to RFP is zoned for industrial development. Industrial facilities within 5 miles of RFP include the TOSCO laboratory (40-acre site located 2 miles south), the Great Western Inorganics Plant (2 miles south), the Frontier



(after: Rockwell International, 1986a)

Figure 2-3:

Land Use in the Vicinity of Rocky Flats Plant

Forest Products yard (2 miles south), the Idealite lightweight aggregate RFP (2.4 miles northwest), and the Jeffco Airport and Industrial Park (990-acre site located 4.8 miles northeast).

Several ranches are located within 10 miles of RFP, primarily in Jefferson and Boulder Counties. They are operated to produce crops, raise beef cattle, supply milk, and breed and train horses. According to the 1977 Colorado Agricultural Statistics, 14,000 acres of crops were planted in 1976 in Jefferson County (total land area of approximately 475,000 acres) and 56,200 acres of crops were planted in Boulder County (total land area of 405,760 acres). Crops consisted of winter wheat, corn, barley, dry beans, sugar beets, hay, and oats. Livestock consisted of 9,500 head of cattle, 200 pigs, and 400 sheep in Jefferson County, and 34,000 head of cattle, 2,300 pigs, and 6,500 sheep in Boulder County.

Approximately 50 percent of the area within 10 miles of RFP is in Jefferson County. The remainder is located in Boulder County (40 percent) and Adams County (10 percent). According to the 1973 Colorado Land Use Map, 75 percent of this land was unused or was used for agriculture. Since that time, portions of this land have been converted to housing, with several new housing subdivisions being started within a few miles of the buffer zone. One such subdivision is located south of the Jefferson County Airport and several are located southeast of RFP.

A demographic study using 1980 census data (Setlock and Barker, 1985) shows that approximately 1.8 million people lived within 50 miles of RFP in 1980. This was projected to increase to 3.5 million people by the year 2000. Approximately 9,500 people lived within 5 miles of RFP in 1980, with a projected increase to 20,000 people by the year 2000. The most populous sector was to the southeast, toward the center of

Denver. This sector had a 1980 population of about 555,000 people living between 10 and 50 miles from RFP, with a projected increase to 1.5 million by the year 2000.

2.1.4 Site Topography and Geology

2.1.4.1 Topography

The Rocky Flats Plant is located at an elevation of approximately 6,000 feet above mean sea level. The site is on the western margin of the Colorado Piedmont section of the Great Plains Physiographic Province. The piedmont represents an old erosional surface along the eastern margin of the Rocky Mountains. It is underlain by gently dipping sedimentary rocks (Paleozoic to Cenozoic in age) which are abruptly upturned at the Front Range (just west of RFP) to form hogback ridges parallel to the mountain front. The piedmont surface is broadly rolling and slopes gently to the east with a topographic relief of only several hundred feet. This relief is due both to resistant bedrock units that locally rise above the surrounding landscape and to the presence of incised stream valleys.

2.1.4.2 881 Hillside Area Geology

The 881 Hillside is located on the southern flank of RFP on a slope from the Rocky Flats surface down to Woman Creek. The following geologic information is based on the RI Report (Rockwell International, 1988a), and the reader is referred to this report for additional details.

Surficial Materials

Surficial materials at the 881 Hillside Area consist of the Rocky Flats Alluvium, colluvium, valley fill alluvium, and artificial fill unconformably overlying

bedrock. In addition, there are a few isolated exposures of claystone bedrock. The study area is located on the south-facing hillside which slopes down from the Rocky Flats terrace surface toward Woman Creek on the south side of RFP. Rocky Flats Alluvium caps the top of the slope, and colluvium (slope wash) covers the hillside. Artificial fill and disturbed surficial materials are present around Building 881 and south of the building to the South Interceptor Ditch. Artificial fill overlies colluvium at SWMU 130, and surficial materials are disturbed in the vicinity of SWMUs 119.1 and 119.2. Valley fill alluvium is present along the drainage of Woman Creek south of the 881 Hillside Area, and terrace alluvium occurs on the north side of the Woman Creek valley fill alluvium.

Of particular significance with respect to contaminant transport in alluvial ground water are the presence of gravel layers in colluvial materials overlying bedrock and near surface. These gravels were likely deposited in a south (downslope) direction by creep and slope wash erosion of the Rocky Flats Alluvium and can be expected to be elongated in the north-south direction with rather limited extent in the east-west. The gravel layers range from 1.3 feet to 5.5 feet in thickness.

Bedrock Material

The Cretaceous Arapahoe Formation underlies surficial materials at the 881 Hillside Area. Six wells were completed in various zones of the bedrock in the 1986 and 1987 drilling programs. The Arapahoe Formation beneath the 881 Hillside consists of claystones with interbedded lenticular sandstones, siltstones, and occasional lignite deposits. The Arapahoe Formation was deposited by meandering streams flowing generally from west to east off the Front Range. Sandstones were deposited in steam channels and as overbank splays, and claystones were deposited in back

swamp and floodplain areas. Leaf fossils, organic matter, and lignite beds were encountered within the claystones during drilling at the 881 Hillside. Contacts between various lithologies are both gradational and sharp. Bedrock is estimated to dip approximately 7 degrees to the east.

Claystone bedrock was the most frequently encountered lithology of the Arapahoe Formation immediately below the bedrock contact. Weathered bedrock was encountered directly beneath surficial materials in all of the boreholes and wells, and weathering appears to penetrate as much as 60 feet below ground surface. The weathered claystone is also characterized by moderate fracturing and thus exhibits higher hydraulic conductivities than unweathered claystone.

Arapahoe sandstones were encountered beneath the 881 Hillside. These sandstones are generally composed of well sorted, subrounded to rounded, very fine- to medium-grained, poorly to moderately well cemented quartz sand with up to 10% lithic fragments. The thickness of individual sandstone beds ranged from approximately five feet to twelve feet.

2.1.5 Sensitive Environments, Surface Water, and Ground Water

2.1.5.1 Sensitive Environments

The Endangered Species Act of 1973 (Public Law 93-0205), as amended, provides that all federal agencies shall carry out programs for the conservation of listed endangered and threatened species. Federal agencies must ensure that actions authorized, funded, or carried out by them will not jeopardize the continued existence of any endangered or threatened species or result in the destruction or

adverse modification or critical habitats as determined by the Secretary of the Interior.

The 881 Hillside Area is not used, nor intended for use, as a public or recreational area, nor for the development of any unique natural resource. No unique ecosystems were found at RFP during extensive biological studies. Communication with the U.S. Fish and Wildlife Service resulted in a finding of no affect on endangered species due to activities at the 881 Hillside Area (personal communication with Mike Lockhart of the U.S.F.W.S., February 1988).

There are no flood plains, wetlands, or historical/archaeological features at the 881 Hillside Area.

2.1.5.2 Surface Water

Woman Creek is an eastward-flowing, ephemeral stream located to the south of the 881 Hillside. The stream drains the southern portion of the Rocky Flats Plant site, and delivers water to Mower Reservoir and Standley Lake which are respectively used for agricultural and domestic water supply (see Figure 2-4). The South Interceptor Ditch, located between the 881 Hillside and Woman Creek, extends from the old landfill to Pond C-2 in the Woman Creek drainage. The ditch isolates runoff from the south side of RFP (including the 881 Hillside) from Woman Creek. Surface water flowing in an easterly direction along the South Interceptor Ditch is collected in Pond C-2, from which it is discharged to Woman Creek in accordance with RFP NPDES permit. The permitted discharge point is designated 007. Pond C-1 receives flow from Woman Creek. A diversion structure located upstream of Pond C-2 diverts flow in Woman Creek around Pond C-2 and into the Woman Creek channel downstream. Along Woman Creek and the South Interceptor Ditch, retention ponds

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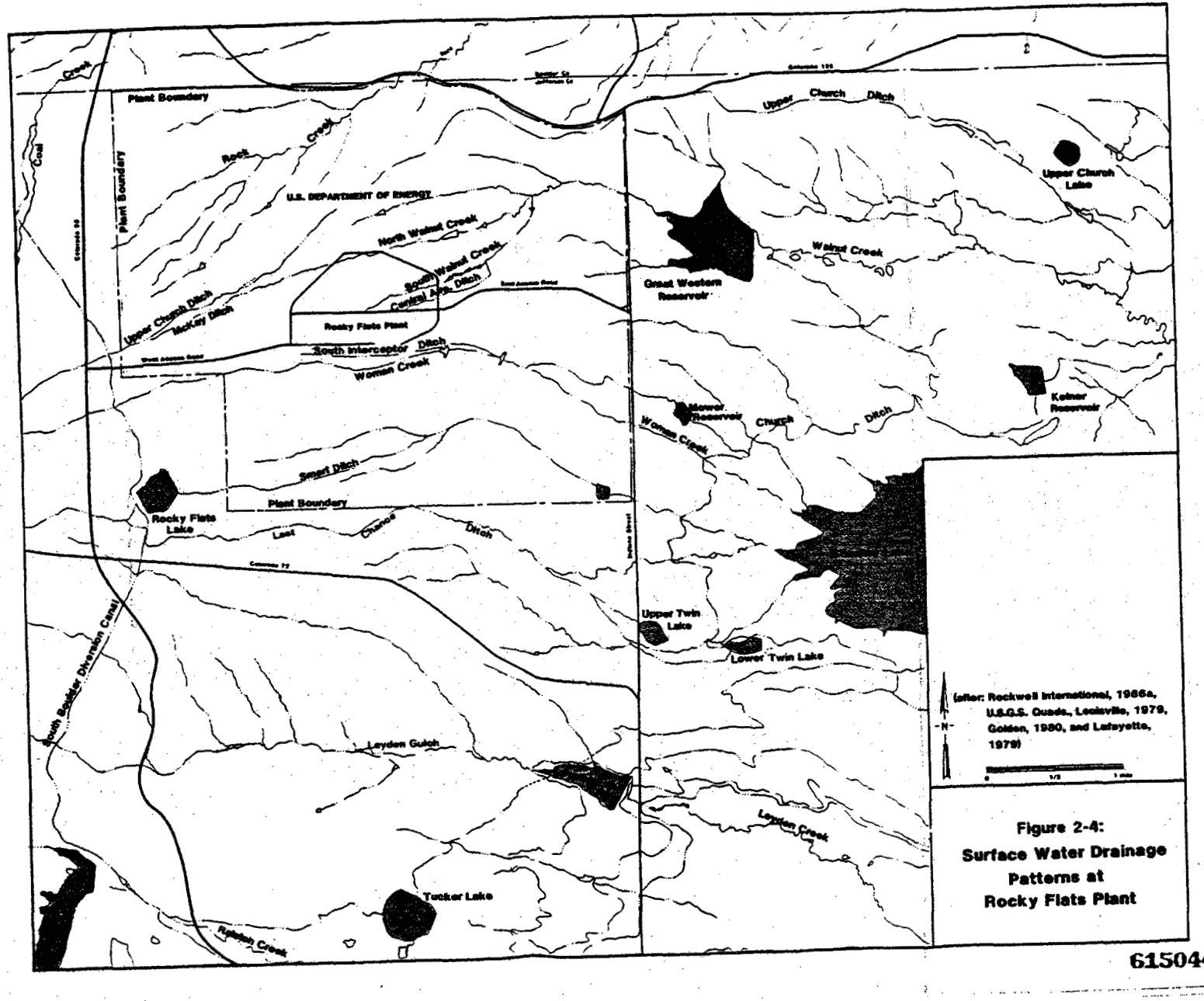

Figure 2-4:
Surface Water Drainage Patterns at Rocky Flats Plant

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valley fill has been estimated at 650 ft/yr. Assuming that ground water flows at this velocity for about three-quarters of the year (i.e., when saturated), a molecule of a conservative solute would travel the 10,000 feet in the valley fill alluvium for the Hillside to the property boundary in about 20 years (Rockwell International, 1989).

Bedrock Ground-Water Flow System

Ground-water flow in the Arapahoe Formation occurs primarily in the sandstones contained within the claystones. Ground-water recharge to sandstones occurs as infiltration from alluvial ground water where sandstones subcrop beneath the alluvium and by leakage through the claystones overlying the sandstones.

There is a strong downward gradient between ground water in surficial materials and bedrock. Vertical gradient data are provided in the RI report (Rockwell International, 1988a). Calculated vertical gradients range from about 2 to 0.3. The presence of unsaturated conditions in some locations and high vertical gradients where subsurface materials are continuously saturated indicates that the intervening material (claystone) has a very low hydraulic conductivity.

Ground-water flow within individual sandstones is from west to east. The maximum horizontal ground-water velocity in sandstone is estimated at about 36 ft/yr. Ground water moves at these rates only if the sandstone unit is continuous or has good interconnection with an adjacent unit. To date, lateral continuity of sandstone units along strike has been demonstrated to be small and only a few correlations have been made along dip.

Usable ground water occurs in the Arapahoe Aquifer. Water in sandstones of the Arapahoe Aquifer are used for irrigation, livestock watering, and domestic purposes east of RFP.

2.1.6 Contaminants -- Description and Sources

2.1.6.1 Ground Water Contamination

Organic contamination of alluvial ground water at the 881 Hillside Area is evident, although the existence of inorganic contamination in either alluvial or bedrock ground water is uncertain at this time. This is due to the limited data on background chemical conditions for alluvial and bedrock ground water. Water quality data from wells 55-86 (alluvial) and 54-86 (bedrock), located southwest of the plant and upgradient of all known SWMUs, are the only current data available for characterizing background ground water chemistry. Although over two years of quarterly data exist for these wells, the data is considered insufficient for background characterization for the following reasons:

1) the data does not account for spatial variability;

2) for alluvial ground water, the data may not be representative of colluvial ground water chemistry; and

3) for bedrock ground water, the well is completed in a Laramie Formation sandstone, whereas the bedrock ground water under evaluation at the 881 Hillside occurs in Arapahoe Formation sandstones.

A background characterization study is currently underway to provide more definitive information of the spatial and temporal variability of alluvial, colluvial, valley fill, and bedrock ground-water quality. These data will be used to evaluate the nature and extent of inorganic contamination at the 881 Hillside and remedial action alternatives that address this contamination for the final RI/FS report. This IRA

only addresses organic contamination of alluvial ground water at the 881 Hillside Area.

Alluvial ground water is contaminated with various volatile organic compounds (VOCs). Alluvial ground water at the 881 Hillside Area has been divided into three groups on the basis of contaminant migration pathway or nature of the contamination as follows:

1) The Building 881 footing drain discharge (SWMU 107), i.e., alluvial ground water discharging to a surface water pathway.

2) Alluvial ground water beneath or in the immediate vicinity of the 881 Hillside Area characterized by the presence of VOCs in many of the wells.

3) Alluvial ground water downgradient of the 881 Hillside Area beyond the limits of VOC contamination.

For each of these groups, the nature of organic contamination is summarized in Tables 2-1, 2-2, and 2-3. Well locations are identified on Figure 2-5. Each table identifies the maximum, minimum, and average concentrations of VOCs that were detected. The chemical-specific ARARs are also identified in the tables. The footing drain discharge is characterized by low concentrations of VOCs. On the average, only methylene chloride and trichloroethene (TCE) exceed ARARs. Alluvial ground water at the 881 Hillside Area is characterized by significant VOC contamination. High concentrations of VOCs are notably present in the vicinity of SWMU 119.1 at well 9-74. Downgradient of the 881 Hillside, the alluvial ground-water chemistry is characterized by the apparent absence of VOC contamination. The methylene chloride and acetone are suspected laboratory contaminants because of their presence in associated laboratory blanks, and the 1,1-Dichloroethene was detected only once in well 2-87 at a level near the detection limit.

TABLE 2-1
VOLATILE ORGANIC COMPOUND CONCENTRATIONS ABOVE ESTIMATED BACKGROUND FOR BUILDING 881 FOOTING DRAIN DISCHARGE
ALL CONCENTRATIONS IN ug/l

Analyte	Background Value		ARAR/TBC Value		Reported when the maximum value exceeds Background: Maximum Value		Minimum Value		Average of All Values**	Wells/Stations in which Background Value was exceeded
Chloromethane	10	U								
Bromomethane	10	U								
Vinyl Chloride	10	U								
Chloroethane	10	U								
Methylene Chloride	5	U	5		21 +		5	U	12 +	SW45
Acetone	10	U	10	U*						
Carbon Disulfide	5	U								
1,1-Dichloroethene	5	U	7							
1,1-Dichloroethane	5	U	5	U*						
Trans-1,2-Dichloroethene	5	U	70							
Chloroform	5	U	5	U*						
1,2-Dichloroethane	5	U	5							
2-Butanone	10	U								
1,1,1-Trichloroethane	5	U	200							
Carbon Tetrachloride	5	U	5		6 +		4	U	4	SW45
Vinyl Acetate	10	U								
Bromodichloromethane	5	U								
1,2-Dichloropropane	5	U								
Trans-1,3-Dichloropropene	5	U								
Trichloroethene	5	U	5		14 +		5	U	8 +	SW45
Dibromochloromethane	5	U								
1,1,2-Trichloroethane	5	U	5	U*						
Benzene	5	U	5	U*						
cis-1,3-Dichloropropene	5	U								
2-Chloroethylvinylether	10	U								
Bromoform	5	U								
4-Methyl-2-pentanone	10	U								
2-Hexanone	10	U								
Tetrachloroethene	5	U	5		128 +		3	J	49 +	SW45
1,1,2,2-Tetrachloroethane	5	U								
Toluene	5	U	2000		12		5	U	7	SW45
Chlorobenzene	5	U								
Ethylbenzene	5	U								
Styrene	5	U								
Total Xylenes	5	U								

* No standard, RCRA Appendix IX constituent, therefore background value is TBC + - Value exceeds ARAR/TBC

**The average is computed by first determining the arithmetic mean concentration at individual wells/stations and then using this data to compute the arithmetic mean for the wells/stations in this group. If a datum indicates non-detected, the value used in the computation is one-half the detection limit.

NS-No Standard. U-Detection Limit. J-Present below Detection Limit. B-Present in Blank _____ - Average exceeds background

Notes: Minimum, Maximum, and Average based on 1987/1988 Quarterly Data.
Background values based on upper limit of values found in well 55-86 for alluvial wells and well 54-86 for bedrock wells.
Wells/Stations in this group: SW45

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TABLE 2-2
VOLATILE ORGANIC COMPOUND CONCENTRATIONS ABOVE ESTIMATED BACKGROUND FOR ALLUVIAL WELLS AT THE 881 HILLSIDE
ALL CONCENTRATIONS IN ug/l

Reported when the maximum value exceeds Background

Analyte	Background Value		ARAR/TBC Value		Maximum Value		Minimum Value		Average of All Values**		Wells/Stations in which Background Value was exceeded
Chloromethane	10	U									
Bromomethane	10	U									
Vinyl Chloride	10	U									
Chloroethane	10	U									
Methylene Chloride	5	U	5		61 +		1	J	8	+	0974, 4387, 5287, 5387
Acetone	10	U	10	U*	130	B +	4	JB	8		4387, 5287, 5487
Carbon Disulfide	5	U									
1,1-Dichloroethene	5	U	7		48000 +		3	J	2577	+	0974, 0487, 4387, 5287, 5387
1,1-Dichloroethane	5	U	5	U*	350 +		5	U	30	+	0974, 4387, 5287
Trans-1,2-Dichloroethene	5	U	70		5070 +		4	U	122	+	0974, 4387, 5287
Chloroform	5	U	5	U*	51 +		3	JB	6	+	1074, 5287, 5487
1,2-Dichloroethane	5	U	5		16000 +		4	J	185	+	0974, 1074, 0487, 4387, 5287
2-Butanone	10	U									
1,1,1-Trichloroethane	5	U	200		30250 +		2	J	1850	+	0974, 1074, 0487, 4387, 5287, 5387
Carbon Tetrachloride	5	U	5		28000 +		4	U	563	+	0974, 1074, 0487, 4387, 5287, 5387
Vinyl Acetate	10	U									
Bromodichloromethane	5	U									
1,2-Dichloropropane	5	U									
Trans-1,3-Dichloropropene	5	U									
Trichloroethene	5	U	5		72000 +		2	J	2890	+	0974, 1074, 0487, 0687, 4387, 5287, 5387
Dibromochloromethane	5	U									
1,1,2-Trichloroethane	5	U	5	U*	14740 +		4	U	247	+	0974, 4387, 5287
Benzene	5	U	5	U*	83 +		5	U	4		4387, 5287
cis-1,3-Dichloropropene	5	U									
2-Chloroethylvinylether	10	U									
Bromoform	5	U									
4-Methyl-2-pentanone	10	U									
2-Hexanone	10	U									
Tetrachloroethene	5	U	5		13200 +		2	J	1023	+	0974, 1074, 0487, 4387, 5287
1,1,2,2-Tetrachloroethane	5	U									
Toluene	5	U	2000		227		0.9	JB	13		0974, 4387, 5287, 5387
Chlorobenzene	5	U									
Ethylbenzene	5	U									
Styrene	5	U									
Total Xylenes	5	U									

* No standard, RCRA Appendix IX constituent, therefore background value is TBC + - Value exceeds ARAR/TBC

**The average is computed by first determining the arithmetic mean concentration at individual wells/stations and then using this data to compute the arithmetic mean for the wells/stations in this group. If a datum indicates non-detected, the value used in the computation is one-half the detection limit.

NS-No Standard. U-Detection Limit. J-Present below Detection Limit. B-Present in Blank _____ - Average exceeds background

Notes: Minimum, Maximum, and Average based on 1987/1988 Quarterly Data.
Background values based on upper limit of values found in well 55-86 for alluvial wells and well 54-86 for bedrock wells.
Wells/Stations in this group: 0974, 1074, 0187, 0487, 0687, 4387, 4487, 4987, 5087, 5187, 5287, 5387, 5487

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TABLE 2-3
VOLATILE ORGANIC COMPOUND CONCENTRATIONS
ABOVE ESTIMATED BACKGROUND FOR ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE
ALL CONCENTRATIONS IN ug/l

Analyte	Background Value		ARAR/TBC Value		Reported when the maximum value exceeds Background: Maximum Value		Minimum Value		Average of All Values**	Wells/Stations in which Background Value was exceeded
Chloromethane	10	U								
Bromomethane	10	U								
Vinyl Chloride	10	U								
Chloroethane	10	U								
Methylene Chloride	5	U	5		35	B +	2	JB	6 +	6586, 6686, 0287, 4787, 5587
Acetone	10	U	10	U*	65	B +	4	JB	7	0287, 4887
Carbon Disulfide	5	U								
1,1-Dichloroethene	5	U	7		6		4	U	2	0287
1,1-Dichloroethane	5	U	5	U*						
Trans-1,2-Dichloroethene	5	U	70							
Chloroform	5	U	5	U*						
1,2-Dichloroethane	5	U	5							
2-Butanone	10	U								
1,1,1-Trichloroethane	5	U	200							
Carbon Tetrachloride	5	U	5							
Vinyl Acetate	10	U								
Bromodichloromethane	5	U								
1,2-Dichloropropane	5	U								
Trans-1,3-Dichloropropene	5	U								
Trichloroethene	5	U	5							
Dibromochloromethane	5	U								
1,1,2-Trichloroethane	5	U	5	U*						
Benzene	5	U	5	U*						
cis-1,3-Dichloropropene	5	U								
2-Chloroethylvinylether	10	U								
Bromoform	5	U								
4-Methyl-2-pentanone	10	U								
2-Hexanone	10	U								
Tetrachloroethene	5	U	5							
1,1,2,2-Tetrachloroethane	5	U								
Toluene	5	U	2000							
Chlorobenzene	5	U								
Ethylbenzene	5	U								
Styrene	5	U								
Total Xylenes	5	U								

* No standard, RCRA Appendix IX constituent, therefore background value is TBC + - Value exceeds ARAR/TBC

**The average is computed by first determining the arithmetic mean concentration at individual wells/stations and then using this data to compute the arithmetic mean for the wells/stations in this group. If a datum indicates non-detected, the value used in the computation is one-half the detection limit.

NS-No Standard. U-Detection Limit. J-Present below Detection Limit. B-Present in Blank _____ - Average exceeds background

Notes: Minimum, Maximum, and Average based on 1987/1988 Quarterly Data.
Background values based on upper limit of values found in well 55-86 for alluvial wells and well 54-86 for bedrock wells.
Wells/Stations in this group: 6486, 6586, 6686, 6986, 0287, 4787, 4887, 5587

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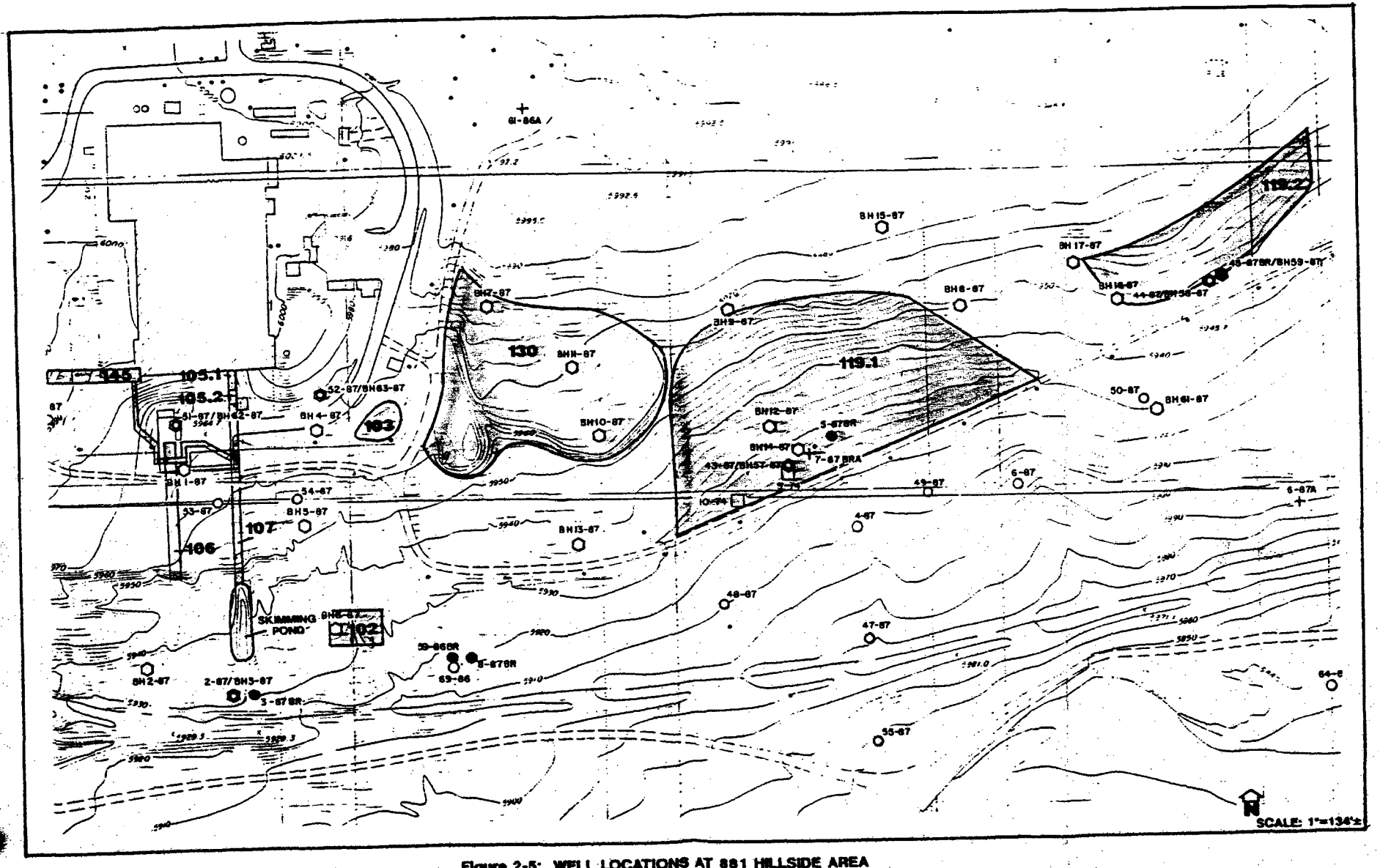

Figure 2-5: WELL LOCATIONS AT 881 HILLSIDE AREA

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2.1.6.2 Soil Contamination

Volatile and semivolatile organic contamination of soils exist at the 881 Hillside Area. Volatile organic contamination is not extensive. It occurred in soils from only 3 of the 23 boreholes that were drilled. The highest concentrations detected for chlorinated solvents were PCE at 190 ug/kg, TCE at 150 ug/kg, and 1,1,1-TCA at 110 ug/kg. However, phthalates occurred regularly and were the principal semivolatile contaminant of the soil, particularly bis(2-ethylhexyl)phthalate (DEHP). The maximum concentration of DEHP in the soil was 7,216 ug/kg. The risk assessment conducted as part of the FS for the 881 Hillside Area concludes that organic contamination of soils does not present an unacceptable risk to the public health from direct contact resulting in contaminant intake via absorption through the skin, inhalation of dust, soil ingestion, or ingestion of vegetables grown in the soils.

2.1.6.3 Surface Water Contamination

Surface waters of Woman Creek and the South Interceptor Ditch flow to Ponds C-1 and C-2, respectively. Discharge from the ponds to Woman Creek is monitored in accordance with RFP's, NPDES permit. Sampling of the ponds indicates no VOCs are present, and radionuclides, metals, and major ions are within background levels. VOCs present in the 881 Building footing drain are diluted and/or volatized before the water enters Pond C-2. Elevated uranium-238 occurs in the South Interceptor Ditch upgradient of the 881 Hillside Area, but concentrations decrease to background levels at Pond C-2.

2.2 ANALYTICAL DATA

Organic contaminants exist in the ground water beneath the 881 Hillside Area. Appendix 1 lists the results of volatile organic analyses from alluvial ground water samples collected at the 881 Hillside Area during 1987 and 1988. The quality of the data is currently being evaluated.

2.3 SITE CONDITIONS THAT JUSTIFY AN IRA

There is no imminent threat to the public health and environment posed by contaminants at the 881 Hillside Area; however, unacceptable risk would be posed to the public by consumption of contaminated alluvial ground water at or immediately downgradient of the 881 Hillside Area. Organic contaminants in alluvial ground water directly beneath the 881 Hillside Area pose the greatest threat to the public health. Although consumption of this water is not likely because it is located within the plant boundary, in order to prevent further organic contaminant migration from the 881 Hillside Area that may exacerbate final cleanup efforts at the site, an IRA will be implemented.

The criteria for clean-up levels of these contaminants are based on ARARs. Compliance with ARARs is discussed in Section 3.0.

SECTION 3.0

IDENTIFICATION OF INTERIM REMEDIAL ACTION OBJECTIVES

3.1 DETERMINATION OF REMEDIAL ACTION SCOPE

The overall objective of the IRA at the 881 Hillside Area is prevention of release and migration of alluvial ground water organic contaminants downgradient, and the cleanup of alluvial ground-water organic contamination to within acceptable levels. The effort is to be performed in the interest of protecting public health as well as the environment.

Specific objectives of the IRA are:

- Contain, reduce, and/or eliminate site organic contaminants identified as representing possible sources of exposure to human and other potential receptors.
- Reduce or eliminate exposure to site organic contaminants by potential receptors by controlling potential contaminant pathways.
- Demonstrate technical feasibility and environmental and cost effectiveness of the remedial action.

Although some inorganic constituent concentrations are above ARAR at the 881 Hillside Area (Rockwell International, 1988b), the risk assessment performed as part of the FS indicates organic contamination to pose the greatest public health risk. Furthermore, background is not adequately characterized to allow accurate determination of site inorganic contaminants and whether variances from ARARs are appropriate where background inorganic constituent concentrations exceed ARAR. The final remedy for the 881 Hillside Area will address potential inorganic contamination.

3.2 INTERIM REMEDIAL ACTION SCHEDULE

Activity	Time Frame
Issuance of FONSI*	Present-August 1989
Design	Present-August 1989
Procurement/Contracting	August 1989-December 1989
Construction	October 1989-June 1990
Startup	June 1990-July 1990

* National Environmental Policy Act Finding of No Significant Impact

3.3 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Response actions at Superfund sites must meet two fundamental clean-up requirements. First, they must attain a level of cleanup which, at a minimum, assures protection of human health and the environment [CERCLA Section 121(d)(2), 42 U.S.C. Section 9621(d)(2)]. Second, CERCLA cleanups must attain or exceed the requirements of all applicable or relevant and appropriate federal and state health and environmental requirements (ARARs). This section identifies and analyzes ARARs relevant to the IRA at the 881 Hillside Area. This remedial action is considered an on-site IRA; therefore, only substantive requirements apply. This section presents ARARs for only organic contaminants because the IRA is designed to achieve compliance with only organic contaminant ARARs.

"Applicable standards" may be defined as substantive environmental protection requirements, criteria, or limitations, promulgated under federal or state law, that specifically address a hazardous substance, pollutant, contaminant, response action, location, or other circumstances at a Superfund site. "Relevant and appropriate requirements" are those substantive environmental protection requirements, promulgated under federal or state law, that, while not jurisdictionally applicable to circumstances at the site, address problems sufficiently similar to those encountered

at the site that their use is well suited to the particular site. ARARs must be identified on a site-specific, case-by-case basis.

In general, there are three categories of potential ARARs at any Superfund site. These categories are:

- Ambient or chemical-specific requirements.
- Locational requirements.
- Performance, design, or other action-specific requirements.

Each category is discussed in more detail below.

3.3.1 Ambient or Chemical-Specific Requirements

Ambient or chemical-specific requirements set health- or risk-based concentration limits in various environmental media for specific hazardous substances or pollutants. These requirements set protective clean-up levels for the chemicals of concern in the designated media, or indicate a safe level of air emission or wastewater discharge.

Chemical-specific ARARs are derived primarily from federal and state health and environmental statutes and regulations. Health Effects Assessments, Health Advisories, Chemical Advisories, and Guidance Documents may also be considered when establishing clean-up standards, but are not considered to be ARARs. These and any proposed standards are classified as items to be considered, or TBCs. Where background concentrations for constituents are above the chemical specific ARAR for that constituent, a variance from the ARAR is appropriate. A summary of chemical

specific ARARs for the contaminants are presented in Table 3-1. Screening for these ARARs is presented in Table 3-2.

3.3.1.1 Safe Drinking Water Act Maximum Contaminant Levels (MCLs) and MCL Goals

Because ground water beneath the 881 Hillside Area is a potential source of drinking water, Maximum Contaminant Levels (MCLs) are relevant and appropriate for all phases of the IRA. MCLs are derived from the Safe Drinking Water Act (PL 93-523). They represent the maximum permissible level of a contaminant in water which is delivered to the free-flowing outlet of the ultimate user of a public water system [40 CFR 141.2(C)]. Maximum Contaminant Level Goals (MCLGs) have also been used to develop clean-up standards at the site. Section 121(d) of CERCLA as amended by SARA suggests that MCLGs may be appropriate under certain circumstances of the release or threatened release of hazardous substances. This is reinforced in EPA's document entitled, Draft CERCLA Compliance with Other Laws Manual, Volume II, Maximum Contaminant Level Goals, June 1987, that identifies the special circumstances where MCLGs should be considered as ARAR. These circumstances are where there are multiple contaminants in ground water, or where multiple pathways of exposure present extraordinary risks. According to the guidance document, the use of MCLGs should be determined on a site-specific basis in consultation with EPA headquarters.

The clean-up criteria for the interim action at the 881 Hillside are based on MCLs and MCLGs wherever such standards have been promulgated for the contaminants of concern. Proposed MCLs and MCLGs are considered TBCs in this analysis.

TABLE 3-1

SUMMARY OF CHEMICAL SPECIFIC ARARS
FOR ORGANIC CONSTITUENTS EXCEEDING ARAR
AT THE 881 HILLSIDE AREA

Chemicals Exceeding ARARS	ARAR/TBC Concentration	Applicable, Relevant and Appropriate or to be Considered	Standard, Criteria or Guidance	Citation	Comment
Benzene	5 ug/l	R&A	SDWA MCL	40 CFR 141.50	
Carbon Tetrachloride	5 ug/l	R&A	SDWA MCL	40 CFR 141.50	
1,2 Dichloroethane	5 ug/l	R&A	SDWA MCL	40 CFR 141.50	
1,1 Dichloroethene	7 ug/l	R&A	SDWA MCL	40 CFR 141.50	
t-1,2 Dichloroethene	70 ug/l	TBC	Proposed SDWA MCL		Proposed SDWA MCL is more appropriate than RCRA conc. limit because it is based on human health protection.
Methylene Chloride	5 ug/l	TBC	EPA drinking water health advisory		
Tetrachloroethene	5 ug/l	TBC	RCRA Conc. Limit	40 CFR 264	Concentration reflects analytical detection limit.
1,1,1 Trichloroethane	200 ug/l	R&A	SDWA MCL	40 CFR 141.50	
1,1,2 Trichloroethane	5 ug/l	TBC	RCRA Conc. Limit	40 CFR 264	Concentration reflects analytical detection limit.
Trichloroethene	5 ug/l	R&A	SDWA MCL	40 CFR 141.50	

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TABLE 3-2

SCREENING OF CHEMICAL SPECIFIC ARARS FOR
VOLATILE ORGANIC COMPOUNDS
PERTINENT TO 881 HILLSIDE AREA IRA OPTIONS

	POTENTIAL ARAR REQUIREMENTS				Remedial Action	
Chemical	Subpart F Concentration Limits	SDWA Maximum Contaminant Level (MCL) (ug/l)	For Use in Special Circumstances SDWA MCLG (ug/l)	CDH Proposed Ground Water Quality Standard[a] (ug/l)	ARAR	Comment
Acetone	10 U **	-	-	-	None	RCRA Subpart F concentration is TBC.[a]
Benzene	5 U	5	0	-	SDWA MCL is R&A	-
Carbon Tetrachloride	5 U	5	0	5.0	SDWA MCL is R&A	
Chloroform	5 U	-	-	0.19	None	RCRA Subpart F concentration limit is TBC.
1,1 Dichloroethane	5 U	-	-	-	None	RCRA Subpart F concentration limit is TBC.
1,2 Dichloroethane	5 U	5	0	5.0	SDWA MCL is R&A	-
1,1 Dichloroethene	5 U	7	7	7.0	SDWA MCL is R&D	-
t-1,2 Dichloroethene	5 U	70*	70*	0.03	None	-

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TABLE 3-2

SCREENING OF CHEMICAL SPECIFIC ARARS FOR
VOLATILE ORGANIC COMPOUNDS
PERTINENT TO 881 HILLSIDE AREA IRA OPTIONS

	POTENTIAL ARAR REQUIREMENTS				Remedial Action	
Chemical	Subpart F Concen-tration Limits	SDWA Maximum Contaminant Level (MCL) (ug/l)	For Use in Special Circumstances SDWA MCLG (ug/l)	CDH Proposed Ground Water Quality Standard (ug/l)	ARAR	Comment
Methyl Ethyl Ketone	5 U	-	-	-	None	EPA's drinking water health advisory for MEK is 200 ug/l. This advisory is considered TBC.[c]
Methylene Chloride	5 U	-	-	-	None	EPA's drinking water health advisory is TBC.[c] The reference concentration for this potential carcinogen is 5 ug/l. This concentration corresponds to the 10^{-6} risk level.
Tetrachloroethene	5 U	5*	0*	0.8	None	CDH proposed ground water quality standard is below the compound detection limit. Therefore, detection limit, which is back-ground concentration, is considered TBC.
Toluene	5 U	2000*	2000*	14,300	MCLG is R&A	-
1,1,1 Trichloroethane	5 U	200	200	200	SDWA MCL is R&A	-

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TABLE 3-2

SCREENING OF CHEMICAL SPECIFIC ARARS FOR
VOLATILE ORGANIC COMPOUNDS
PERTINENT TO 881 HILLSIDE AREA IRA OPTIONS

	POTENTIAL ARAR REQUIREMENTS				Remedial Action	
Chemical	Subpart F Concen-tration Limits	SDWA Maximum Contaminant Level (MCL) (ug/l)	For Use in Special Circumstances SDWA MCLG (ug/l)	CDH Proposed Ground Water Quality Standard (ug/l)	ARAR	Comment
1,1,2 Trichloroethane	5 U	-	-	0.6	None	CDH proposed ground water quality standard is below the compound detection limit. Therefore, detection limit, which is background concentration, is considered TBC.
Trichloroethene	5 U	5	0	5.0	SDWA MCL is R&A	-

* Proposed value

** Limit of detection for analyte

a 5 CCR 1002-8, Section 3.11.5 (C), Basic Standards Applicable to Ground Waters of the State, Proposed Amendments to the Basic Standards and Methodologies, Nov. 1987

b TBC - To be considered; The most recent EPA guidance on the identification of ARARS states that existing criteria, advisories, guidance, or proposed standards should be considered for a chemical in the absence of a promulgated standard.

3.3.1.2 Ambient Water Quality Criteria

The Ambient Water Quality Criteria are nonenforceable guidance developed under the Clean Water Act. Guidance is set for surface waters for the protection of aquatic life and for the protection of human health, based on both drinking water and consuming aquatic organisms from that water. Since the IRA proposed here involves the treatment and subsequent reinjection of ground water, the Water Quality Criteria are considered neither relevant nor appropriate for this action.

3.3.1.3 Colorado Ground Water Quality Standards

The Colorado Department of Health (CDH) has proposed ground-water quality standards for many organic compounds. These are considered TBCs for the constituents where they exist. It should be noted that public comment on these standards is ongoing and that they are subject to change. Some of the proposed standards are lower than the current standard detection limits for the compounds of concern. When this occurs, the detection limit will be considered as the TBC.

3.3.1.4 RCRA Maximum Concentration Limits

Owners or operators of facilities that treat, store, or dispose of hazardous waste must ensure that hazardous constituents listed in 40 CFR 264, Appendix IX, entering the ground water from a regulated unit do not exceed concentration limits under 40 CFR 264.94. The concentration limits include standards for fourteen compounds, with background used as the standard for the other RCRA Appendix IX constituents. These concentration limits apply to RCRA-regulated units subject to permitting (landfills, surface impoundments, waste piles, and land treatment units) that received RCRA hazardous waste after July 26, 1982. This site is not a RCRA-

regulated unit and it is not known that RCRA hazardous wastes are involved with the site. Therefore, the RCRA clean-up criterion of background concentrations for Appendix IX constituents is relevant but not appropriate. This criterion is, however, considered TBC at this site in the absence of any human health-based standards.

3.3.2 Locational Requirements

Locational requirements are statutes or regulations which set restrictions on activities, or limits on contaminant levels, depending on the characteristics of a site or its immediate environs. Examples of locational requirements are federal and state siting laws for hazardous waste facilities, or sites on the National Register of Historic Places. Also included are the Wilderness Protection Act and floodplain regulations promulgated pursuant to the Federal Emergency Management Agency's National Flood Insurance Program.

Location-specific ARARs that are relevant and appropriate are the State of Colorado siting criteria for RCRA treatment units, and for surface water discharges, the CDH Water Quality Division's regulations pertaining to preapproval of treatment facility location.

3.3.3 Performance, Design, or Other Action-Specific Requirements

Performance, design, or other action-specific requirements set controls or restrictions on particular kinds of activities related to management of hazardous substances or pollutants. These requirements are not triggered by the specific chemicals present at a site, but rather by the particular IRA alternatives that are evaluated as part of this plan. Action-specific ARARs are technology-based performance standards, such as the Best Available Technology standard of the Federal

Water Pollution Control Act. Other examples include RCRA treatment, storage and disposal standards, and Clean Water Act pretreatment standards for discharges to publicly-owned treatment works (POTWs). Action specific ARARs for the removal actions evaluated here are included in Table 3-3.

TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE

Action	Requirement	Prerequisite	Citation	ARAR	Comments
Treatment	BDAT standards for spent solvent wastes and dioxin-containing wastes are based on one of four technologies or combinations; for waste waters, (1) steam stripping, (2) biological treatment, or (3) carbon absorption (alone or in combination with (1) or (2)); and for all other wastes, incineration. Any technology may be used, however, if it will achieve the concentration levels specified.	Effective November 8, 1988, disposal of contaminated soil or debris resulting from CERCLA response actions or RCRA corrective actions is subject to land disposal prohibitions and/or treatment standards established for spent solvent wastes, dioxin-containing wastes, and "California List" wastes.	RCRA Sections 3004 (d)(3), (e)(3) 42 U.S.C. 6924(d)(3),(e)(3)	Applicable	Movement of excavated soil onsite or transportation of soil offsite for disposal must be treated to attain levels achievable by best demonstrated available treatment technologies before being land-disposed.
Capping	Placement of a cap over waste (e.g., closing a landfill, or closing a surface impoundment or waste pile as a landfill, or similar action) requires a cover designed and constructed to: o Provide long-term minimization migration of liquids through the capped area; o Function with minimum maintenance; o Promote drainage and minimize erosion or abrasion of the cover;	RCRA hazardous waste placed at site after November 19, 1980, or movement of hazardous waste from one unit, area of contamination, or location into another unit or area of contamination will make requirements applicable. Capping without such movement will not make requirements applicable, but technical requirements are likely to be relevant and appropriate.	40 CFR 264.258(b) 40 CFR 264.310(a)	R&A	Capping of waste in place using RCRA technical requirements R&A

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TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE
(continued)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
	o Accommodate settling and subsidence so that the cover's integrity is maintained; and				
	o Have a permeability less than or equal to the permeability of any bottom liner system or natural sub-soils present.				
	Eliminate free liquids, stabilize wastes before capping (surface impoundments).		40 CFR 264.228(a)		
	Restrict post-closure use of property as necessary to prevent damage to the cover.		40 CFR 264.117(c)		
	Prevent run-on and run-off from damaging cover.		40 CFR 264.228(b) 40 CFR 264.310(b)		
	Protect and maintain surveyed benchmarks used to locate waste cells (landfills, waste piles).		40 CFR 264.310(b)		

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TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE
(continued)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
Closure with Waste in Place (Capping)	Eliminate free liquids by removal or solidification.	Disposal of RCRA hazardous waste (listed or characteristic) at site after November 19, 1980, or movement of hazardous waste from one unit, area of contamination, or location into another unit or area of contamination. Not applicable to material undisturbed since November 19, 1980.	40 CFR 264.228 (a)(2)	See capping	See capping
	Stabilization of remaining waste and waste residues to support cover.		40 CFR 264.228 (a)(2) and 40 CFR 264.258(b)		
	Installation of final cover to provide long-term minimization of infiltration.		40 CFR 264.310		
	Post-closure care and ground-water monitoring.		40 CFR 264.310		
Clean Closure (Removal)	General performance standard requires minimization of need for further maintenance and control; minimization or elimination of post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products.	RCRA hazardous waste (listed or characteristic) placed at site after November 19, 1980, or movement of hazardous waste from one unit, area of contamination, or location into another unit or area of contamination. Not applicable to material undisturbed since November 19, 1980	40 CFR 264.111	RRA	Applicable to soil excavated for offsite disposal.
	Disposal of decontamination of equipment, structures, and soils.	May apply to surface impoundment; contaminated soil, including soil from dredging or soil disturbed in the course of drilling or excavation, and returned to land.	40 CFR 264.111		

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TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE
(continued)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
	Removal or decontamination of all waste residues, contaminated containment system components (e.g. liners, dikes), contaminated subsoils, and structures and equipment contaminated with waste and leachate, and management of them as hazardous waste.		40 CFR 264.228(a)(1) and 40 CFR 264.258		
	Meet health-based levels at unit.		40 CFR 244.111		
Excavation/ Consolidation	Area from which materials are excavated may require cleanup to levels established by closure requirements	Movement of hazardous waste(listed or characteristic) from one unit or area of contamination into another. Consolidation within a unit or area of contamination does not trigger applicability.	See Clean Closure	R&A	RCRA requirements for clean closure are R&A to to remedial action involving soil excavation.
	Consolidation in storage piles/storage tanks will trigger storage requirements.			R&A	RCRA requirements for storage in waste piles or tanks are relevent and appropriate for interim storage of excavated soil destined for consolidation or offsite disposal. R&A because soil may not be RCRA hazardous waste.
	Placement on or in land outside unit boundary or area of contamination will trigger land disposal requirements and restrictions.		40 CFR 268 (Subpart D)	R&A	Soil excavated during installation of french drains is subject to land disposal restrictions for solvent containing waste. Requirements are are applicable for RCRA hazardous waste; R&A if not RCRA hazardous waste.

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TABLE 3-3
SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE
(continued)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
Ground-Water Diversion	Excavation of soil for construction of slurry wall may trigger cleanup or land disposal restrictions.	RCRA hazardous waste placed at site after November 19, 1980, or movement hazardous waste from one unit, area of contamination, or location into another unit or area of contamination	See Excavation/ Consolidation	R&A	See Excavation/Consolidation
Underground Injection of Wastes and Treated Ground Water	UIC program prohibits:		40 CFR 144.12	Applicable/R&A	Requirements pertaining to the operation of Class IV wells are applicable to remedial actions for the 881 hillside because ground water will be treated before reinjection. More stringent requirements for Class 1 wells (direct injection of untreated hazardous waste) are not applicable to the 881 hillside; however some requirements for Class 1 wells may be relevant and appropriate.
	o Injection activities that allow movement of contaminants into underground sources of drinking water and results in violations of MCLs or adversely affects health.				
	o Construction of new Class IV wells, and operation and maintenance of existing wells.		40 CFR 144.13		
	Wells used to inject contaminated ground water that has been treated and is being reinjected into the same formation from which it was drawn are not prohibited if activity is part of CERCLA or RCRA actions.		40 CFR 144.14	Applicable	Applicable for injection of treated ground water by french drain or drilled well.
	All hazardous waste injection wells must also comply with the RCRA requirements.		40 CFR 144.16	Not applicable	

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TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE
(continued)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
	The Director of the UIC program in a State may lessen the stringency of 40 CFR 144.23 construction, operation, and manifesting requirements for a well if injection does not occur into, through, or above a USDW or if the radius of endangering influence (see 40 CFR 146.06(c)) is less than or equal to the radius of the well.		40 CFR 144.21		
	Owners and operators must:		40 CFR 144.26 40 CFR 144.27		
	o Submit inventory information to the Director of the UIC program for the State; including hydrogeologic data for wells, construction record, nature or composition of injected fluids, injection rate and pressure, and ground-water monitoring data.				
	o Report non-compliance orally within 24 hours.		40 CFR 144.28		
	o Prepare, maintain, and comply with plugging and abandonment plan.				

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TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE
(continued)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
	Monitor class 1 wells by:				
	o frequent analysis of injection fluid.				
	o continuous monitoring of injection pressure.				
	o flow rate, and volume and,				
	o installation and monitoring of ground-water monitoring wells.				
	Applications for Class 1 permits must:		40 CFR 144.55		
	o Identify all injection wells within the area of review.				
	o Take action as necessary to ensure that such wells are properly sealed, completed, or abandoned to prevent contamination of USDW.				
	Criteria for determining whether an aquifer may be determined to be an exempted aquifer include current and future use, yield, and water quality characteristics.		40 CFR 146.4		

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TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE
(continued)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
	Case and cement all Class 1 wells to prevent movement of fluids into USDW, taking into consideration, well depth, injection pressure, hole size, composition of injected waste and other factors.				
	Conduct appropriate logs and other tests during construction and a descriptive report prepared and submitted to the UIC program director.				
	Injection pressure may not exceed a maximum level designed to ensure that injection does not initiate new fractures or propagate existing ones and cause the movement of fluids into a USDW.		40 CFR 146.13		
	Continuous monitoring of injection pressure, flow rate, and volume, and annual pressure, if required.				
	Demonstration of mechanical integrity is required every 5 years.				
	Ground-water monitoring may also be required.				

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TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE
(continued)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
Treatment or Storage in Tanks	Tanks must have sufficient shell strength (thickness), and, for closed tanks, pressure controls, to assure that they do not collapse or rupture.	RCRA hazardous waste(listed or characteristic), held for temporary period before treatment, disposal, or storage elsewhere, (40 CFR 264.10) in a tank.	40 CFR 264.190	R&A	Relevent and Appropriate for treatment and storage tanks used in treating contaminated groundwater
	Waste must not be incompatible with the tank material unless the tank is protected by a liner or by other means.		40 CFR 264.191		
	Tanks must be provided with controls to prevent overfilling, and sufficient freeboard maintained in open tanks to prevent overtopping by wave action or precipitation.		40 CFR 264.194		
	Inspect the following: overfilling control, control equipment, monitoring data, waste level (for uncovered tanks), tank condition, above-ground portions of tanks, (to assess their structural integrity) and the area surrounding the tank (to identify signs of leakage).		40 CFR 264.195		
	Repair any corrosion, crack, or leak.		40 CFR 264.196		

615074

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TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE
(continued)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
	At closure, remove all hazardous waste and hazardous waste residues from tanks, discharge control equipment, and discharge confinement structures.		40 CFR 264.197		
	Store ignitable and reactive waste so as to prevent the waste from igniting or reacting. Ignitable or reactive wates in covered tanks must comply with buffer zone requirements in "Flammable and Combustible Liquids Code," Tables 2-1 through 2-6 (National Fire Protection Association, 1976 or 1981).		40 CFR 264.198		
Container Storage (On-Site)	Containers of hazardous waste must be:	RCRA hazardous waste(listed or characteristic) held for a temporary period before treatment, disposal, or storage elsewhere, (40 CFR 264.10) in a container (i.e., any portable device in which a material is stored, transported, disposed of, or handled) (40 CFR 264.10)		R&A	RCRA container storage requirements are R&A
	o Maintained in good condition;		40 CFR 264.171		
	o Compatible with hazardous waste to be stored; and		40 CFR 264.172		
	o Closed during storage (except to add or remove waste).		40 CFR 264.173		
	Inspect container storage areas weekly for deterioration.		40 CFR 264.174		

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TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE
(continued)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
	Place containers on a sloped, crack-free base, and protect from contact with accumulated liquid. Provide containment system with a capacity of 10% of the volume of containers of free liquids. Remove spilled or leaked waste in a timely manner to prevent overflow of the containment system.		40 CFR 264.175		
	Keep containers of ignitable or reactive waste at least 50 feet from the facility's property line.		40 CFR 264.176		
	Keep incompatible materials separate. Separate incompatible materials stored near each other by a dike or other barrier.		40 CFR 264.177		
	At closure, remove all hazardous waste and residues from the containment system, and decontaminate or remove all containers, liners.		40 CFR 264.178		

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TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE
(continued)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
Off-Site Treatment Storage or Disposal	In the case of any removal or remedial action involving the transfer of any hazardous substance or pollutant or contaminant offsite, such hazardous substance or pollutant or contaminant shall only be transferred to a facility which is operating in compliance with section 3004 and 3005 of the Solid Waste Disposal Act (or where applicable, in compliance with the Toxic Substances Control Act or other applicable federal law) and all applicable State requirements. Such substance or pollutant or contaminant may be transferred to a land disposal facility only if the President determines that both of the following requirements are met: o The unit to which the hazardous substance or pollutant or contaminant is transferred is not releasing any hazardous waste, or constituent thereof, into the groundwater or surface water or soil.		SARA section 121 (d)(2)(C)	Applicable	Applicable to the offsite treatment, storage, or disposal of wastes generated during onsite remedial actions.

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TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE
(continued)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
	o All such releases from other units at the facility are being controlled by a corrective action program approved by the Administrator under subtitle C of the Solid Waste Disposal Act.				
Hazardous Waste Operations	As mandated by SARA, OSHA has promulgated regulations that require employers to develop and implement a written safety/health program designed to regulate employee safety and health during hazardous waste operations. The safety and health program must include: releases of hazardous substances. o Organizational structure- Establish and implement chain of command and specify the responsibilities of key personnel. o Comprehensive Work Plan- Identify anticipated activities, define work tasks, establish personnel requirements, and provide for the implementation of medical surveillance and training programs as required by these regulations.	Regulations apply to hazardous substance response operations under CERCLA; Corrective cleanup under RCRA; hazardous waste operations that have been designated for cleanup by state or local authorities; most operations involving the treatment, storage or disposal of hazardous wastes regulated under RCRA; and emergency response operations for releases or threats of	29 CFR Part 1910.120		

615078

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TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE
(continued)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
	o Site-Specific Health and Safety Plans A site health and safety plan must be prepared for each phase of operation that addresses key personnel; hazard recognition; training assignments; personnel protective equipment to be used; medical surveillance; frequency and type of monitoring, including air and personal monitoring; site control measures; decontamination procedures; emergency contingency plans.				
	General Requirements of these regulations:				
	o Site characterization and analysis- Identify site hazards to determine levels of personnel protection		29 CFR 1910.120(c)	Applicable	Site hazards have been characterized through the RI/FS process
	o Site Control- Implement site control zones to minimize employee exposure to hazardous substances.		29 CFR 1910.120(d)	Applicable	Site control zones will be defined in site-specific health and safety plans.
	o Training- Initial training and refresher training required before employee is permitted to engage in site activities.		29 CFR 1910.120(e)	Applicable	Personnel engaged in remedial actions at the 881 hillside are required to meet minimum training requirements as specified in the OSHA standards

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TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE
(continued)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
	o Material Handling Hazardous substances, contaminated soils, liquids or other residues shall be handled, transported, and labeled according to subsection (j) of the OSHA standard		29 CFR 1910.120(j)	Applicable	D.O.T. specification containers will be used to handle, store, or transport.
	o Decontamination Decontamination procedures outlined in subsection (k) of the standard must be complied with during onsite remedial action.		29 CFR 1910.120(k)	Applicable	Decontamination procedures will be presented in the site health and safety plan.
	o Emergency Response Contingency plans must be developed as part of site health and safety planning		29 CFR 1910.120(l)	Applicable	Contingency plans will developed for the site health and safety plan
	o Illumination/Sanitation Minimum illumination and sanitation facilities must be provided for employees involved in hazardous waste operations		29 CFR 1910.120(m)(n)	Applicable	

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TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE
(continued)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
	o Medical Surveillance Employers must implement medical surveillance for employees potentially exposed to hazardous substances.		29 CFR 1910.120(f)	Applicable	
	o Engineering Controls, work practices and personnel protective equipment One or all of these shall be used to minimize exposure of employees to hazardous substances and health hazards		29 CFR 1910.120(g)	Applicable	
	o Monitoring- Monitoring of exposures of employees to hazardous substances is required to determine the efficacy of protective equipment and engineering controls.		29 CFR 1910.120(h)	Applicable	
	o Informational Programs Employees, contractors, and subcontractors shall be informed of the degree and nature of hazards associated with site activities.		29 CFR 1910.120(i)	Applicable	All personnel involved in site activities will be required to read and comply with the site safety plan. The safety plan will outline the anticipated physical and chemical hazards.

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TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE
(continued)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
	o Site Excavation Site excavations must be shored or sloped to prevent collapse.		29 CFR 1910.120/1926	Applicable	
	o Contractors and Subcontractors Employers must inform contractors or subcontractors of potential hazards associated with site activities		29 CFR 1910.120	Applicable	

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SECTION 4.0

IDENTIFICATION AND INITIAL SCREENING OF POTENTIAL IRA OPTIONS

4.1 SUMMARY OF THE 881 HILLSIDE TECHNOLOGY AND REMEDIAL ALTERNATIVE SCREENING PROCESS

The 881 Hillside Area FS Report (Rockwell International, 1988b) was prepared according to the EPA Feasibility Study Guidance (EPA, 1985) available at the time. The initial screening process eliminated infeasible, inappropriate and environmentally unacceptable technologies. The following technologies were retained after screening:

1. No remedial action - monitoring only (not considered here)
2. Off-site RCRA landfill
3. Well arrays
4. Subsurface drains
5. Soil-bentonite slurry wall
6. Multi-layer cap
7. Grading and vegetation
8. Surface water diversion
9. In situ immobilization (grouting)
10. Soil flushing
11. UV/Peroxide water treatment
12. Air stripping water treatment
13. Activated carbon adsorption waste treatment

Technologies were then combined that are complementary and interrelated, to form alternatives that address the site issues and control contaminant pathways. The three water treatment technologies were subjected to a more detailed evaluation to determine the most cost-effective, reliable treatment system for inclusion with the alternatives requiring water treatment. SARA further requires that alternatives be developed that consider:

- Elimination of long term site management;
- Reduction of waste toxicity, mobility, or volume;
- Waste containment with little or no treatment;
- Use of innovative technologies.

The developed alternatives are as follows:

1. Collection of ground water using a line of downgradient wells and a source well at SWMU 119.1, collection of footing drain flow, and reinjection of treated water downgradient of the 881 Hillside Area in the Valley Fill Alluvium of the Woman Creek drainage;
2. Collection of ground water using a french drain and a source well at SWMU 119.1, collection of footing drain flow, and reinjection of treated water downgradient of the 881 Hillside Area in the Valley Fill Alluvium of the Woman Creek drainage;
3. Collection of ground water using a french drain and a source well at SWMU 119.1, collection of footing drain flow from, and discharge of treated water to the surface, and in situ treatment of soils using soil flushing;
4. Total encapsulation of source areas using a multi-layer cap and slurry wall with control of gradients by pumping an internal sump (dewatering fluids to be treated at an existing treatment plant);
5. Pump a source well at SWMU 119.1, collect footing drain flow, and reinjection of treated water downgradient of the 881 Hillside Area in the Valley Fill Alluvium of the Woman Creek drainage;
6. Immobilization of contaminants using a chemical grout; and
7. Collection of ground water using a french drain and a source well at SWMU 119.1, collection of footing drain flow, reinjection of a treated water downgradient of the 881 Hillside in the Valley Fill Alluvium of the Woman Creek drainage, and partial removal of soils to a RCRA permitted disposal facility.

Three broad considerations, consistent with the National Contingency Plan, were utilized as the basis for the preliminary screening of developed alternatives:

- <u>Cost</u> - The cost of implementing the remedial action was considered including operating and maintenance costs. An alternative whose cost far exceeds that of others being evaluated without providing significantly greater protection were eliminated.

- o Acceptable Engineering Practices - Alternatives which do not provide a proven and reliable means of addressing the problem were eliminated.

- o Effectiveness - Alternatives which do not effectively contribute to the protection of public health, welfare, and the environment were eliminated. Alternatives posing significant adverse environmental effects and only limited benefits were also excluded from further consideration.

Of the seven described remedial action alternatives, four of the alternatives were eliminated because they did not provide adequate protection of public health, welfare, and the environment, or were much more costly without providing significantly greater protection. The following three alternatives were retained for detailed evaluation.

1. Collection of ground water using a french drain and a source well, collection of footing drain flow, treatment of collected water in a new treatment plant and reinjection;

2. Total encapsulation of source areas using a multi-layer cap and slurry wall with control of gradients by pumping an internal sump (dewatering fluids to be treated at an existing treatment plant); and

3. Pump a source well at SWMU 119.1, collect footing drain flow, treat collected water at a new treatment plant, and reinjection.

The 881 Hillside Area Feasibility Study Report, March 1988, provides the details of the screening process to this point. The detailed analysis of the three remaining alternatives is presented in this document and is based on the March 30, 1988 EE/CA Guidance. The alternatives will be evaluated individually based on effectiveness, implementability, and cost. Also included is a detailed analysis of the technologies for the removal of organic contaminants from the ground water.

4.2 SCREENING PROCESS

4.2.1 Effectiveness

The criteria for evaluation of effectiveness of removal alternatives includes protectiveness and use of alternatives to land disposal. Protectiveness includes protection of the community and workers during the removal action; threat reduction (mitigation of identified threats); determination of the length of time until protection is achieved; compliance with chemical and location specific ARARs; compliance with criteria, advisories and guidances; description of potential exposure to residuals remaining on-site; and long-term reliability for providing continued protection. The effectiveness criteria also includes use of alternatives to land disposal, thus promoting utilization of treatment or recycling instead of land disposal.

4.2.2 Implementability

The criteria for evaluation of implementability of removal alternatives includes technical feasibility, availability and administrative feasibility. Technical feasibility includes the ability to construct the technology and to maintain its operation; compliance with action-specific ARARs; ability to meet process efficiencies or performance goals; demonstrated performance; evaluation of impact of environmental conditions; and compliance with the SARA requirement that removal actions should contribute to the efficient performance of long term remedial action to the extent practicable. Availability includes the availability of necessary equipment, materials and personnel; availability of adequate off-site treatment, storage, and disposal capacity, if appropriate; and description of post-removal site controls which

will be required at the completion of the action. Administrative feasibility includes the likelihood of public acceptance of the alternative, including state and local concern; coordination of activities with other agencies; and ability to obtain any necessary approvals or permits.

4.2.3 Cost

The criteria for evaluation of cost of removal alternatives includes total cost and statutory limits. Total cost includes direct capital costs, indirect capital costs, and any post-removal site control costs. Since the 881 Hillside is not an EPA-financed removal action, the $2 million statutory cost limit does not apply.

4.3 GROUND WATER TREATMENT TECHNOLOGIES EVALUATION

The ground water treatment technologies that were selected for detailed evaluation include carbon adsorption, UV/peroxide (chemical oxidation), and air stripping. These technologies are being evaluated for their ability to remove organic contaminants only. The specific treatment systems listed are provided as examples of systems that can provide the level of treatment needed to meet chemical-specific ARARs for the organic contaminants of concern. It is recognized that many companies provide similar treatment systems, and the system ultimately selected for installation will be required to provide the same level of efficiency as that specified here.

The treatment system selected must be capable of treating a 30 gpm peak and a 10 gpm average flow of contaminated ground water with influent characteristics as shown in Table 4-1. The effluent quality must meet the chemical-specific ARARs.

TABLE 4-1

BASIS OF DESIGN

	Composite Concentration* (ug/l)	Treatment Requirements (ug/l)
VOLATILE ORGANICS		
TCE	830	5
PCE	327	5 (TBC)**
1,1-DCE	740	7
t-1,2-DCE	35	70 (TBC)
1,1-DCA	9	5 (TBC)
1,2-DCA	53	5
1,1,1-TCA	530	200
1,1,2-TCA	71	5 (TBC)
Carbon Tetrachloride	160	5
Methylene Chloride	11	5 (TBC)

* Hypothetical composite sample consisting of a flow-weighted average of organic contaminants in the footing drain discharge (SW-45) at 5 gpm (see Table 2-1); and alluvial wells at the 881 Hillside Area at 2 gpm (see Table 2-2). Average organic contaminant concentrations were used that were computed from data collected in 1987 and 1988.

**TBC Treatment goals to be considered

The location- and action- specific ARARs, are similar for each of the treatment technologies, and are discussed in Section 3. Only air stripping has unique action specific requirements because it is subject to the Colorado Department of Health Air Quality regulations for the air emissions.

4.3.1. Activated Carbon Adsorption

4.3.1.1 Description

For the granular activated carbon (GAC) adsorption system, the ground water will be pumped through two GAC columns in parallel operated in downflow fixed-bed mode, each column followed by a polishing GAC unit in series (Figure 4-1). Each carbon column is 44 inches in diameter and 89 inches high, and contains 1,800 pounds of carbon. Based on a peak flow rate of 30 gpm, the hydraulic loading to each column will be approximately 1.4 gpm/ft^2. Contact time for each column will be approximately 25 minutes.

To completely utilize the carbon, use of columns in series allows the lead column to become fully exhausted before regeneration while providing an additional 25 minutes of contact time at 30 gpm. Periodic samples will be taken from the effluent of each unit, and when the lead unit effluent exceeds chemical-specific ARARs, the lead carbon column will be removed, the polishing (second) column will become the lead column, and the shelf-space carbon column containing the regenerated carbon will be put in service as the polishing unit. The carbon column with the exhausted carbon will then be shipped to an off-site location for regeneration.

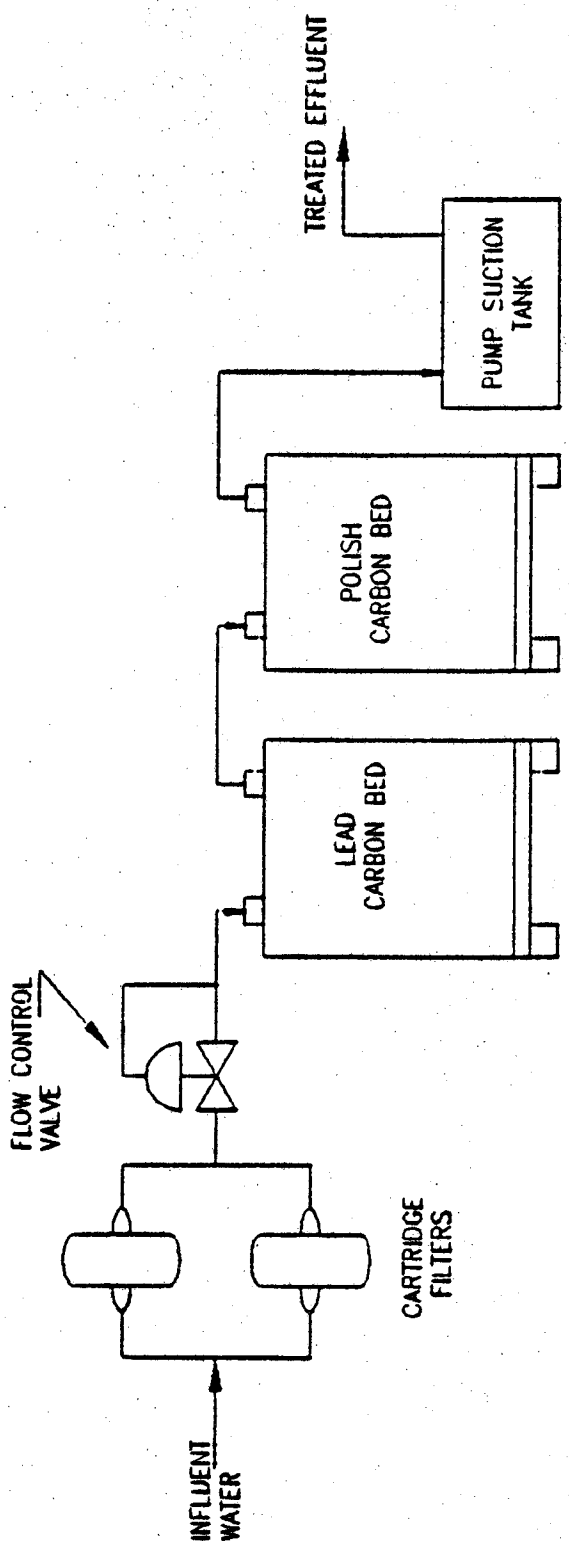

FIGURE 4-1

CARBON ADSORPTION TREATMENT UNIT

R37013.MB

4.3.1.2 Effectiveness

GAC adsorption systems have been shown to remove VOCs from contaminated ground water to levels that comply with the chemical-specific ARARs. EPA (*Federal Register*, Vol. 52, No. 130, page 25698) has designated carbon adsorption a "Best Available Technology" for the removal of seven specific volatile organic compounds (including TCE, 1,2-DCA, and 1,1,1-TCA) from drinking water. The GAC adsorption system that is proposed here for the treatment of the 881 Hillside ground water will be in continuous operation until the concentrations of VOCs in the ground water decrease to chemical-specific ARAR concentrations, at which time further treatment will be unnecessary. The probability of equipment failure will be minimized in this system because of the redundancy of having two (2) parallel on-line units, each of which could treat the design flow. Two shelf-spare units on site adds to the system reliability.

Appropriate safety measures required when moving and installing large equipment will be complied with during installation. The operation and maintenance of the system will be by personnel who are trained in the handling of hazardous and radioactive wastes. Because carbon will remove oxygen from the air, any time personnel are working in confined areas where oxygen may be limited, special care must be taken to ensure that an adequate air supply is available.

The operators of the GAC system will not be exposed to VOC-laden carbon because the use of the containerized and transportable carbon contactors allows removal and replacement of the exhausted carbon at a remote carbon reactivation site. Carbon will not be handled at the site. Transporting the entire exhausted carbon

column itself to the regeneration facility ensures operators are protected from the carbon itself, and need only follow routine safety procedures when handling heavy equipment.

The exhausted carbon is generally regenerated through a thermal treatment process which strips the volatile organics from the carbon. The organics are subsequently destroyed via incineration. During this regeneration process, a small quantity of ash may be generated which requires disposal at a landfill. Thus, this process can be considered an alternative to land disposal since the carbon is continuously recycled. However, if the spent carbon was determined to be a mixed waste, then it would require land disposal at the Nevada Test Site.

GAC adsorption treatment in sealed, fixed-bed contractor vessels does not produce any waste streams or vapor emissions. Nearby communities and the environment should realize no safety concerns. This treatment process will effectively remove organic contaminants from the ground water. Treated water will be monitored at the effluent and also at an intermediate point in the system to ensure contaminants are below the chemical-specific ARAR concentrations before being released to the environment during implementation of the process.

4.3.1.3 Implementability

GAC adsorption is a proven technology for removing volatile organics compounds (VOCs) from ground water. A treatability study performed by Rockwell International (1988b) demonstrated activated carbon can remove VOCs to meet chemical-specific ARARs. A second carbon unit connected in series with the lead unit would serve as a polishing unit and will ensure removal of the VOCs to these

levels. The carbon columns can be shipped and readily installed in the treatment building. The system should be ready to operate at full capacity, after initial adjustments and test runs, within a day.

4.3.1.4 Costs

Results of the treatability study indicate the carbon usage rate will be 3.1 pounds per 1,000 gallons of ground water, based on breakthrough of methylene chloride. At a cost of approximately $1.15 per pound for regenerated carbon, the annual costs are estimated to be $18,600 for carbon (based on an average flow rate of 10 gpm). The cost of shipping contaminated carbon (as a manifested waste) for regeneration is estimated to be $2,500 (the costs could vary substantially) and $500 for receiving regenerated carbon, for a total of $3,000 per exchange. Annual operation and maintenance costs and power costs are estimated to be about $9,000.

Using the preceding information, the estimated capital costs for installing a carbon adsorption system and the estimated annual operating costs are shown in Table 4-2. Total cost (Present Worth) of the GAC adsorption system based on 10 percent simple interest, a 30-year duration of operation, and no salvage value, is estimated to be about $744,000.

4.3.2 Ultraviolet (UV) Peroxide Oxidation

4.3.2.1 Description

UV/peroxide treatment unit consists of an 80-gallon stainless steel oxidation chamber, which provides for a maximum ground-water retention time of 2.66 minutes at a constant system flowrate of 30 gpm (Figure 4-2). The oxidation chamber contains 4 medium pressure UV lamps, which are mounted horizontally in quartz

TABLE 4-2

ESTIMATED COSTS FOR CARBON ADSORPTION SYSTEM

Item	Capital Cost (Dollars)	Annual Cost (Dollars)
Building improvements, utilities	150,000	
Carbon Treatment System	68,000	
Auxiliaries	11,000	
(See Figure 4-1)		
Annual Costs[1]		
Carbon Purchases (~9 loads/yr @ $1.15/lb)		18,600
Shipping (~9 loads/yr @ $3,000 round trip)		27,000
Operation & Maintenance, Power		9,000
TOTAL	229,000	54,600

[1]Based on a continuous yearly flowrate of 10 gpm

PRESENT WORTH:

Present Worth Factor (PWF) = 9.427 (for annual operating costs)

$54,600/year x 9.427 =	$515,000
1989 Capital Cost =	$229,000
	$744,000

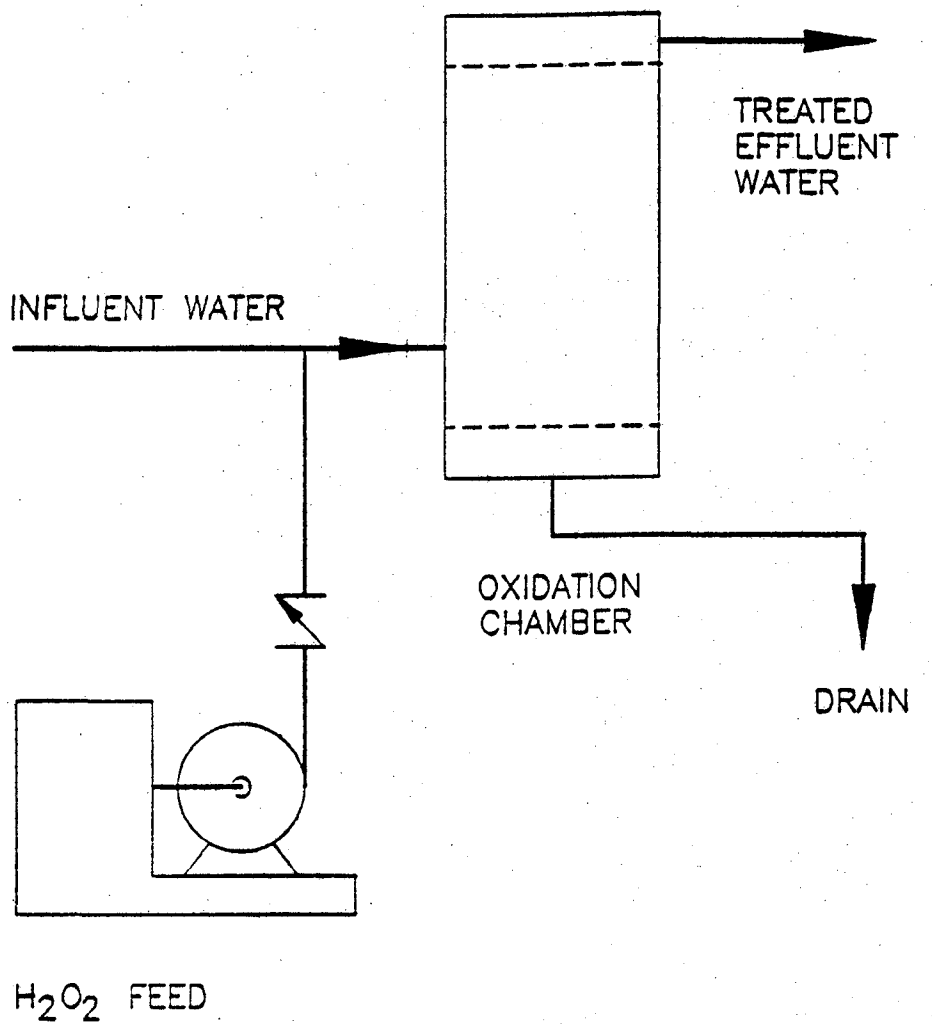

FIGURE 4-2
UV/PEROXIDE SYSTEM

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sheaths. A hydrogen peroxide feed system is used to inject approximately 50 mg/l (per ppm of organic contaminants) of a 50 percent H_2O_2 solution into the ground-water feed line. The ground-water/peroxide mixture then passes through an in-line static mixer before entering the bottom of the oxidation chamber. The ground water then flows through the reaction chamber, passing the UV lamps, before it exits the top of the oxidation chamber.

4.3.2.2 Effectiveness

The UV/Peroxide system is capable of removing all of the volatile organics from the ground water to levels below the chemical-specific ARARs. Bench-scale studies, using 881 Hillside Area water, were conducted by Peroxidation Systems, Inc. (Rockwell International, 1988b). The bench-scale testing provided for a dynamic flow simulation of actual operating conditions of a full-scale UV/peroxide ground-water treatment system. Parameters investigated during the testing included hydrogen peroxide (H_2O_2) dosage and power requirements, retention time, system pH, and influent/effluent chemical conditions. Contaminant concentrations were reduced to non-detectable levels for initial ground-water influent total VOC concentrations of 1 ppm. These results indicate that the UV/peroxide ground-water treatment process is capable of achieving the effluent criteria for all of the volatile organics listed in Table 4-1. The system will remain in operation until the ground water has been fully treated to these levels. The system requires periodic UV lamp replacement and routine maintenance, but is expected to have long-term reliability in terms of operation and performance. The risk of failure of the system at any time is highly unlikely. Since the volatile organics are destroyed in the UV/Peroxide system, no wastes are produced which require ultimate disposal. Thus, this technology provides an alternative to land disposal.

During operation of the UV/peroxide ground-water treatment unit, the use of hydrogen peroxide, a strong oxidizer, will require that operators are aware of this potential hazard. The H_2O_2 feed tank will be properly vented to assure no pressure buildup. Existing DOE and Rockwell health and safety guidelines at Rocky Flats regarding operator safety while working with strong oxidizers will be followed. UV lamps operate utilizing high voltage, and thus caution must be used when working with the system and during the periodic replacement of the UV lamps.

Nearby communities and the environment should realize no safety concerns as this treatment process will effectively destroy ground-water contaminants. Treated water will be monitored to ensure contaminants are within regulatory guidelines before being released to the environment. No short-term safety concerns for nearby communities and the environment are anticipated during implementation of the process.

4.3.2.3 Implementability

UV/peroxide oxidation is an innovative technology for the complete destruction and detoxification of hazardous organic compounds in aqueous solutions. Although the technology is relatively new and has had limited application in the field, SARA requires EPA to prefer remedial actions that significantly and permanently reduce the toxicity, mobility, or volume of hazardous wastes by employing innovative technologies that result in the destruction or detoxification of the wastes.

Demonstrated performance of the UV/peroxide ground-water treatment system has been somewhat limited due to the relatively new development of the process.

However, Peroxidation Systems, Inc. has 6 UV/peroxide units currently operational or on-line and ready for operation. One of these units is located at Rocketdyne's Santa Susana facility in California. Pilot scale operations were performed by Peroxidation Systems, Inc., on ground water containing Vocs (TCA, TCE, etc.) at system flow rates of approximately 20-40 gpm. Results from the pilot scale testing were favorable, and a UV/peroxide ground-water treatment unit has been purchased, set-up, and site tested. Another UV/peroxide ground-water treatment system, located locally, was visited and appeared to be a low maintenance, highly effective ground-water treatment unit. This system was treating ground water with TCA concentrations significantly lower than those found at the 881 Hillside (approximately 7 ppb). However, the treatment process had initially treated ground water with much higher concentrations. Based upon actual bench scale results using 881 Hillside ground water and information received regarding currently operating treatment systems, the innovative UV/peroxide ground-water treatment system appears to be a reliable treatment technology.

Operating and maintenance requirements for the UV/peroxide treatment system are relatively minor. The system will require approximately 20 kW of power and 2,100 pounds/year of 50 percent H_2O_2 solution for normal operation. Routine maintenance of the equipment is required and the UV lamps will require replacement approximately every 2-6 months. Routine system maintenance is estimated to be approximately 16 hours/month. All four system UV lamps can be exchanged in about an hour. The system requires only occasional observation to ensure the system is operating properly, although system alarms will notify operators if a problem does occur.

The commercially available UV/peroxide ground-water treatment system would be installed upon completion of the treatment plant building. The UV/peroxide system could be fully operational within a month after delivery.

4.3.2.4 Costs

Estimated costs for the UV/peroxide ground-water treatment unit are shown in Table 4-3. Capital cost for the UV/peroxide ground-water treatment system is approximately $370,000. Operational costs include procurement of hydrogen peroxide (6,100 pounds/year), power utilization (20 kW), replacement parts (5% of capital), and lamp replacement (every 3-6 months at a cost of $300/lamp). Operational costs are based on a continuous system flow rate of 10 gpm. Assuming a 10% interest rate and a 30 year operating life, the present worth of the system is $559,000.

4.3.3 Air Stripping with Off-Gas Treatment

4.3.3.1 Description

During air stripping, VOCs are transferred from the water to a continuously flowing airstream which is in direct contact with the water. (Figure 4-3).

Influent contaminated ground water will enter the top of a 22-inch diameter, 34-foot air stripping column and subsequently contact clean air supplied through the bottom of the column (column sizes are approximate). Appropriate air-to-water flow rates will be utilized to provide for the optimum (99+%) transfer of the contaminants from the ground water to the air stream. The treated ground water will then be pumped through a 1800 pound liquid phase carbon treatment polishing unit (identical to the one described in Section 4.3.1). The air stripper emissions will be dehumidified

TABLE 4-3

OVERALL COSTS FOR THE UV/PEROXIDE GROUNDWATER TREATMENT UNIT

ITEM	CAPITAL COST (Dollars)	ANNUAL COST (Dollars)
Building improvements, utilities	$150,000	
Treatment Unit & Equipment	220,000	
Operating Costs[1]		
- Hydrogen Peroxide ($0.52/lb[2])		$3,000
- Power ($0.07/kwh)		12,000
- Lamp Replacement (every 3 months)		5,000
TOTAL:		
- UV/Peroxide	$370,000	$20,000

[1] Operating costs based upon continuous yearly flowrate of 10 gpm.

PRESENT WORTH

Present Worth Factor (PWF) = 9.427 (for annual operating costs)

$20,000/year x 9.427 =	$189,000
1989 capital cost =	$370,000
	$559,000

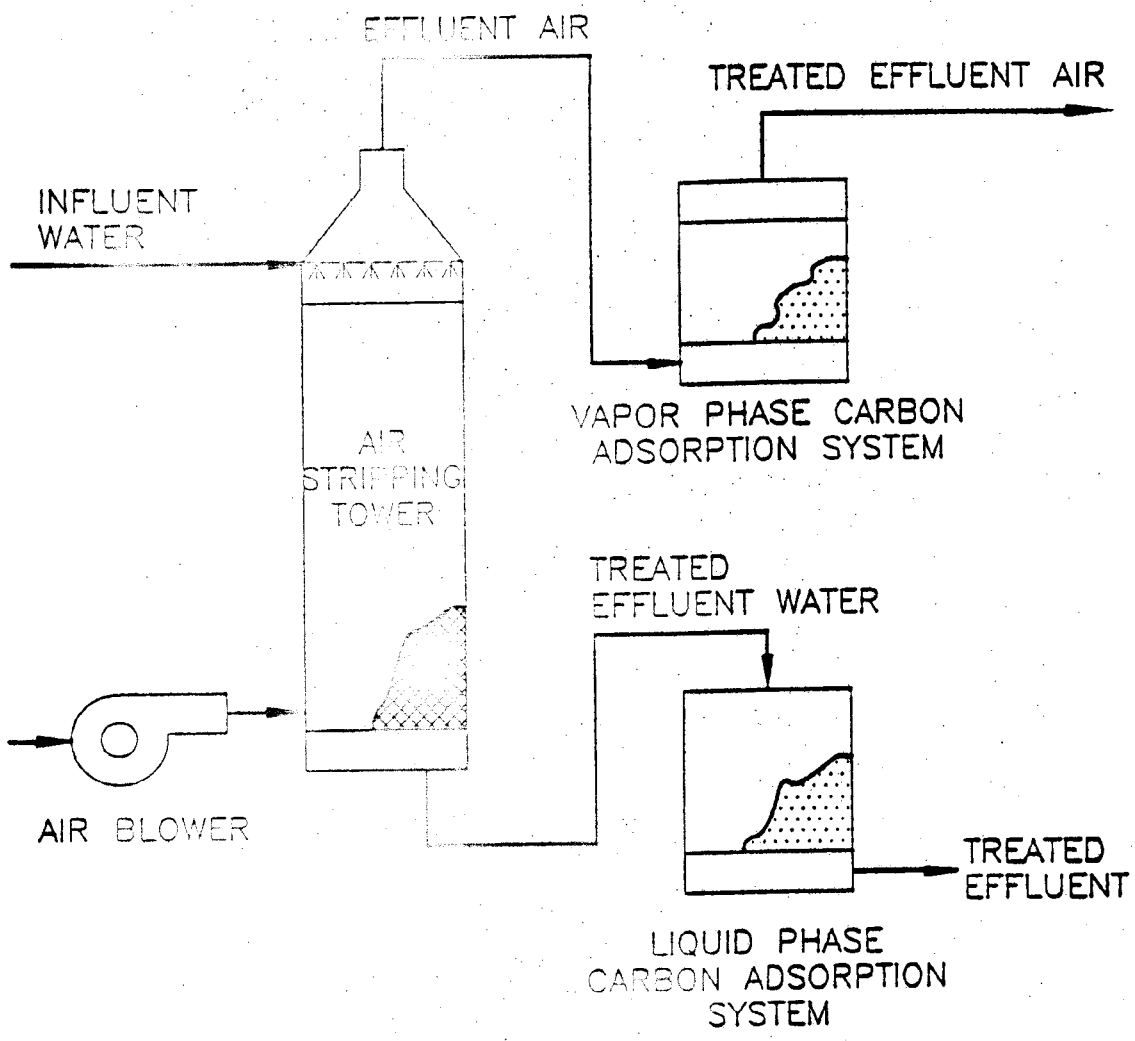

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FIGURE 4-3
AIR STRIPPING

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by use of a heater, and then passed through a vapor phase carbon system to remove the organics before being released to the environment. The vapor phase carbon unit will contain 2,000 pounds of carbon.

4.3.3.2 Effectiveness

The use of an air stripper is a highly effective method of removing hazardous volatile organic compounds (VOCs) from ground water. The efficiency of the process is well documented. The Environmental Protection Agency (Federal Register), Vol. 52, No. 130, page 25698) has [illegible] packed tower aeration along with granular activated carbon, as a Best Available Technology (BAT) for the removal of VOCs from drinking water.

An air stripper coupled with liquid and vapor phase carbon adsorption is a proven system that has a dependable record of use. It is expected that this treatment process, with proper maintenance, will provide the desired level of contaminant control until complete cleanup of the [illegible] Hillside has been achieved.

The probability of equipment failure will be minimized because the system is oversize for the intended flow of 30 gpm and includes two (2) vapor phase carbon units - one (1) installed and one (1) shelf-space. The shelf-space on site unit adds to the system reliability.

All appropriate safety measures required when moving and installing large equipment will [illegible] installation. The operation and maintenance of the system will be performed by personnel properly trained in the handling of hazardous and radioactive wastes. Because carbon will remove oxygen from the air, whenever personnel are working in confined areas (i.e., tanks) where assistance may

be limited, special care must be taken to ensure that an adequate air supply is available.

The operators of the system will not be exposed to VOC-laden carbon from the vapor phase or liquid phase carbon units because the use of containerized and transportable carbon contactors allows removal and replacement of the exhausted carbon at a remote carbon reactivation site. Carbon will not be handled at the site. Transporting the entire exhausted carbon column itself to the regeneration facility ensures operators are protected from the carbon itself, and need only follow routine safety procedures when handling heavy equipment.

The exhausted carbon is generally regenerated through a thermal treatment process which strips the volatile organics from the carbon. The organics are subsequently destroyed via incineration. During this regeneration process, a small quantity of ash may be generated which requires disposal at a landfill. Thus, this process can be considered an alternative land disposal since the carbon is continuously recycled. However, if the spent liquid phase carbon was determined do be a mixed waste, then it would require land disposal to the Nevada Test site. The vapor phase carbon adsorption system will remove the organics from the air stripper emissions before being released to the environment. Therefore, the vapor phase carbon adsorption system will eliminate the impact of any air stripper emissions on the public health. Nearby communities and the environment should realize no safety concerns. Treated water and air will be monitored to ensure contaminants levels are within regulatory guidelines before being released to the environment. No safety concerns for nearby communities and the environment are anticipated during implementation of the process.

4.3.3.3 Implementability

The air stripper will remove greater than 99% of the contaminants in the ground water. Because the air stripper performance is sensitive to changes in flow and contaminant concentrations, a liquid phase carbon adsorption unit is in series with the air stripper to enhance system performance and to ensure that the treated effluent meets regulatory standards for volatile organic compounds. Based on a constant yearly flow rate of 10 gpm, liquid phase carbon usage will be approximately 9 pounds/day and each 1800 pound carbon unit will require replacement approximately every six months. Based on an average flow rate of 10 gpm, vapor phase carbon usage will be approximately 10 pounds/day and each 2,000 pound carbon unit will require replacement approximately every six months.

Operation of the treatment process is relatively simple, requiring occasional cleaning of the air stripping column and replacement of carbon. The air stripper will require cleaning to remove scale buildup on the packing material in order to maintain optimum removal efficiency. Transportation and regeneration of the liquid phase and vapor phase carbon units at a remote carbon reactivation site will be required. The air stripping with off-gas treatment system for remediating VOC contaminated ground water is available commercially and could be implemented quickly. No difficulties are anticipated during the installation and start-up of this treatment system.

4.3.3.4 Costs

Estimated costs for the air stripping ground water treatment system are shown in Table 4-4. The total capital cost for the system is $245,000. The liquid phase

TABLE 4-4

OVERALL COSTS FOR THE AIR STRIPPER GROUND-WATER TREATMENT UNIT

ITEM	CAPITAL COST (Dollars)	ANNUAL COST (Dollars)
Building improvements, utilities	$150,000	
Treatment Unit & Equipment		
- Air Stripper Column (with pump tank)	20,000	
- Ancillary equipment (heater, extra blower)	5,000	
- Liquid Phase Carbon System	45,000	
- Vapor Phase Carbon System	25,000	
Operating Costs[1]		
- Liquid carbon phase replacement (2 units/year)		$2,100
- Vapor Phase Carbon Replacement (2/year)		4,000
- Transportation and Disposal of Spent Liquid Phase Carbon		3,000
- Transportation and Disposal of Spent Vapor Phase Carbon		6,000
- Operation and Maintenance and Power		15,000
TOTAL:		
- Air Stripper System	$245,000	$30,100

[1] Operating costs are based upon continuous yearly flowrate of 10 gpm.

PRESENT WORTH

Present Worth Factor (PWF) = 9.427 (for annual operating costs)

$30,100/year x 9.427 =	$284,000
1989 capital cost =	$245,000
	$529,000

carbon unit is the same unit described in Section 4.3.1. The majority of the operating costs result from the replacement of spent vapor phase and liquid phase carbon. These costs were derived from the same treatability study results and unit pricing presented in Section 4.3.1.4. It should be noted that these operating costs are based on disposal of the spent carbon as a hazardous waste. If the spent carbon requires disposal at the Nevada Test Site as a mixed waste, these costs could change substantially.

The total present worth cost of the system based on 10% simple interest, a 30 year period of operation, and no salvage is estimated to be approximately $529,000.

4.4 COMPARATIVE ANALYSIS OF THE GROUND WATER TREATMENT TECHNOLOGIES

Based on performance, reliability, implementability, safety, and environmental and institutional impacts, there is not a substantial difference between the three processes. Since all three processes will effectively decontaminate the ground water, the choice of treatment is based on expediency in destroying the ground-water contaminants.

The present worth of each of the three alternatives has been estimated assuming a simple interest rate of 10% over a 30-year period of operation. For activated carbon adsorption, the present worth is $744,000; for UV/Peroxide oxidation, $559,000; and for air stripping with both liquid and vapor phase activated carbon, $529,000. Thus, from a cost basis, the activated carbon system is substantially more expensive than the other two. The costs for the UV/Peroxide and air stripping systems differ by only about 5%, and both can be considered competitive.

SARA favors innovative treatment technologies that destroy contaminants, and UV/peroxide meets this objective. The air stripping and activated carbon adsorption systems both use activated carbon, and with regeneration, the contaminants that have adsorbed onto the carbon would eventually be destroyed. However, this assumes that the carbon is not radioactively contaminated, thereby requiring shipment to the Nevada Test Site for disposal. (Uranium, either naturally occurring or resulting from waste disposal, will likely adsorb to the activated carbon.) Therefore, the advantage provided by a UV/peroxide system of directly destroying the ground-water contaminants is the deciding factor in selecting UV/peroxide as the preferred process for ground-water decontamination.

4.5 DETAILED EVALUATION OF REMOVAL ACTION ALTERNATIVES

4.5.1 Alternative 1: Collect Ground Water from Footing Drain, Source Well, and French Drain, and Reinject Treated Ground Water Downgradient of the 881 Hillside Area

4.5.1.1 Description

This alternative involves construction of a french drain (trench) at the location shown on Figure 4-4. The downstream face of the trench will be covered with a synthetic membrane to limit flow from the clean side of the trench (Figure 4-5). The inclusion of the downstream synthetic membrane coupled with the continuity of the drain is expected to provide positive cutoff of the ground water. Water collected from the drain plus a source well at SWMU 119.1 (a new well near well 9-74) will be treated in a new treatment plant (see Section 4.4). In addition, a sump will be built to collect the flow from the Building 881 footing drain. Sump pumps will be used to move the footing drain flow to the treatment plant in a separate piping system. Effluent from the treatment plant will be reinjection of treated water

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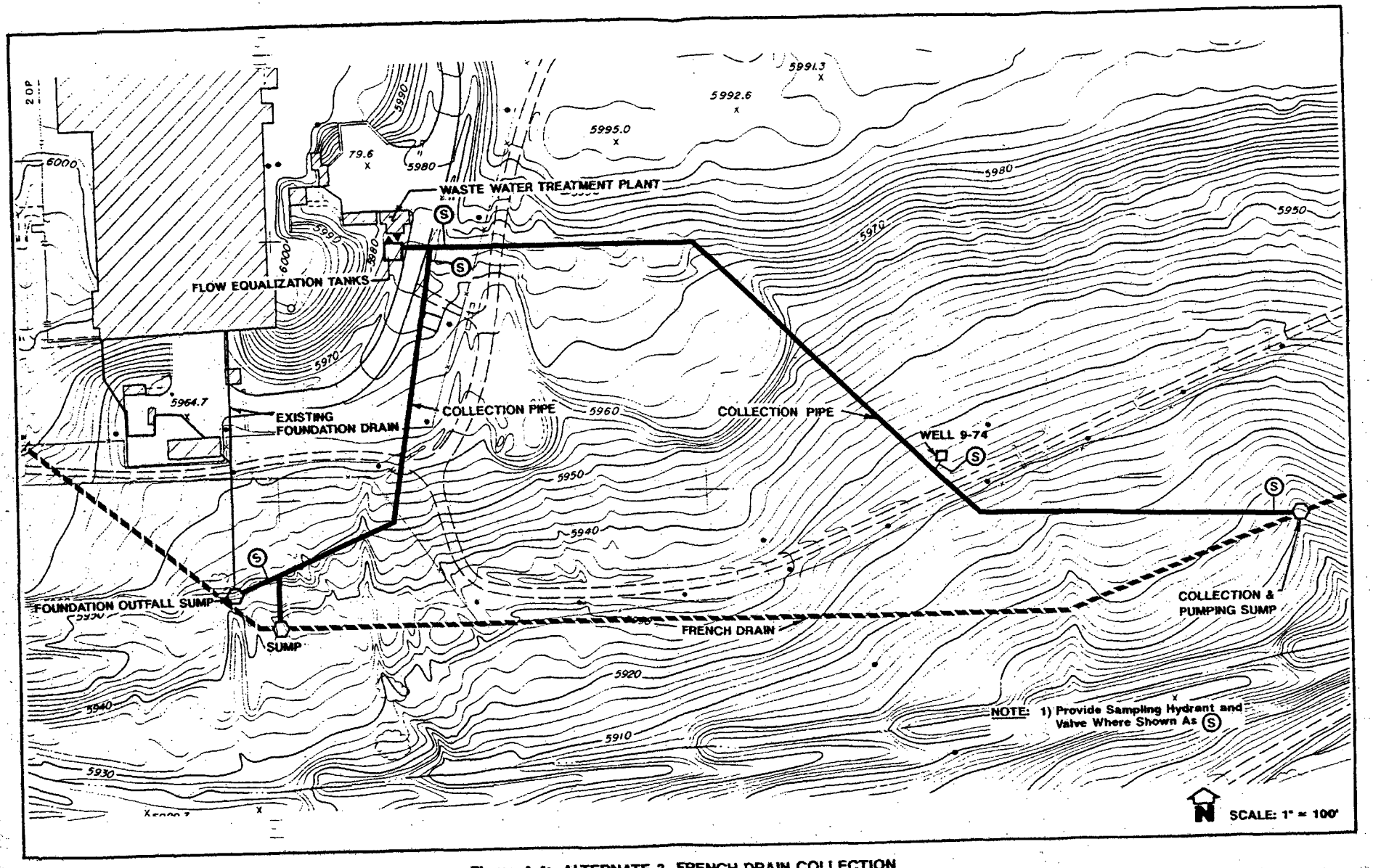

Figure 4-4: ALTERNATE 3 FRENCH DRAIN COLLECTION

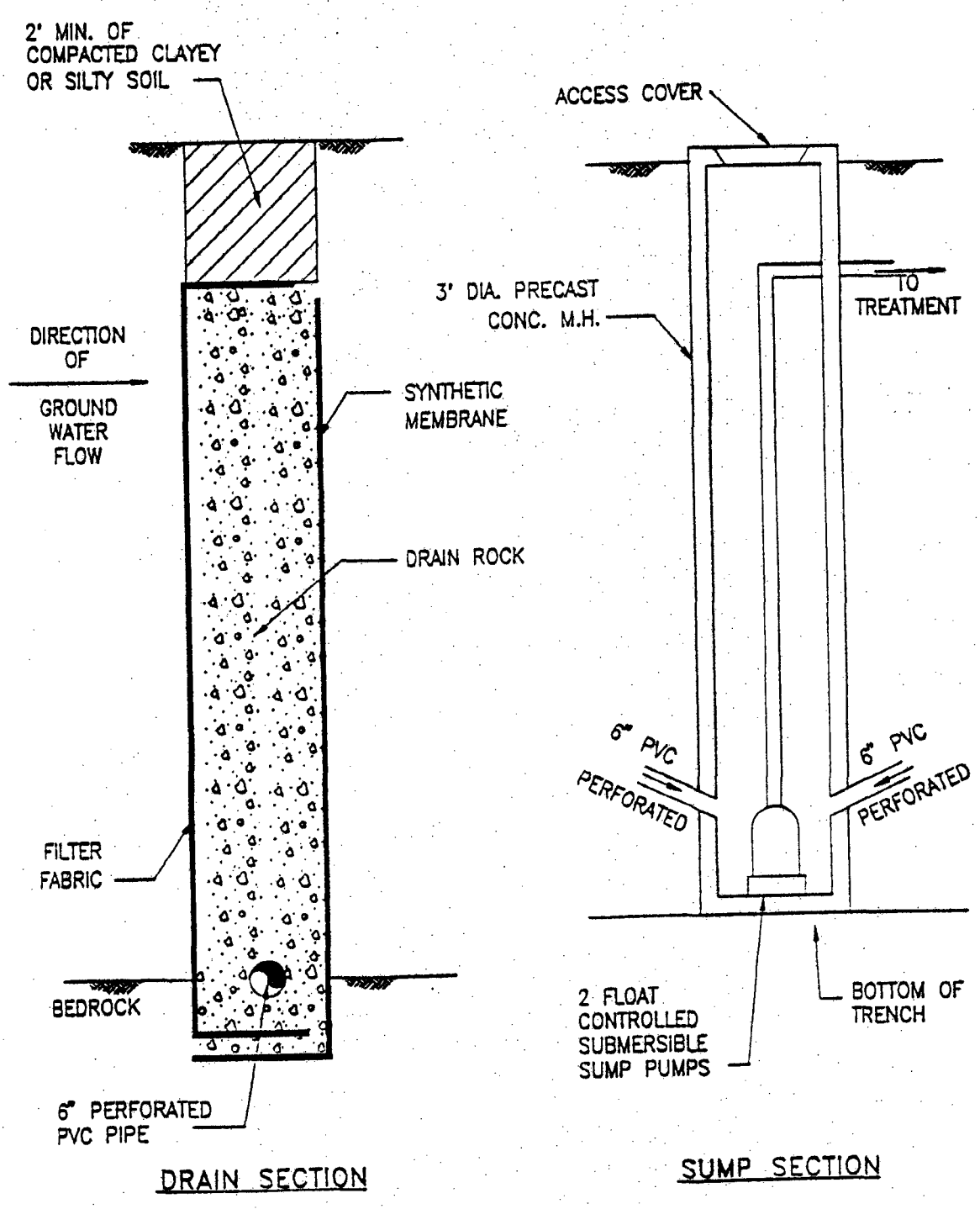

FIGURE 4-5
FRENCH DRAIN SECTION

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downgradient of the 881 Hillside Area in the Valley Fill Alluvium of the Woman Creek drainage.

The conceptual design of this alternative involves a drain keyed into bedrock (in order to fully penetrate the soils) and 1,680 feet long. A drainage pipe (PVC) inside the drain will flow under gravity to two collection sumps (3-foot diameter concrete pipe). A submersible sump pump will be used to deliver the water from the drain to the treatment plant. In order to expedite contaminant removal from SWMU 119.1, well 9-74 will also be pumped and routed to the treatment plant.

Flow from the trench could be on the order of 10 gpm initially, but is expected to drop to less than 5 gpm within a few days. Steady flow from the trench could be as low as 2 gpm.

4.5.1.2 Effectiveness

Worker safety precaution will be required during construction of this alternative because of the potential for encountering contaminated water in the excavation. However, at the location of the drain it is expected that contamination in both soil and water will not be detected.

This alternative prevents alluvial ground-water contamination from moving beyond the 881 Hillside Area which in turn will eliminate any future public exposure to alluvial ground-water contaminants off-site. Alluvial ground water flowing through the site will continue to move contaminants away from the site and into the french drain for subsequent removal by the treatment system. The french drain will also tend to reduce the water pressure the alluvial ground water exerts on the bedrock system, thereby decreasing the potential for vertical flow of ground water. There are

no adverse environmental effects that would result from implementation of this alternative.

4.5.1.3 Implementability

A french drain is expected to be highly effective in containing and collecting alluvial ground water at the 881 Hillside. Drains for containment and collection of contaminated ground water have been successfully used for many years. When the drain can be keyed into a low permeability base and backed up with a downstream, low permeability wall, a french drain is the most positive method of ground-water control available. As such, the drain proposed in this alternative is expected to effectively contain all alluvial ground-water flow from the area. If all alluvial ground-water flow from the area is contained, there will be no further downgradient releases of organic contaminants from the 881 Hillside Area via this pathway.

The useful life of the french drain system is expected to be at least thirty years. The drain design provides for clean-outs at regular distances along its length which can be used for both mechanical and chemical cleaning, should this be required. Replacement of the pumps in the sumps should be expected as part of routine operation.

French drains have been used successfully for many years for control of ground water. French drains are almost always effective, except when ground water can flow over, under or around the drain, or when the drain becomes clogged. The drain proposed for the 881 Hillside will fully penetrate the colluvium and be keyed into claystone bedrock, precluding the possibility of flow under or over the drain. It extends uphill on the west side to an elevation equal to that of SWMU 107 and is keyed into a dry ridge on the east end. This should preclude flow around the drain.

Clogging is not expected to be a problem because the footing drain at Building 881 has been in service since the early 1950's without clogging.

Operation and maintenance requirements are small for a french drain. Flow to the sump is by gravity. Liquid level controllers switch on a submersible pump in the central sump whenever there is sufficient water present. Pumping records will be reviewed regularly to be sure that the system is operating. If long periods of non-pumpage are observed, water levels in the drain will be investigated to determine if the pumps have failed or if clean-out is required. In addition, ground-water and surface water conditions will be monitored. Thus, routine operational requirements are minimal.

Action-specific ARARs relating to soil excavation which may be pertinent to this alternative include the requirements under RCRA that address the storage of RCRA wastes in waste piles, and restrictions on the land disposal of solvent-containing wastes that exceed treatment based standards for those constituents. Although the majority of the soil excavated during the installation of french drains will not be moved to another location (i.e. it will be used as backfill for the trenches from which it was excavated) and thus not trigger the land disposal restrictions, the requirements for temporary storage of the potentially contaminated soil in accordance with RCRA storage in waste piles are relevant and appropriate. Of particular relevance to the handling and storage of the soil is the requirement, under RCRA, of diverting run-on away from the piles, preventing wind dispersal of wastes, and collecting free liquids or leachate for treatment as a hazardous waste. RCRA requirements for the storage of soil in containers (roll-off boxes or drums) would also be relevant and appropriate if containers are used for storage. Lastly, the RCRA requirement for a multi-layer cap for the contaminated sites is relevant but not

appropriate since a cap limiting infiltration is counter-productive to the cleanup strategy of this alternative.

RCRA restrictions on the land disposal of solvent containing wastes are relevant and appropriate to residual soils left after backfilling operations are completed. Soils may not be disposed on site or off site unless they have been analyzed and found to contain levels of contamination below threshold limits (treatment based standards) for those contaminants, or treated to Best Demonstrated Available Technology (BDAT) standards.

Implementation of this alternative involves only routine construction procedures. Construction of the drain can be completed in a period of approximately two months. Ground water will be effectively contained at the beginning of construction when the excavation is dewatered. The system will be operational immediately upon completion.

4.5.2 Alternative 2: Total Encapsulation

4.5.2.1 Description

This alternative involves total encapsulation of the contaminant sources near SWMU 107 and within SWMU 119.1 using RCRA caps and slurry walls at the locations shown on Figure 4-6. Each area will be covered with a three-layer cap consisting of six-inches of vegetated topsoil, a minimum of six inches of drain rock, and a composite synthetic membrane/compacted soil cover of at least two-foot thickness (Figure 4-7). The surface of the cover will be sloped at a minimum of 2% to drain toward peripheral ditches. The peripheral ditches will discharge to the South Interceptor Trench. The cover at SWMU 107 is estimated to consist of approximately

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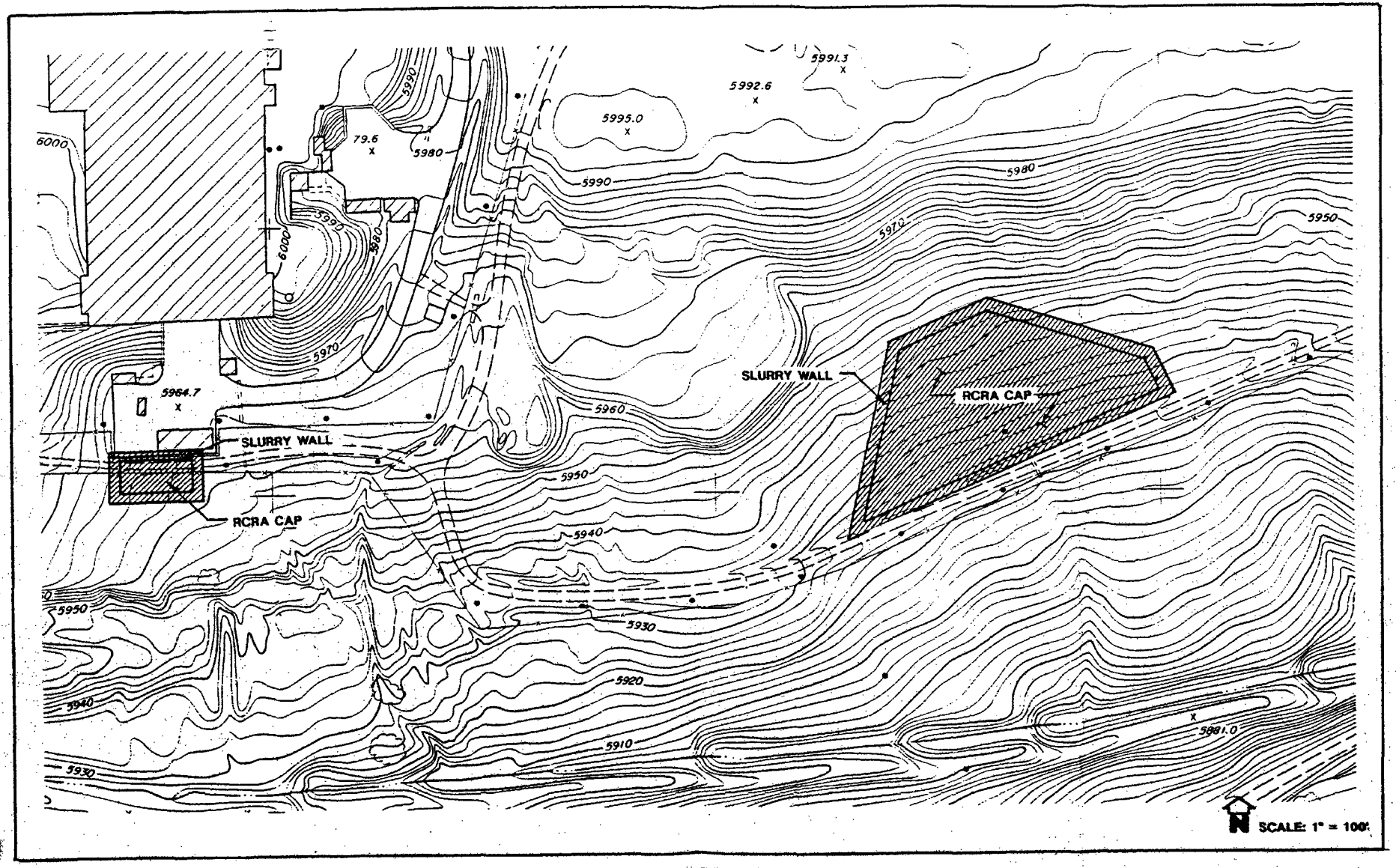

Figure 4-6: ALTERNATE 5 TOTAL ENCAPSULATION

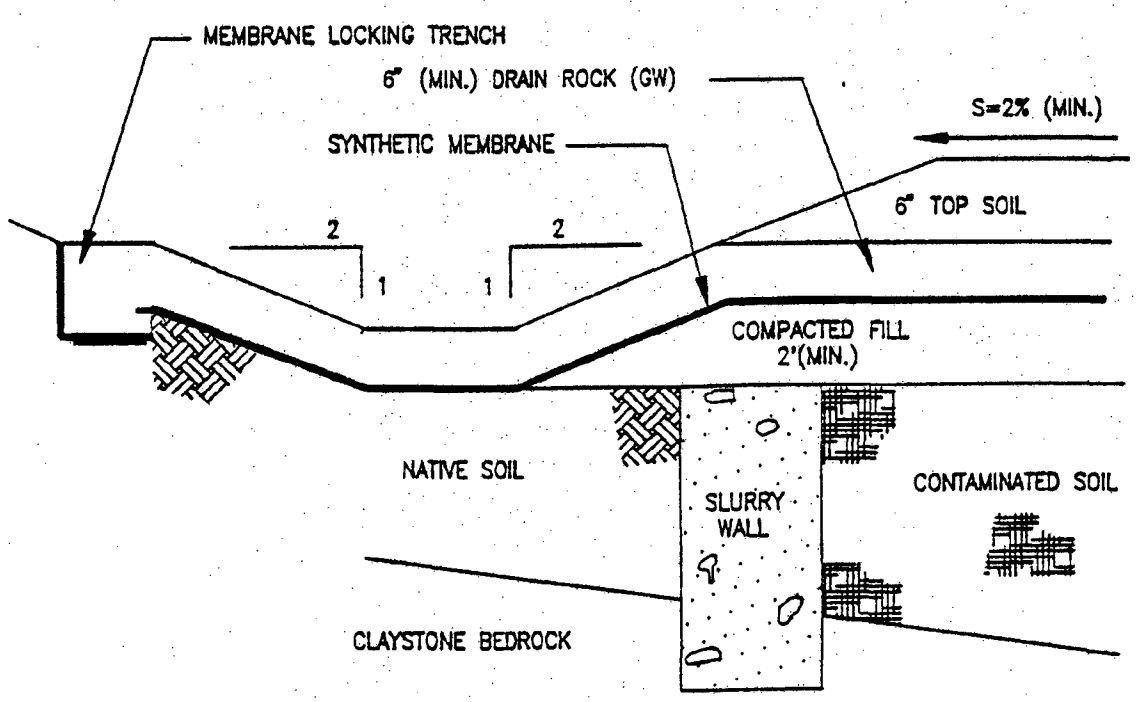

FIGURE 4-7
TOTAL ENCAPSULATION SECTION

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6,000 square feet; the cover at SWMU 119.1, approximately 40,000 square feet. The covers will extend a minimum of five feet beyond the slurry walls.

Peripheral containment will be achieved by construction of soil-bentonite slurry walls to completely encircle the contaminated soils. The walls will be keyed into claystone bedrock, which is expected to provide bottom containment. The SWMU 107 slurry wall is estimated to be approximately 320 feet long and depths are anticipated to range from about 4 to 17 feet. It is estimated that the SWMU 119.1 wall will not exceed about twenty feet in depth (15 feet average) and that it will be approximately 1,000 feet long.

In addition, ground water inside the containment systems will be removed using internal sumps. This will result in hydraulic gradients toward the encapsulated soil and will reduce the potential for any releases. The small volume of water produced from the sumps will be stored in tanks on site to be transferred for treatment at the existing Rocky Flats Plant treatment facility.

The cap and perimeter ditches will be inspected on an annual basis and repaired as necessary. The ditches will be maintained in clean and properly graded condition so that collected runoff is rapidly removed from the area.

The performance of the system will be monitored by sampling wells and surface waters in the area. For conceptual design level costing purposes, it has been assumed that the monitoring program will be the same as described in the previous alternative excluding monitoring of a treatment plant.

4.5.2.2 Effectiveness

Partial control of the SWMUs will be achieved as soon as the peripheral containment structures are constructed. Full control will not be achieved until the entire system is complete and pumping of the sumps begins.

Worker safety precaution will be required during construction of this alternative and during monitoring and dewatering operations. In addition, safety precautions will be required during excavation for and construction of the compacted soil barrier walls.

This alternative will adequately contain and immobilize the sources of contamination. As discussed in Section 2, ground water contaminated with VOCs is known to exist downgradient of SWMU 119.1 and may exist downgradient of SWMU 107. These waters will be released to the environment. This is not expected to pose a hazard to the public or the environment because of attenuation and dilution along the flowpath in the Valley Fill Alluvium. Therefore, this alternative minimizes future contaminant migration from the sources and minimizes future public exposure to contaminants off site.

4.5.2.3 Implementability

Infiltration and ground-water flow through the SWMUs is expected to be practically eliminated by the total encapsulation system. As a consequence, the release of contaminants from the SWMUs is also expected to be eliminated. It must be noted that the system will not be as effective if the SWMU areas are not underlain by continuous claystone.

The useful life of the total encapsulation system is expected to exceed thirty years. The containment features involving geologic materials (slurry wall and compacted soil cover) should function indefinitely, particularly given that flow through them will be from the non-contaminated to the contaminated side. The synthetic membrane can be expected to function adequately for at least twenty years, and it is backed-up by the compacted soil layer. The vegetated cover and peripheral ditches will require regular maintenance, and the internal sump will require regular operation.

The technologies proposed in this alternative are all proven technologies. The multi-layer cap system has been used for nearly ten years with good success at many sites. Soil-bentonite slurry walls have also been used for many years to effectively control ground-water flow. The gradient control provided by the sump is a modification of the standard encapsulation system and should provide an extra level of protection.

Operation and maintenance requirements are very small for the total encapsulation alternative. There are essentially no operational requirements, with the exception of routine pumpage of the sump. This is expected to be required no more frequently than annually after the initial dewatering. Maintenance will involve inspection and cleaning of peripheral ditches, inspection and repair of the vegetated cover, and inspection and replacement of the sump pump. In addition, ground-water and surface water conditions in the vicinity of the Hillside will be monitored.

This alternative can be implemented using standard construction practices. Seaming of synthetic membranes has become common enough that a qualified local

contractor can probably be found. Construction of the encapsulation systems will probably require about three months.

Construction of a slurry wall at SWMU 119.1 may prove impractical where the wall runs parallel to the grade (slope may be too steep). For the two legs of the wall running up the hill, it is recommended that a compacted soil cutoff wall be constructed in an excavated trench. The trench will probably vary from about 15 feet deep at the downhill end to about 2 feet deep at the uphill end. The trench can be excavated with standard earth-moving equipment. Some of the excavated material may be suitable for use in constructing the wall. The length of compacted wall is estimated to be 600 feet, while the remaining slurry portion is about 400 feet long. A compacted soil wall is expected to provide performance characteristics equivalent to a slurry wall.

Material for construction of the compacted soil cover and wall can be obtained from the Arapahoe Formation. The Arapahoe is covered by a thin veneer of colluvium along Woman Creek and could be excavated from a number of nearby areas; however, in order to avoid oversteepening the slopes, the borrow area should probably be established on the south side of Woman Creek.

ARARS pertinent to the total encapsulation alternative include the relevant and appropriate requirements under RCRA that address the technical specifications of capping closure and post-closure care. In addition, soil that is excavated must be returned to the area from which it was originally removed to avoid triggering the restrictions on land disposal of solvent containing wastes.

Wastewater that is recovered from the source well within the encapsulated area must be treated in an on-site or off-site facility operating in compliance with the

substantive requirements of RCRA. If recovered ground-water is to be treated on site in a treatment facility, specific RCRA requirements for the treatment of hazardous waste are relevant and appropriate. If wastewater is transported off-site, both the substantive and administrative requirements of RCRA will apply to the wastewater management.

4.5.3 Alternative 3: Source Well and Footing Drain

4.5.3.1 Description

This alternative involves pumping a new source well (located near 9-74) at SWMU 119.1 and collection of the footing drain discharge at SWMU 107 (Figure 4-8). The collected water will be treated in the new treatment plant with reinjection of treated water downgradient of the 881 Hillside Area in the Valley Fill Alluvium of the Woman Creek drainage. It is estimated that flow from a completely dewatered 9-74 will begin at about 1 gpm but rapidly fall to a steady flow of about 0.04 gpm. It is anticipated that the flow from the drain will vary between about one and five gpm although the flow may cease during periods of low precipitation.

The performance of the system will be monitored by sampling wells and surface waters in the area. For conceptual design level costing purposes, it has been assumed that the monitoring program will be the same as the first alternative.

4.5.3.2 Effectiveness

Removal of the majority of contamination in the vicinity of well 9-74 will significantly minimize off-site migration of contaminants. Future off-site public exposure to the contaminants is unlikely; however, such exposure is more probable

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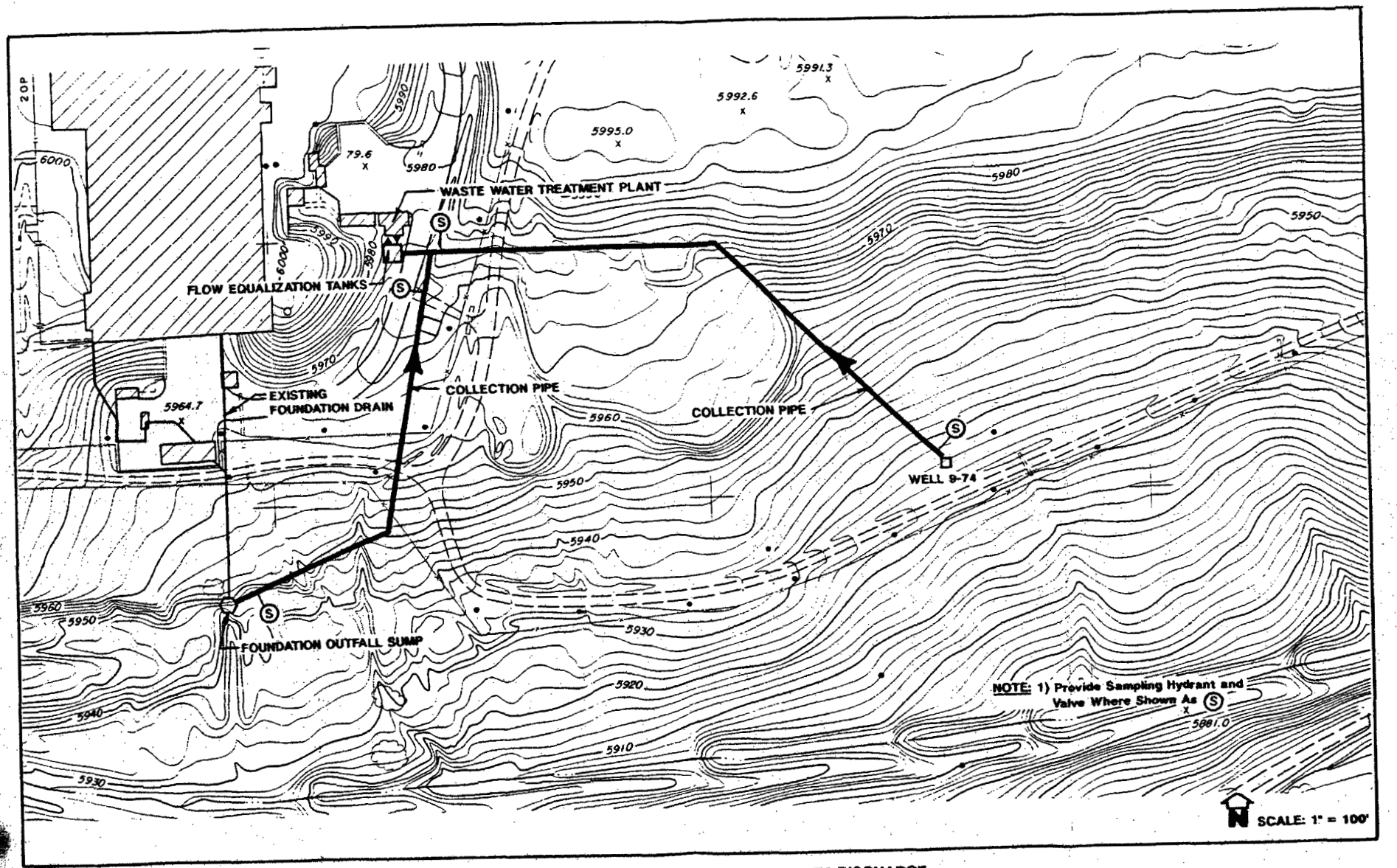

Figure 4-8: ALTERNATE 7 TREAT DRAIN & WELL 9-74 DISCHARGE

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than that expected for alternatives that effectively contain and/or remove the contaminants.

As with the other alternatives, a health and safety plan will be prepared for use in implementation of this alternative to assure worker protection.

4.5.3.3 Implementability

Relative to no action, this alternative is expected to effectively improve the level of protection of public health and the environment. Although current conditions do not pose an imminent hazard to the public health, this alternative minimizes any future exposure of the public off site to the contaminants at the 881 Hillside.

The useful life of this alternative is expected to exceed thirty years. The footing drain at SWMU 107 has already been functioning satisfactorily for thirty years and there is no reason to believe that this will change. A large diameter withdrawal well will provide efficient dewatering of the alluvium in the vicinity of well 9-74. The well will be surrounded by monitoring wells so that an evaluation of the efficiency of the well can be easily made.

It appears likely that pumping of the withdrawal well will be continuous for the first several years of remediation, but may not be required later. This is due to the small amount of ground water in the vicinity of SWMU 119.1. Collection of the footing drain flow will likely be required for the full thirty years.

This system is expected to be highly reliable because the drain has been functioning for over thirty years without problems, and because wells have been used for collection of ground water for many years.

Operation and maintenance requirements for collection of the footing drain flow are minimal. Discharge from the drain will be pumped to the treatment plant based on liquid level switches. Two pumps will be provided to protect against pump failure. Operation and maintenance of the dewatering well are similar. It too will be operated with a liquid level controller and requires little more than routine inspection. The system is highly implementable because the withdrawal well, and associated pumps and mechanical connections are standard items.

Details of the chemical- and location-specific ARARs associated with ground-water remediation are presented in the screening of ARARs found in Tables 3-2 and 3-3.

It is estimated that an operational system could be in place in a few months and that environmental improvement would begin immediately.

4.6 ESTIMATED COSTS FOR ALTERNATIVES

Cost estimates were prepared using in-house computer software and unit rates. In-house unit rates are based upon Rocky Flats Plant experience in planning and managing similar construction projects at this site. Other recognized references were used where site specific unit rates were unavailable and for comparison or checking. These documents include: "Compendium of Remedial Technologies at Hazardous Waste Sites", U.S. EPA, September 1985; "Treatability Manual, Volume IV. Cost

Estimating", U.S. EPA, April 1983; and "Building Construction Data", R.S. Means Co., Inc., 1987.

Costs are reported in 1989 dollars for both initial and future costs. Future costs include replacement of capital cost items (e.g., monitor wells or non-expendable items) and cyclic costs, such as operation and maintenance (O&M) costs, energy costs, and expendable supplies. Life cycle costs for each alternative have been presented, in 1989 dollars, as present worth costs assuming a discount rate of 10% and a duration of active remedy of thirty years.

Costs were analyzed by first identifying capital items common to one or more remedial alternatives. These capital items and associated costs are presented for each alternative in Table 4-5. Similarly, identified cyclic costs for each alternative are presented in Table 4-6.

Present worth analyses are performed by using the total costs presented in Tables 4-5 and 4-6, and assuming the duration of the remedy is 30 years, year "0" begins upon initiation of design and construction activities and continue through the end of year 30. Thirty years was selected as the expected duration of the IRA for use in cost analyses for two principal reasons; 40 CFR 264.117 requires a minimum of 30 years post-closure monitoring, and beyond 30 years present value costs are less than 6% of their future worth and thus become insignificant with respect to these analyses. These schedule assumptions are made to facilitate comparisons between alternatives and do not supersede any existing schedules created as a result of any administrative rule, statute, or agreement with agencies authorized to regulate remedial activities at this site. The present worth analysis (in 1989 dollars) is presented for each alternative in Tables 4-7.

TABLE 4-5

CAPITAL COSTS COMPONENT WORK SHEET

COMPONENT DESCRIPTION	ALTERNATIVE NUMBER 1	2	3
1 ea Foundation Drain Sump w/Pump	$17,800		$17,800
Withdrawal Well	$5,800	$5,800	$5,800
2500 LF Influent/Effluent Pipe & Manholes	$50,000		$50,000
Treatment Unit & Building Improvements	$370,000		$370,000
1680 LF French Drain with Sumps	$271,400		
Influent/Effluent Tanks	$78,000		$78,000
Effluent Infiltration Gallery	$155,700		$155,700
58800 SF RCRA Cap		$143,500	
19800 SF Slurry Wall		$138,600	
1 ea 7500 gal Tank Wagon		$32,000	
Parking Pad	$4,300		$4,300
Electrical	$117,100		$117,100
Mechanical	$122,600		$122,600
Instrumentation	$40,500		$40,500
SUB-TOTAL	$1,233,200	$319,900	$961,500
DESIGN @15%	$185,000	$48,000	$144,200
CONSTR MGM @5%	$61,700	$16,000	$48,100
CONTINGENCY @20%	$246,700	$64,000	$192,300
TOTAL CAPITAL COST	$1,726,600	$447,900	$1,346,100

TABLE 4-6

CYCLIC COSTS COMPONENT WORK SHEET
(DOLLARS PER YEAR)

COMPONENT DESCRIPTION	ALTERNATIVE NUMBER 1	2	3
1 ea Foundation Drain Sump w/Pump	$200		$200
1 ea Well Pump	$200	$200	$200
Treatment Unit	$20,000	$2,500	$20,000
1 ea 7500 gal Tank Wagon		$2,500	
Treatment System Monitoring (4 samples/mo)	$72,000		$72,000
SUB-TOTAL	$92,400	$5,200	$92,400
CONTINGENCY @20%	$18,480	$1,040	$18,480
TOTAL	$110,880	$6,240	$110,880

TABLE 4-7

SUMMARY OF ALTERNATIVE COSTS

	CAPITAL COSTS	ANNUAL COSTS	PRESENT WORTH COSTS*
Alternative 1	$1,726,600	$110,880	$2,771,900
Alternative 2	$447,900	$6,240	$506,700
Alternative 3	$1,364,100	$110,880	$2,391,400

* 30 year period at 10% discount rate.

Rigorous sensitivity analyses demonstrating the effect of possible variations or inaccuracies in assumptions or estimates have not been performed. Only one parameter, the duration of active remedial measures, was identified as being significant with respect to sensitivity analyses. However, uncertainties in the rates of reclamation of the alternatives prevents performance of more rigorous analyses.

A discussion of cost benefits of individual alternatives is presented in Section 5, Summary of Alternatives.

4.7 ARARS ASSOCIATED WITH GROUND-WATER TREATMENT AND SUBSURFACE DISCHARGE

4.7.1 Chemical-Specific ARARs

A distinct set of ARARs have been identified for remedial actions involving the subsurface discharge of treated ground water. Health-based chemical-specific ARARs pertinent to ground-water discharge have been identified and screened for the Target Compound List organic compounds found above detectable levels in the 881 Hillside wells. Potential ARARs include applicable standards for the protection of ground water promulgated under the Colorado Water Quality Control Act and applicable standards defined by the Safe Drinking Water Act, Underground Injection Program.

Screening of the potential chemical-specific ARARs pertinent to subsurface discharge is documented in Section 3. A summary of the organic chemicals found to exceed ARARs as a result of this screening are presented in Table 3-1. An analysis of the chemical-specific ARARs identified for subsurface discharge reveals that the selected treatment alternatives will provide treatment that exceeds ARARs for organic contaminants.

4.7.2 Action-Specific ARARs

Action-specific ARARs pertinent to subsurface discharge are the relevant and appropriate requirements under RCRA for the storage and treatment of hazardous waste in containers and tanks prior to subsurface discharge and the relevant and appropriate requirements under the Safe Drinking Water Act, Underground Injection Control Program.

The design, operation, and maintenance of the selected treatment facilities will meet chemical-specific ARARs identified for the contaminants of concern and action-specific ARARs related to the subsurface discharge of treatment system effluent. Highlights of these action-specific ARARs are listed below:

- Applicable federally approved state water quality standards must be complied with for discharges to surface or ground waters of the state. These standards may be in addition to or more stringent than other federal standards under the Clean Water Act.
- General requirements for treatment and storage of RCRA hazardous waste in containers and tanks are relevant and appropriate. Recordkeeping requirements under these sections are not ARARS.
- If a CERCLA response action at a Class IV injection well involves a RCRA listed waste that is subject to land disposal restrictions, the waste must be treated to Best Demonstrated Available Technology (BDAT) levels before reinjection.

A complete ARARs analysis for a number of unit operations is included in Table 3-3.

4.7.3 Location-Specific ARARs

Location-specific ARARs are discussed in Section 3.3.2.

SECTION 5

COMPARATIVE ANALYSIS

5.1 INTRODUCTION

This section summarizes the three screened alternatives and presents a tabular comparison of them (Table 5-1). A recommendation is made for appropriate removal action using the comparative analysis.

5.2 COMPARISON OF ALTERNATIVES

The following alternatives were retained in the screening process and evaluated in detail in Section 4.

1. Collection of ground water using a french drain and a source well, collection of footing drain flow from SWMU 107, treatment of collected water in a new treatment plant and reinjection of the treated water.

2. Total encapsulation of source areas using a multi-layer cap and slurry well with control of gradients by pumping an internal sump (dewatering fluids to be treated at an existing treatment plant); and

3. Pump a source well of SWMU 119.1, collect a footing drain flow from SWMU 107, treatment of collected water at a new treatment plant, and reinjection of the treated water.

The french drain coupled with ground-water treatment will meet chemical specific ARARs for organic contaminants and will halt releases to alluvial ground water downgradient of the 881 Hillside Area.

TABLE 5-1

SUMMARY OF ALTERNATIVES

Alternatives & Present Worth	Implementability	Effectiveness	Comments
1. French Drain, Source Well, and Footing Drain with Ground-water Treatment $2,771,900	The alternative relys on proven technologies for collection and treatment of ground water. There are no site conditions that render construction difficult.	The french drain will provide positive collection of all organic contaminated alluvial ground-water flow from the Hillside and will therefore prevent organic contaminant releases to downgradient alluvial ground water.	Complies with action and location specific ARARs, and meets or exceeds chemical specific ARARs for organic contaminants.
2. Total Encapsulation $506,700	The encapsulation system uses proven technology and is expected to perform well. Routine maintenance of the cover and ditches, and long-term security and monitoring are required.	Encapsulation will prevent all future organic contaminant releases from the SWMUs. A small quantity of ground water with low levels of VOCs will be allowed to flow toward Woman Creek. Should organic contaminants reach the Valley Fill Alluvium, they will be diluted to acceptable concentration at the property boundary.	Complies with action and location specific ARARs, and meets chemical specific ARARs with the exception of water immediately downgradient of SWMU 119.1 that will be released.
3. Source Well & Footing Drain $2,391,400	The alternative relys on proven technologies for ground water treatment. Site earthwork is not required.	Pumping of a well at SWMU 119.1 and collection of footing drain flow, followed by treatment of the collected water, will result in immediate improvement of ground-water quality conditions at SWMU 119.1 and provide added protection against detectable VOC releases to surface water from SWMU 107. Ground water containing low levels of VOCs downgradient of SWMU 119.1 will be released, but this is not considered to pose a hazard.	Does not meet chemical specific ARARs for organic contaminants but will significantly minimize future hazards to the public health.

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Total encapsulation will prevent all future VOC releases from the SWMUs but will allow a small quantity of ground water with concentrations of VOCs in the range of 5 to 150 ug/l to be released. The portion of this water that is not consumed by evapotranspiration will ultimately reach the Woman Creek Valley Fill Alluvium and flow east toward the property boundary. It is unlikely that volatile organics will ever be detected at the boundary from this release. This alternative uses proven technology intended for much higher contamination levels than are present on the 881 Hillside; thus, public reception of the alternative should be good, except in so far as the public may be concerned about the small contaminant release to the Valley Fill Alluvium.

Collection of the footing drain flow and pumping of an existing well at SWMU 119.1 (with treatment of collected water) is a limited scope response that should make a significant impact on releases from the two SWMUs. Although volatiles currently are not detectable in the surface waters receiving flow from the footing drain, collection and treatment of the footing drain flow will provide an extra level of assurance that significant releases will not occur in the future. Pumping the well completed in the center of SWMU 119.1 will clearly improve conditions by removing the most contaminated ground water. Continued pumping may result in complete dewatering of the colluvial materials beneath the SWMU because of limited recharge to the area.

5.3 RECOMMENDED REMEDIAL ACTION

It is recommended that the french drain with treatment of collected water alternative be implemented at the 881 Hillside. This alternative was selected using the following logic.

1. The total encapsulation alternative is by far the least expensive but requires long term management of the site, does not destroy contaminants and allows a contaminant release to the environment.

2. The footing drain/source well alternative does not result in appreciable cost savings relative to the french drain alternative because of the high cost of treating the water.

Therefore, the french drain with treatment of collected water alternative is recommended because it provides positive control of organic contaminated alluvial ground-water flow from the Hillside and treatment of collected water in a cost-effective manner.

SECTION 6

PROPOSED IRA

This alternative involves construction of a french drain (trench) to intercept all contaminated ground water from the 881 Hillside Area. The downstream face of the trench will be covered with a synthetic membrane to limit flow from the clean side of the trench. The inclusion of the downstream synthetic membrane coupled with the continuity of the drain will provide positive cutoff of the ground water. Water collected from the drain plus a source well at SWMU 119.1 (new withdrawal well near well 9-74) will be treated in a new treatment plant. In addition, a sump will be built to collect the flow from the Building 881 footing drain. Sump pumps will be used to move the footing drain flow to the treatment plant in a separate piping system. Effluent from the treatment plant will be reinjected into the Valley Fill Alluvium of Woman Creek southeast of the 881 Hillside Area.

The conceptual design of this alternative involves a drain keyed into bedrock (in order to fully penetrate the soils) and 1,680 feet long. Appendix 2 is the subsurface investigation report pertaining to the design of the drain. Drainage pipe (PVC) inside the drain will flow under gravity to two collection sumps (3-foot diameter concrete pipe). Submersible sump pumps will be used to deliver the water from the drain to the treatment plant. In order to expedite contaminant removal from SWMU 119.1, a withdrawal well near well 9-74 will also be pumped and routed to the treatment plant in separate plumbing.

The ground water collected will be treated using a UV peroxide system. An existing building will be modified as an enclosure for the water treatment system to

protect weather or temperature sensitive components. External water pipes will be buried approximately four feet to protect against freezing. Major components of the treatment system include:

Exterior to Building

1. Two 15,000-gallon influent surge tanks.
2. Two 15,000-gallon effluent tanks.
3. Roughing filters.
4 Piping.
5 Associated pumps, gages, and valves.

Interior to Building

1. UV/peroxide equipment.
2. Parallel system of FULFLO^R filters.
3. Sump pump.
4. Associated pumps, piping, gages, and valves.
5. Support equipment for treatment units, including a hydrogen peroxide supply tank and feed system for the UV/peroxide process.

As shown in Figure 6-1, ground water and footing drain water will be pumped through roughing filters, to remove suspended solids, and then pumped into the surge tanks. The flows from the different sources are expected to be variable. The surge tanks will ensure a constant flow through the treatment unit at 30 gpm, in a batch process. These tanks will also provide approximately two days collection potential when the treatment unit is down for repairs, cleaning, etc.

When the treatment is initiated, the water will be pumped from the surge tanks through FULFLO^R filters to remove remaining suspended materials. The filters will be placed in descending order of size to remove progressively smaller particulates. The water will next enter the treatment unit.

The UV/peroxide treatment unit consists of an 80-gallon stainless steel oxidation chamber, which provides for a maximum ground-water retention time of

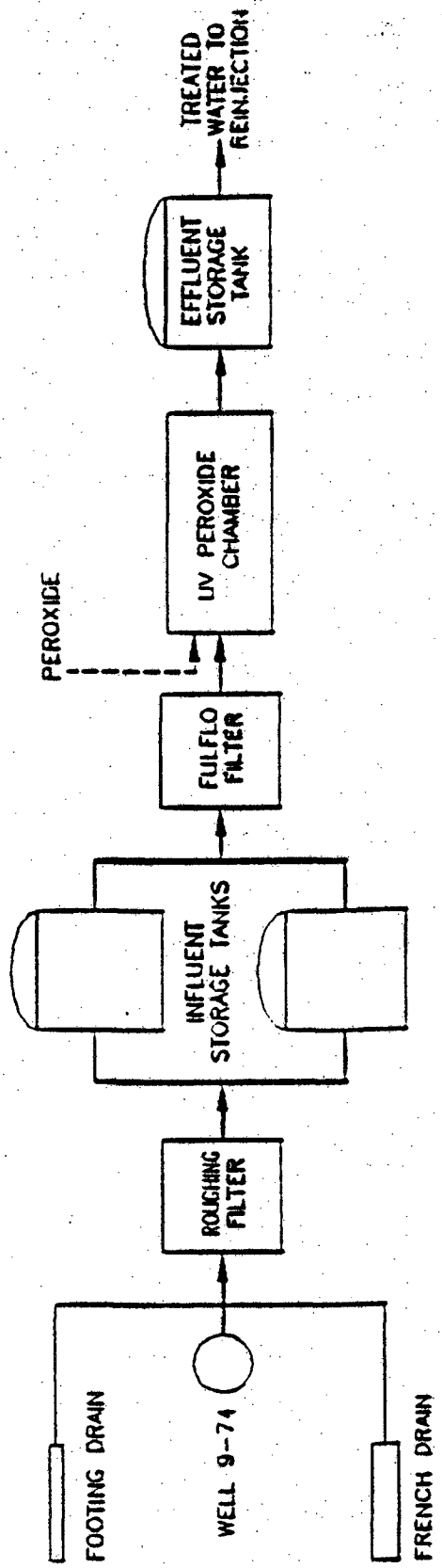

FIGURE 6-1
REMOVAL ACTION FLOW DIAGRAM

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2.66 minutes at a constant system flowrate of 30 gpm. The oxidation chamber contains four medium pressure UV lamps, which are mounted horizontally in quartz sheaths. A hydrogen peroxide feed system is used to inject approximately 140 mg/l (50 mg/l per ppm of organic contaminants) of a 50 percent H_2O_2 solution into the ground-water feed line. The ground-water/peroxide mixture then passes through an in-line static mixer before entering the bottom of the oxidation chamber. The ground water then flows through the reaction chamber, passing the UV lamps, before it exits the top of the oxidation chamber. As the ground water passes the UV lamps, the contaminants will be effectively destroyed to comply with chemical-specific ARARs. Following treatment, the water will be directed to an effluent tank before reinjection in the Valley Fill Alluvium of Woman Creek. The detailed design summary and civil engineering drawings are provided in Appendix 3.

SECTION 7

REFERENCES

Rockwell International, 1988a. Draft Final Remedial Investigation Report for High Priority Sites (881 Hillside Area), March 1988.

Rockwell International, 1988b. Draft Feasibility Study Report for High Priority Sites (881 Hillside Area), March 1988.

Rockwell International, 1989. 881 Hillside Remedial Investigation and Feasibility Study Responses to EPA Comments, February 1989.

APPENDIX 1

VOLATILE ORGANIC CONTAMINANT DATA FOR ALLUVIAL GROUND WATER AT THE 881 HILLSIDE AREA

Surface Water Volatile Organic Results

For Stations at Rockwell (Rocky Flats)

BUILDING 881 FOOTING DRAIN DISCHARGE

Station Number	Date Sampled	Qtr.	Chloro methane uG/L	Bromo methane uG/L	Vinyl Chloride uG/L	Chloro ethane uG/L	Methylene Chloride uG/L	Acetone uG/L	Carbon Disulfide uG/L
SW-45	05/26/87		NR	NR	NR	NR	NR	NR	NR
SW-45	11/17/87		10 U	10 U	10 U	10 U	21	10 U	5 U
SW-45	06/28/88		10 U	10 U	10 U	10 U	5 U	10 U	5 U

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

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Surface Water Volatile Organic Results

For Stations at Rockwell (Rocky Flats)

BUILDING 881 FOOTING DRAIN DISCHARGE

Station Number	Date Sampled	Qtr.	1,1-Dichloro ethene uG/L	1,1-Dichloro ethane uG/L	Trans-1,2-Di chloroethene uG/L	Chloroform uG/L	1,2-Dichloro ethane uG/L	2-Butanone uG/L	1,1,1-Tri chloroethane uG/L
SW-45	05/26/87		4 U	NR	4 U	4 U	4 U	NR	4 U
SW-45	11/17/87		5 U	5 U	5 U	5 U	5 U	10 U	5 U
SW-45	06/28/88		5 U	5 U	5 U	5 U	5 U	10 U	5 U

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

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Surface Water Volatile Organic Results

For Stations at Rockwell (Rocky Flats)

BUILDING 881 FOOTING DRAIN DISCHARGE

Station Number	Date Sampled	Qtr.	Carbon Tetra chloride uG/L	Vinyl Acetate uG/L	Bromodichlo-romethane uG/L	1,2-Dichloro propane uG/L	Trans-1,3-Di chloropro-pene (uG/L)	Trichloro ethene uG/L	Dibromochlo-romethane uG/L
SW-45	05/26/87		4 U	NR	NR	NR	NR	14	NR
SW-45	11/17/87		6	10 U	5 U	5 U	5 U	8	5 U
SW-45	06/28/88		5 U	10 U	5 U	5 U	5 U	5 U	5 U

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

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Surface Water Volatile Organic Results

For Stations at Rockwell (Rocky Flats)

BUILDING 881 FOOTING DRAIN DISCHARGE

Station Number	Date Sampled	Qtr.	1,1,2-Tri chloroethane uG/L	Benzene uG/L	Cis-1,3-Di chloropro-pene (uG/L)	2-Chloro ethylvinyl ether (uG/L)	Bromoform uG/L	4-Methyl-2-pentanone uG/L	2-Hexanone uG/L
SW-45	05/26/87		4 U	NR	NR	NR	NR	NR	NR
SW-45	11/17/87		5 U	5 U	5 U	NR	5 U	10 U	10 U
SW-45	06/28/88		5 U	5 U	5 U	10 U	5 U	10 U	10 U

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

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Surface Water Volatile Organic Results

For Stations at Rockwell (Rocky Flats)

BUILDING 881 FOOTING DRAIN DISCHARGE

Station Number	Date Sampled	Qtr.	Tetrachloro ethene uG/L	1,1,2,2-Tetrachloro ethane(uG/L)	Toluene uG/L	Chloro benzene uG/L	Ethyl benzene uG/L	Styrene uG/L	Total Xylenes uG/L
SW-45	05/26/87		128	NR	NR	NR	NR	NR	NR
SW-45	11/17/87		16	5 U	12	5 U	5 U	5 U	5 U
SW-45	06/28/88		3 J	5 U	5 U	5 U	5 U	5 U	5 U

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

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Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Chloro methane uG/L	Bromo methane uG/L	Vinyl Chloride uG/L	Chloro ethane uG/L	Methylene Chloride uG/L	Acetone uG/L	Carbon Disulfide uG/L
09-74	08/29/86		10 U	10 U	10 U	10 U	9 J	4 BJ	5 U
09-74	03/09/87	1	NR	NR	NR	NR	NR	NR	NR
09-74	04/09/87	1	NR	NR	NR	NR	NR	NR	NR
09-74	05/21/87	2	NR	NR	NR	NR	NR	NR	NR
09-74	07/02/87	3	NR	NR	NR	NR	NR	NR	NR
09-74	08/11/87	3	DRY						
09-74	10/20/87	4	NR	NR	NR	NR	NR	NR	NR
09-74	10/28/87	4	10U	10U	10U	10U	1. J	7. JB	5U
09-74	11/17/87	4	10 U	10 U	10 U	10 U	48	10 U	5 U
09-74	02/25/88	1	10 U	10 U	10 U	10 U	5 U	10 U	5 U
09-74	04/14/88	2	10 U	10 U	10 U	10 U	5 U	9 J	5 U
09-74	04/15/88	2	10 U	10 U	10 U	10 U	5 U	10 U	5 U
09-74	07/20/88	3	10 U	10 U	10 U	10 U	5 U	10 U	5 U
09-74	10/25/88	4	10 U	10 U	10 U	10 U	23	10 U	5 U
10-74	05/21/87	2	NR	NR	NR	NR	NR	NR	NR
10-74	07/01/87	3	DRY						
10-74	10/20/87	4	NR	NR	NR	NR	NR	NR	NR
10-74	10/20/87	4	100U	100U	100U	100U	10. J	120. B	50U
10-74	02/25/88	1	10 U	10 U	10 U	10 U	5 U	10 U	5 U

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

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Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	1,1-Dichloro ethene uG/L	1,1-Dichloro ethane uG/L	Trans-1,2-Di chloroethene uG/L	Chloroform uG/L	1,2-Dichloro ethane uG/L	2-Butanone uG/L	1,1,1-Tri chloroethane uG/L
09-74	08/29/86		7200	35	42	5	38	22	14000
09-74	03/09/87	1	12400	NR	48	4 U	75	NR	13800
09-74	04/09/87	1	9600	NR	80	4 U	126	NR	12600
09-74	05/21/87	2	48000	NR	4 U	4 U	16000	NR	4 U
09-74	07/02/87	3	703	NR	4 U	4 U	5262	NR	20285
09-74	08/11/87	3	DRY						
09-74	10/20/87	4	28530	NR	5 U	5 U	34	NR	30250
09-74	10/28/87	4	5U	5U	5U	5U	5U	10U	5U
09-74	11/17/87	4	23056	54	5 U	5 U	4J	10 U	21692
09-74	02/25/88	1	4470	15	7	5 U	15	10 U	3020
09-74	04/14/88	2	3820	5 U	5 U	5 U	5 U	10 U	3130
09-74	04/15/88	2	3390	5 U	5 U	5 U	5 U	10 U	3110
09-74	07/20/88	3	3380	5 U	79	5 U	5 U	10 U	5 U
09-74	10/25/88	4	4800	23	5 U	4 JB	5 U	10 U	8200
10-74	05/21/87	2	4 U	NR	4 U	4 U	140	NR	4 U
10-74	07/01/87	3	DRY						
10-74	10/20/87	4	5 U	NR	5 U	30	5 U	NR	5 U
10-74	10/20/87	4	50U	50U	50U	32. J	50U	100U	50U
10-74	02/25/88	1	5 U	5 U	5 U	42	5 U	10 U	312

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

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Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Carbon Tetra chloride uG/L	Vinyl Acetate uG/L	Bromodichlo-romethane uG/L	1,2-Dichloro propane uG/L	Trans-1,3-Di chloropro-pene (uG/L)	Trichloro ethene uG/L	Dibromochlo-romethane uG/L
09-74	08/29/86		5 U	10 U	5 U	5 U	5 U	11000	5 U
09-74	03/09/87	1	4 U	NR	NR	NR	NR	20000	NR
09-74	04/09/87	1	4 U	NR	NR	NR	NR	20800	NR
09-74	05/21/87	2	28000	NR	NR	NR	NR	72000	NR
09-74	07/02/87	3	4 U	NR	NR	NR	NR	11768	NR
09-74	08/11/87	3	DRY						
09-74	10/20/87	4	5 U	NR	NR	NR	NR	12760	NR
09-74	10/28/87	4	5U	10U	5U	5U	5U	24. B	5U
09-74	11/17/87	4	3522	10 U	5 U	5 U	5 U	17538	5 U
09-74	02/25/88	1	990	10 U	5 U	5 U	5 U	6810	5 U
09-74	04/14/88	2	1200	10 U	5 U	5 U	5 U	5840	5 U
09-74	04/15/88	2	1140	10 U	5 U	5 U	5 U	5860	5 U
09-74	07/20/88	3	5 U	10 U	5 U	5 U	5 U	4380	5 U
09-74	10/25/88	4	5 U	10 U	5 U	5 U	5 U	9500	5 U
10-74	05/21/87	2	1400	NR	NR	NR	NR	3600	NR
10-74	07/01/87	3	DRY						
10-74	10/20/87	4	441	NR	NR	NR	NR	258	NR
10-74	10/20/87	4	50U	100U	50U	50U	50U	580. B	50U
10-74	02/25/88	1	1219	10 U	5 U	5 U	5 U	625	5 U

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615148

603613-00001604-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	1,1,2-Tri chloroethane uG/L	Benzene uG/L	Cis-1,3-Di chloropro-pene (uG/L)	2-Chloro ethylvinyl ether (uG/L)	Bromoform uG/L	4-Methyl-2-pentanone uG/L	2-Hexanone uG/L
09-74	08/29/86		91	5 U	5 U	10 U	5 U	10 U	10 U
09-74	03/09/87	1	96	NR	NR	NR	NR	NR	NR
09-74	04/09/87	1	4 U	NR	NR	NR	NR	NR	NR
09-74	05/21/87	2	4 U	NR	NR	NR	NR	NR	NR
09-74	07/02/87	3	4 U	NR	NR	NR	NR	NR	NR
09-74	08/11/87	3	DRY						
09-74	10/20/87	4	5 U	NR	NR	NR	NR	NR	NR
09-74	10/28/87	4	5U	5U	5U	10U	5U	10U	10U
09-74	11/17/87	4	139	5 U	5 U	NR	5 U	10 U	10 U
09-74	02/25/88	1	5 U	5 U	5 U	10 U	5 U	10 U	10 U
09-74	04/14/88	2	14740	5 U	5 U	10 U	5 U	10 U	10 U
09-74	04/15/88	2	14190	5 U	5 U	10 U	5 U	10 U	10 U
09-74	07/20/88	3	5 U	5 U	5 U	10 U	5 U	10 U	10 U
09-74	10/25/88	4	73	5 U	5 U	10 U	5 U	10 U	10 U
10-74	05/21/87	2	4 U	NR	NR	NR	NR	NR	NR
10-74	07/01/87	3	DRY						
10-74	10/20/87	4	5 U	NR	NR	NR	NR	NR	NR
10-74	10/20/87	4	50U	50U	50U	100U	50U	100U	100U
10-74	02/25/88	1	5 U	5 U	5 U	10 U	5 U	10 U	10 U

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615149

603613-00001605-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Tetrachloro ethene uG/L	1,1,2,2-Tetrachloro ethane(uG/L)	Toluene uG/L	Chloro benzene uG/L	Ethyl benzene uG/L	Styrene uG/L	Total Xylenes uG/L
09-74	08/29/86		4800	5 U	31	5 U	5 U	5 U	5 U
09-74	03/09/87	1	6400	NR	NR	NR	NR	NR	NR
09-74	04/09/87	1	2400	NR	NR	NR	NR	NR	NR
09-74	05/21/87	2	13200	NR	NR	NR	NR	NR	NR
09-74	07/02/87	3	3393	NR	NR	NR	NR	NR	NR
09-74	08/11/87	3	DRY						
09-74	10/20/87	4	5840	NR	NR	NR	NR	NR	NR
09-74	10/28/87	4	5U	5U	5U	5U	5U	5U	5U
09-74	11/17/87	4	6322	5 U	19	5 U	5 U	5 U	5 U
09-74	02/25/88	1	1800	5 U	5 U	5 U	5 U	5 U	5 U
09-74	04/14/88	2	1940	5 U	5 U	5 U	5 U	5 U	5 U
09-74	04/15/88	2	1920	5 U	5 U	5 U	5 U	5 U	5 U
09-74	07/20/88	3	1180	5 U	5 U	5 U	5 U	5 U	5 U
09-74	10/25/88	4	2500	5 U	2 J	5 U	5 U	5 U	5 U
10-74	05/21/87	2	4 U	NR	NR	NR	NR	NR	NR
10-74	07/01/87	3	DRY						
10-74	10/20/87	4	5 U	NR	NR	NR	NR	NR	NR
10-74	10/20/87	4	50U	50U	50U	50U	50U	50U	50U
10-74	02/25/88	1	17	5 U	5 U	5 U	5 U	5 U	5 U

NR = Analyte not reported
U = Analyzed but not detected
* = Holding time not met
E = Estimated value
J = Present below detection limit
B = Present in laboratory blank
N = Batch spike not in 80-120% range

615150

603613-00001606-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Chloro methane uG/L	Bromo methane uG/L	Vinyl Chloride uG/L	Chloro ethane uG/L	Methylene Chloride uG/L	Acetone uG/L	Carbon Disulfide uG/L
10-74	07/19/86	3	10 U	10 U	10 U	10 U	5 U	10 U	5 U
10-74	10/25/88	4	10 U	10 U	10 U	10 U	5 U	10 U	5 U
01-87	10/12/87	4	DRY						
01-87	02/10/88	1	10 U	10 U	10 U	10 U	5 U	10 U	5 U
01-87	04/11/88	1	DRY						
01-87	04/11/88	2	DRY						
01-87	07/20/88	3	10 U	10 U	10 U	10 U	5 U	10 U	5 U
01-87	10/26/88	4	10 U	10 U	10 U	10 U	5 U	10 U	5 U
04-87	05/20/87	1	NR	NR	NR	NR	NR	NR	NR
04-87	05/26/87	2	10U	10U	10U	10U	15 B	4 J	5U
04-87	07/09/87	3	NR	NR	NR	NR	NR	NR	NR
04-87	10/14/87	4	NR	NR	NR	NR	NR	NR	NR
04-87	10/14/87	4	INSUFFICIENT SAMPLE FOR VOLATILE ORGANIC ANALYSIS						
04-87	02/15/88	1	10 U	10 U	10 U	10 U	5 U	10 U	5 U
04-87	04/13/88	2	10 U	10 U	10 U	10 U	5 U	10 U	5 U
04-87	07/14/88	3	10 U	10 U	10 U	10 U	5 U	10 U	5 U
04-87	10/20/88	4	10 U	10 U	10 U	10 U	5 U	10 U	5 U

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615151

603613-00001607-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	1,1-Dichloro ethene uG/L	1,1-Dichloro ethane uG/L	Trans-1,2-Di chloroethene uG/L	Chloroform uG/L	1,2-Dichloro ethane uG/L	2-Butanone uG/L	1,1,1-Tri chloroethane uG/L
10-74	07/19/88	3	5 U	5 U	5 U	51	5 U	10 U	5 U
10-74	10/25/88	4	5 U	5 U	5 U	30 B	5 U	10 U	5 U
01-87	10/12/87	4	DRY						
01-87	02/10/88	1	5 U	5 U	5 U	5 U	5 U	10 U	5 U
01-87	04/11/88	1	DRY						
01-87	04/11/88	2	DRY						
01-87	07/20/88	3	5 U	5 U	5 U	5 U	5 U	10 U	5 U
01-87	10/26/88	4	5 U	5 U	5 U	5 U	5 U	10 U	5 U
04-87	05/20/87	1	8	NR	4 U	4 U	32	NR	4 U
04-87	05/26/87	2	3 J	5U	5U	6	5U	10U	5
04-87	07/09/87	3	4 U	NR	4 U	4 U	4 U	NR	4 U
04-87	10/14/87	4	5 U	NR	5 U	5 U	5 U	NR	5 U
04-87	10/14/87	4	INSUFFICIENT SAMPLE FOR VOLATILE ORGANIC ANALYSIS						
04-87	02/15/88	1	5 U	5 U	5 U	5 U	5 U	10 U	11
04-87	04/13/88	2	3 J	5 U	5 U	5 U	5 U	10 U	20
04-87	07/14/88	3	5 U	5 U	5 U	5 U	5 U	10 U	5 U
04-87	10/20/88	4	5 U	5 U	5 U	5 U	5 U	10 U	5 U

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615152

603613-00001608-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Carbon Tetra chloride uG/L	Vinyl Acetate uG/L	Bromodichlo-romethane uG/L	1,2-Dichloro propane uG/L	Trans-1,3-Di chloropro-pene (uG/L)	Trichloro ethene uG/L	Dibromochlo-romethane uG/L
10-74	07/19/88	3	3370	10 U	5 U	5 U	5 U	850	5 U
10-74	10/25/88	4	1600	10 U	5 U	5 U	5 U	600	5 U
01-87	10/12/87	4	DRY						
01-87	02/10/88	1	5 U	10 U	5 U	5 U	5 U	5 U	5 U
01-87	04/11/88	1	DRY						
01-87	04/11/88	2	DRY						
01-87	07/20/88	3	5 U	10 U	5 U	5 U	5 U	5 U	5 U
01-87	10/26/88	4	5 U	10 U	5 U	5 U	5 U	5 U	5 U
04-87	05/20/87	1	5	NR	NR	NR	NR	525	NR
04-87	05/26/87	2	21	10U	5U	5U	5U	230	5U
04-87	07/09/87	3	4 U	NR	NR	NR	NR	23	NR
04-87	10/14/87	4	10	NR	NR	NR	NR	44	NR
04-87	10/14/87	4	INSUFFICIENT SAMPLE FOR VOLATILE ORGANIC ANALYSIS						
04-87	02/15/88	1	5 U	10 U	5 U	5 U	5 U	32	5 U
04-87	04/13/88	2	5 U	10 U	5 U	5 U	5 U	37	5 U
04-87	07/14/88	3	5 U	10 U	5 U	5 U	5 U	26	5 U
04-87	10/20/88	4	5 U	10 U	5 U	5 U	5 U	56	5 U

NR = Analyte not reported
U = Analyzed but not detected
* = Holding time not met
E = Estimated value
J = Present below detection limit
B = Present in laboratory blank
N = Batch spike not in 80-120% range

615153

603613-00001609-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	1,1,2-Tri chloroethane uG/L	Benzene uG/L	Cis-1,3-Di chloropro-pene (uG/L)	2-Chloro ethylvinyl ether (uG/L)	Bromoform uG/L	4-Methyl-2-pentanone uG/L	2-Hexanone uG/L
10-74	07/19/88	3	5 U	5 U	5 U	10 U	5 U	10 U	10 U
10-74	10/25/88	4	5 U	5 U	5 U	10 U	5 U	10 U	10 U
01-87	10/12/87	4	DRY						
01-87	02/10/88	1	5 U	5 U	5 U	10 U	5 U	10 U	10 U
01-87	04/11/88	1	DRY						
01-87	04/11/88	2	DRY						
01-87	07/20/88	3	5 U	5 U	5 U	10 U	5 U	10 U	10 U
01-87	10/26/88	4	5 U	5 U	5 U	10 U	5 U	10 U	10 U
04-87	05/20/87	1	4 U	NR	NR	NR	NR	NR	NR
04-87	05/26/87	2	5U	5U	5U	10U	5U	10U	10U
04-87	07/09/87	3	4 U	NR	NR	NR	NR	NR	NR
04-87	10/14/87	4	5 U	NR	NR	NR	NR	NR	NR
04-87	10/14/87	4	INSUFFICIENT SAMPLE FOR VOLATILE ORGANIC ANALYSIS						
04-87	02/15/88	1	5 U	5 U	5 U	10 U	5 U	10 U	10 U
04-87	04/13/88	2	5 U	5 U	5 U	10 U	5 U	10 U	10 U
04-87	07/14/88	3	5 U	5 U	5 U	10 U	5 U	10 U	10 U
04-87	10/20/88	4	5 U	5 U	5 U	10 U	5 U	10 U	10 U

NR = Analyte not reported
U = Analyzed but not detected
* = Holding time not met
E = Estimated value
J = Present below detection limit
B = Present in laboratory blank
N = Batch spike not in 80-120% range

615154

603613-00001610-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Tetrachloro ethene uG/L	1,1,2,2-Tetrachloro ethane(uG/L)	Toluene uG/L	Chloro benzene uG/L	Ethyl benzene uG/L	Styrene uG/L	Total Xylenes uG/L
10-74	07/19/88	3	5 U	5 U	5 U	5 U	5 U	5 U	5 U
10-74	10/25/88	4	5 U	5 U	5 U	5 U	5 U	5 U	5 U
01-87	10/12/87	4	DRY						
01-87	02/10/88	1	5 U	5 U	5 U	5 U	5 U	5 U	5 U
01-87	04/11/88	1	DRY						
01-87	04/11/88	2	DRY						
01-87	07/20/88	3	5 U	5 U	5 U	5 U	5 U	5 U	5 U
01-87	10/26/88	4	5 U	5 U	5 U	5 U	5 U	5 U	5 U
04-87	05/20/87	1	84	NR	NR	NR	NR	NR	NR
04-87	05/26/87	2	14	5U	5U	5U	5U	5U	5U
04-87	07/09/87	3	4 U	NR	NR	NR	NR	NR	NR
04-87	10/14/87	4	6	NR	NR	NR	NR	NR	NR
04-87	10/14/87	4	INSUFFICIENT SAMPLE FOR VOLATILE ORGANIC ANALYSIS						
04-87	02/15/88	1	5 U	5 U	5 U	5 U	5 U	5 U	5 U
04-87	04/13/88	2	12	5 U	5 U	5 U	5 U	5 U	5 U
04-87	07/14/88	3	5 U	5 U	5 U	5 U	5 U	5 U	5 U
04-87	10/20/88	4	3 J	5 U	5 U	5 U	5 U	5 U	5 U

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615155

603613-00001611-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Chloro methane uG/L	Bromo methane uG/L	Vinyl Chloride uG/L	Chloro ethane uG/L	Methylene Chloride uG/L	Acetone uG/L	Carbon Disulfide uG/L
06-87	07/30/87	3	NF	NF	NF	NF	NF	NF	NF
06-87	08/25/87	3	NR	NR	NR	NR	NR	NR	NR
06-87	10/14/87	4	NR	NR	NR	NR	NR	NR	NR
06-87	10/14/87	4	10U	10U	10U	10U	3JB	4JB	5U
06-87	02/17/88	1	10 U	10 U	10 U	10 U	5 U	10 U	5 U
06-87	04/13/88	2	10 U	10 U	10 U	10 U	5 U	10 U	5 U
06-87	07/14/88	3	10 U	10 U	10 U	10 U	5 U	10 U	5 U
06-87	10/26/88	4	DRY						
43-87	12/18/87	4	10 U	10 U	10 U	10 U	36	9J	5 U
43-87	02/22/88	1	10 U	10 U	10 U	10 U	40	25	5 U
43-87	04/11/88	2	10 U	10 U	10 U	10 U	19	10 U	5 U
43-87	07/20/88	3	10 U	10 U	10 U	10 U	61	10 U	5 U
43-87	10/17/88	4	10 U	10 U	10 U	10 U	31	5 J	5 U
44-87	11/14/87	4	DRY						
44-87	02/22/88	1	DRY						
44-87	04/18/88	2	DRY						

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615156

603613-00001612-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	1,1-Dichloro ethene uG/L	1,1-Dichloro ethane uG/L	Trans-1,2-Di chloroethene uG/L	Chloroform uG/L	1,2-Dichloro ethane uG/L	2-Butanone uG/L	1,1,1-Tri chloroethane uG/L
06-87	07/30/87	3	NF	NF	NF	NF	NF	NF	NF
06-87	08/25/87	3	5 U	NR	5 U	5 U	5 U	NR	5 U
06-87	10/14/87	4	5 U	NR	5 U	5 U	5 U	NR	5 U
06-87	10/14/87	4	5U	5U	5U	5U	5U	10U	5U
06-87	02/17/88	1	5 U	5 U	5 U	5 U	5 U	10 U	5 U
06-87	04/13/88	2	5 U	5 U	5 U	5 U	5 U	10 U	5 U
06-87	07/14/88	3	5 U	5 U	5 U	5 U	5 U	10 U	5 U
06-87	10/26/88	4	DRY						
43-87	12/18/87	4	32687	342	5070	5 U	5 U	10 U	12734
43-87	02/22/88	1	8855	192	9	5 U	18	10 U	5920
43-87	04/11/88	2	3525	100	5 U	5 U	5 U	10 U	5 U
43-87	07/20/88	3	13390	344	5 U	5 U	5 U	10 U	5 U
43-87	10/17/88	4	11000	350E	830E	3 JB	5 U	10 U	25000E
44-87	11/14/87	4	DRY						
44-87	02/22/88	1	DRY						
44-87	04/18/88	2	DRY						

NR = Analyte not reported
U = Analyzed but not detected
* = Holding time not met
E = Estimated value
J = Present below detection limit
B = Present in laboratory blank
N = Batch spike not in 80-120% range

615157

603613-00001613-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Carbon Tetra chloride uG/L	Vinyl Acetate uG/L	Bromodichlo-romethane uG/L	1,2-Dichloro propane uG/L	Trans-1,3-Di chloropro-pene (uG/L)	Trichloro ethene uG/L	Dibromochlo-romethane uG/L
06-87	07/30/87	3	NF	NF	NF	NF	NF	NF	NF
06-87	08/25/87	3	5 U	NR	NR	NR	NR	20	NR
06-87	10/14/87	4	5 U	NR	NR	NR	NR	12	NR
06-87	10/14/87	4	5U	10U	5U	5U	5U	168	5U
06-87	02/17/88	1	5 U	10 U	5 U	5 U	5 U	14	5 U
06-87	04/13/88	2	5 U	10 U	5 U	5 U	5 U	16	5 U
06-87	07/14/88	3	5 U	10 U	5 U	5 U	5 U	12	5 U
06-87	10/26/88	4	DRY						
43-87	12/18/87	4	2170	10 U	5 U	5 U	5 U	6999	5 U
43-87	02/22/88	1	2995	10 U	5 U	5 U	5 U	12920	5 U
43-87	04/11/88	2	5 U	10 U	5 U	5 U	5 U	7343	5 U
43-87	07/20/88	3	5 U	10 U	5 U	5 U	5 U	15540	5 U
43-87	10/17/88	4	310E	10 U	5 U	5 U	5 U	17000	5 U
44-87	11/14/87	4	DRY						
44-87	02/22/88	1	DRY						
44-87	04/18/88	2	DRY						

NR = Analyte not reported
U = Analyzed but not detected
* = Holding time not met
E = Estimated value
J = Present below detection limit
B = Present in laboratory blank
N = Batch spike not in 80-120% range

615158

603613-00001614-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	1,1,2-Tri chloroethane uG/L	Benzene uG/L	Cis-1,3-Di chloropro-pene (uG/L)	2-Chloro ethylvinyl ether (uG/L)	Bromoform uG/L	4-Methyl-2-pentanone uG/L	2-Hexanone uG/L
06-87	07/30/87	3	NF	NF	NF	NF	NF	NF	NF
06-87	08/25/87	3	5 U	NR	NR	NR	NR	NR	NR
06-87	10/14/87	4	5 U	NR	NR	NR	NR	NR	NR
06-87	10/14/87	4	5U	5U	5U	10U	5U	10U	10U
06-87	02/17/88	1	5 U	5 U	5 U	10 U	5 U	10 U	10 U
06-87	04/13/88	2	5 U	5 U	5 U	10 U	5 U	10 U	10 U
06-87	07/14/88	3	5 U	5 U	5 U	10 U	5 U	10 U	10 U
06-87	10/26/88	4	DRY						
43-87	12/18/87	4	48	5 U	5 U	NR	5 U	10 U	10 U
43-87	02/22/88	1	5 U	5 U	5 U	10 U	5 U	10 U	10 U
43-87	04/11/88	2	5 U	5 U	5 U	10 U	5 U	10 U	10 U
43-87	07/20/88	3	5 U	5 U	5 U	10 U	5 U	10 U	10 U
43-87	10/17/88	4	5 U	83	5 U	10 U	5 U	10 U	10 U
44-87	11/14/87	4	DRY						
44-87	02/22/88	1	DRY						
44-87	04/18/88	2	DRY						

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615159

603613-00001615-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Tetrachloro ethene uG/L	1,1,2,2-Tetrachloro ethane(uG/L)	Toluene uG/L	Chloro benzene uG/L	Ethyl benzene uG/L	Styrene uG/L	Total Xylenes uG/L
06-87	07/30/87	3	NF	NF	NF	NF	NF	NF	NF
06-87	08/25/87	3	5 U	NR	NR	NR	NR	NR	NR
06-87	10/14/87	4	5 U	NR	NR	NR	NR	NR	NR
06-87	10/14/87	4	5U	5U	5U	5U	5U	5U	5U
06-87	02/17/88	1	5 U	5 U	5 U	5 U	5 U	5 U	5 U
06-87	04/13/88	2	5 U	5 U	5 U	5 U	5 U	5 U	5 U
06-87	07/14/88	3	5 U	5 U	5 U	5 U	5 U	5 U	5 U
06-87	10/26/88	4	DRY						
43-87	12/18/87	4	4259	5 U	67	5 U	5 U	5 U	5 U
43-87	02/22/88	1	7590	5 U	24	5 U	5 U	5 U	5 U
43-87	04/11/88	2	4495	5 U	5 U	5 U	5 U	5 U	5 U
43-87	07/20/88	3	6970	5 U	227	5 U	5 U	5 U	5 U
43-87	10/17/88	4	8100	5 U	180 B	5 U	4 J	5 U	5 U
44-87	11/14/87	4	DRY						
44-87	02/22/88	1	DRY						
44-87	04/18/88	2	DRY						

NR = Analyte not reported
U = Analyzed but not detected
* = Holding time not met
E = Estimated value
J = Present below detection limit
B = Present in laboratory blank
N = Batch spike not in 80-120% range

615160

603613-00001616-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Chloro methane uG/L	Bromo methane uG/L	Vinyl Chloride uG/L	Chloro ethane uG/L	Methylene Chloride uG/L	Acetone uG/L	Carbon Disulfide uG/L
44-87	07/20/88	3	DRY						
44-87	10/26/88	4	DRY						
49-87	11/18/87	4	DRY						
49-87	02/17/88	1	DRY						
49-87	04/13/88	2	DRY						
49-87	04/13/88	2	DRY						
49-87	07/18/88	3	DRY						
49-87	10/21/88	4	DRY						
50-87	11/18/87	4	10 U	10 U	10 U	10 U	5 U	10 U	5 U
50-87	11/18/87	4	10 U	10 U	10 U	10 U	2 JB	4 JB	5 U
50-87	02/17/88	1	DRY						
50-87	04/13/88	2	DRY						
50-87	07/18/88	3	DRY						
50-87	10/21/88	4	DRY						
51-87	11/23/87	4	DRY						

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615161

603613-00001617-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	1,1-Dichloro ethene uG/L	1,1-Dichloro ethane uG/L	Trans-1,2-Di chloroethene uG/L	Chloroform uG/L	1,2-Dichloro ethane uG/L	2-Butanone uG/L	1,1,1-Tri chloroethane uG/L
44-87	07/20/88	3	DRY						
44-87	10/26/88	4	DRY						
49-87	11/18/87	4	DRY						
49-87	02/17/88	1	DRY						
49-87	04/13/88	2	DRY						
49-87	04/13/88	2	DRY						
49-87	07/18/88	3	DRY						
49-87	10/21/88	4	DRY						
50-87	11/18/87	4	5 U	5 U	5 U	5 U	5 U	10 U	5 U
50-87	11/18/87	4	5 U	5 U	5 U	5 U	5 U	10 U	5 U
50-87	02/17/88	1	DRY						
50-87	04/13/88	2	DRY						
50-87	07/18/88	3	DRY						
50-87	10/21/88	4	DRY						
51-87	11/23/87	4	DRY						

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615162

603613-00001618-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Carbon Tetra chloride uG/L	Vinyl Acetate uG/L	Bromodichlo-romethane uG/L	1,2-Dichloro propane uG/L	Trans-1,3-Di chloropro-pene (uG/L)	Trichloro ethene uG/L	Dibromochlo-romethane uG/L
44-87	07/20/88	3	DRY						
44-87	10/26/88	4	DRY						
49-87	11/18/87	4	DRY						
49-87	02/17/88	1	DRY						
49-87	04/13/88	2	DRY						
49-87	04/13/88	2	DRY						
49-87	07/18/88	3	DRY						
49-87	10/21/88	4	DRY						
50-87	11/18/87	4	5 U	10 U	5 U	5 U	5 U	5 U	5 U
50-87	11/18/87	4	5 U	10 U	5 U	5 U	5 U	5 U	5 U
50-87	02/17/88	1	DRY						
50-87	04/13/88	2	DRY						
50-87	07/18/88	3	DRY						
50-87	10/21/88	4	DRY						
51-87	11/23/87	4	DRY						

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615163

603613-00001619-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	1,1,2-Tri chloroethane uG/L	Benzene uG/L	Cis-1,3-Di chloropro-pene (uG/L)	2-Chloro ethylvinyl ether (uG/L)	Bromoform uG/L	4-Methyl-2-pentanone uG/L	2-Hexanone uG/L
44-87	07/20/88	3	DRY						
44-87	10/26/88	4	DRY						
49-87	11/18/87	4	DRY						
49-87	02/17/88	1	DRY						
49-87	04/13/88	2	DRY						
49-87	04/13/88	2	DRY						
49-87	07/18/88	3	DRY						
49-87	10/21/88	4	DRY						
50-87	11/18/87	4	5 U	5 U	5 U	NR	5 U	10 U	10 U
50-87	11/18/87	4	5 U	5 U	5 U	10 U	5 U	10 U	10 U
50-87	02/17/88	1	DRY						
50-87	04/13/88	2	DRY						
50-87	07/18/88	3	DRY						
50-87	10/21/88	4	DRY						
51-87	11/23/87	4	DRY						

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615164

603613-00001620-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Tetrachloro ethene uG/L	1,1,2,2-Tetrachloro ethane(uG/L)	Toluene uG/L	Chloro benzene uG/L	Ethyl benzene uG/L	Styrene uG/L	Total Xylenes uG/L
44-87	07/20/88	3	DRY						
44-87	10/26/88	4	DRY						
49-87	11/18/87	4	DRY						
49-87	02/17/88	1	DRY						
49-87	04/13/88	2	DRY						
49-87	04/13/88	2	DRY						
49-87	07/18/88	3	DRY						
49-87	10/21/88	4	DRY						
50-87	11/18/87	4	5 U	5 U	5 U	5 U	5 U	5 U	5 U
50-87	11/18/87	4	3 J	5 U	5 U	5 U	5 U	5 U	5 U
50-87	02/17/88	1	DRY						
50-87	04/13/88	2	DRY						
50-87	07/18/88	3	DRY						
50-87	10/21/88	4	DRY						
51-87	11/23/87	4	DRY						

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615165

603613-00001621-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Chloro methane uG/L	Bromo methane uG/L	Vinyl Chloride uG/L	Chloro ethane uG/L	Methylene Chloride uG/L	Acetone uG/L	Carbon Disulfide uG/L
51-87	02/12/88	1	DRY						
51-87	04/18/88	2	DRY						
51-87	07/18/88	3	DRY						
51-87	10/21/88	4	DRY						
52-87	11/23/87	4	10 U	10 U	10 U	10 U	5 U	10 U	5 U
52-87	11/23/87	4	50 U	50 U	50 U	50 U	21 JB	130 B	25 U
52-87	02/12/88	1	10 U	10 U	10 U	10 U	5 U	10 U	5 U
52-87	04/18/88	2	10 U	10 U	10 U	10 U	5 U	10 U	5 U
52-87	07/18/88	3	10 U	10 U	10 U	10 U	5 U	10 U	5 U
52-87	10/18/88	4	10 U	10 U	10 U	10 U	5 U	10 U	5 U
53-87	11/18/87	4	10 U	10 U	10 U	10 U	21	10 U	5 U
53-87	11/18/87	4	10 U	10 U	10 U	10 U	2 JB	9 JB	5 U
53-87	02/10/88	1	DRY						
53-87	04/11/88	2	10 U	10 U	10 U	10 U	5 U	10 U	5 U
53-87	07/18/88	3	DRY						
53-87	10/21/88	4	DRY						

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615166

603613-00001622-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	1,1-Dichloro ethene uG/L	1,1-Dichloro ethane uG/L	Trans-1,2-Di chloroethene uG/L	Chloroform uG/L	1,2-Dichloro ethane uG/L	2-Butanone uG/L	1,1,1-Tri chloroethane uG/L
51-87	02/12/88	1	DRY						
51-87	04/18/88	2	DRY						
51-87	07/18/88	3	DRY						
51-87	10/21/88	4	DRY						
52-87	11/23/87	4	5 U	5 U	5 U	5 U	5 U	10 U	5 U
52-87	11/23/87	4	25 U	25 U	25 U	25 U	25 U	50 U	25 U
52-87	02/12/88	1	5 U	5 U	5 U	5 U	5 U	10 U	5 U
52-87	04/18/88	2	5 U	5 U	5 U	5 U	5 U	10 U	5 U
52-87	07/18/88	3	5 U	5 U	5 U	5 U	5 U	10 U	5 U
52-87	10/18/88	4	5 U	5 U	5 U	5 U	5 U	10 U	5 U
53-87	11/18/87	4	21	5 U	5 U	5 U	5 U	10 U	18
53-87	11/18/87	4	5 U	5 U	5 U	5 U	5 U	10 U	2 J
53-87	02/10/88	1	DRY						
53-87	04/11/88	2	5 U	5 U	5 U	5 U	5 U	10 U	5 U
53-87	07/18/88	3	DRY						
53-87	10/21/88	4	DRY						

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615167

603613-00001623-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Carbon Tetra chloride uG/L	Vinyl Acetate uG/L	Bromodichlo-romethane uG/L	1,2-Dichloro propane uG/L	Trans-1,3-Di chloropro-pene (uG/L)	Trichloro ethene uG/L	Dibromochlo-romethane uG/L
51-87	02/12/88	1	DRY						
51-87	04/18/88	2	DRY						
51-87	07/18/88	3	DRY						
51-87	10/21/88	4	DRY						
52-87	11/23/87	4	5 U	10 U	5 U	5 U	5 U	5 U	5 U
52-87	11/23/87	4	25 U	50 U	25 U	25 U	25 U	25 U	25 U
52-87	02/12/88	1	5 U	10 U	5 U	5 U	5 U	5 U	5 U
52-87	04/18/88	2	5 U	10 U	5 U	5 U	5 U	5 U	5 U
52-87	07/18/88	3	5 U	10 U	5 U	5 U	5 U	5 U	5 U
52-87	10/18/88	4	5 U	10 U	5 U	5 U	5 U	2 J	5 U
53-87	11/18/87	4	6	10 U	5 U	5 U	5 U	23	5 U
53-87	11/18/87	4	5 U	10 U	5 U	5 U	5 U	5 U	5 U
53-87	02/10/88	1	DRY						
53-87	04/11/88	2	5 U	10 U	5 U	5 U	5 U	3 J	5 U
53-87	07/18/88	3	DRY						
53-87	10/21/88	4	DRY						

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615168

603613-00001624-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	1,1,2-Tri chloroethane uG/L	Benzene uG/L	Cis-1,3-Di chloropro-pene (uG/L)	2-Chloro ethylvinyl ether (uG/L)	Bromoform uG/L	4-Methyl-2-pentanone uG/L	2-Hexanone uG/L
51-87	02/12/88	1	DRY						
51-87	04/18/88	2	DRY						
51-87	07/18/88	3	DRY						
51-87	10/21/88	4	DRY						
52-87	11/23/87	4	5 U	5 U	5 U	NR	5 U	10 U	10 U
52-87	11/23/87	4	25 U	25 U	25 U	50 U	25 U	50 U	50 U
52-87	02/12/88	1	5 U	5 U	5 U	10 U	5 U	10 U	10 U
52-87	04/18/88	2	5 U	5 U	5 U	10 U	5 U	10 U	10 U
52-87	07/18/88	3	5 U	5 U	5 U	10 U	5 U	10 U	10 U
52-87	10/18/88	4	5 U	5 U	5 U	10 U	5 U	10 U	10 U
53-87	11/18/87	4	5 U	5 U	5 U	NR	5 U	10 U	10 U
53-87	11/18/87	4	5 U	5 U	5 U	10 U	5 U	10 U	10 U
53-87	02/10/88	1	DRY						
53-87	04/11/88	2	5 U	5 U	5 U	10 U	5 U	10 U	10 U
53-87	07/18/88	3	DRY						
53-87	10/21/88	4	DRY						

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615169

603613-00001625-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Tetrachloro ethene uG/L	1,1,2,2-Tetrachloro ethane(uG/L)	Toluene uG/L	Chloro benzene uG/L	Ethyl benzene uG/L	Styrene uG/L	Total Xylenes uG/L
51-87	02/12/88	1	DRY						
51-87	04/18/88	2	DRY						
51-87	07/18/88	3	DRY						
51-87	10/21/88	4	DRY						
52-87	11/23/87	4	5 U	5 U	5 U	5 U	5 U	5 U	5 U
52-87	11/23/87	4	25 U	25 U	25 U	25 U	25 U	25 U	25 U
52-87	02/12/88	1	5 U	5 U	5 U	5 U	5 U	5 U	5 U
52-87	04/18/88	2	2 J	5 U	5 U	5 U	5 U	5 U	5 U
52-87	07/18/88	3	5 U	5 U	5 U	5 U	5 U	5 U	5 U
52-87	10/18/88	4	2 J	5 U	0.9 JB	5 U	5 U	5 U	5 U
53-87	11/18/87	4	5 U	5 U	11	5 U	5 U	5 U	5 U
53-87	11/18/87	4	3 J	5 U	5 U	5 U	5 U	5 U	5 U
53-87	02/10/88	1	DRY						
53-87	04/11/88	2	3 J	5 U	5 U	5 U	5 U	5 U	5 U
53-87	07/18/88	3	DRY						
53-87	10/21/88	4	DRY						

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615170

603613-00001626-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Chloro methane uG/L	Bromo methane uG/L	Vinyl Chloride uG/L	Chloro ethane uG/L	Methylene Chloride uG/L	Acetone uG/L	Carbon Disulfide uG/L
54-87	11/18/87	4	10 U	10 U	10 U	10 U	5 U	10 U	5 U
54-87	11/18/87	4	10 U	10 U	10 U	10 U	5 U	10 U	5 U
54-87	11/18/87	4	10 U	10 U	10 U	10 U	2 JB	13 B	5 U
54-87	02/10/88	1	DRY						
54-87	04/11/88	2	10 U	10 U	10 U	10 U	5 U	10 U	5 U
54-87	07/18/88	3	DRY						
54-87	10/21/88	4	DRY						

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615171

603613-00001627-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	1,1-Dichloro ethene uG/L	1,1-Dichloro ethane uG/L	Trans-1,2-Di chloroethene uG/L	Chloroform uG/L	1,2-Dichloro ethane uG/L	2-Butanone uG/L	1,1,1-Tri chloroethane uG/L
54-87	11/18/87	4	5 U	5 U	5 U	8	5 U	10 U	5 U
54-87	11/18/87	4	5 U	5 U	5 U	5 U	5 U	10 U	5 U
54-87	11/18/87	4	5 U	5 U	5 U	5 U	5 U	10 U	2 J
54-87	02/10/88	1	DRY						
54-87	04/11/88	2	5 U	5 U	5 U	5 U	5 U	10 U	5 U
54-87	07/18/88	3	DRY						
54-87	10/21/88	4	DRY						

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615172

603613-00001628-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Carbon Tetra chloride uG/L	Vinyl Acetate uG/L	Bromodichlo-romethane uG/L	1,2-Dichloro propane uG/L	Trans-1,3-Di chloropro-pene (uG/L)	Trichloro ethene uG/L	Dibromochlo-romethane uG/L
54-87	11/18/87	4	5 U	10 U	5 U	5 U	5 U	5 U	5 U
54-87	11/18/87	4	5 U	10 U	5 U	5 U	5 U	5 U	5 U
54-87	11/18/87	4	5 U	10 U	5 U	5 U	5 U	5 U	5 U
54-87	02/10/88	1	DRY						
54-87	04/11/88	2	5 U	10 U	5 U	5 U	5 U	5 U	5 U
54-87	07/18/88	3	DRY						
54-87	10/21/88	4	DRY						

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615173

603613-00001629-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	1,1,2-Tri chloroethane uG/L	Benzene uG/L	Cis-1,3-Di chloropro-pene (uG/L)	2-Chloro ethylvinyl ether (uG/L)	Bromoform uG/L	4-Methyl-2-pentanone uG/L	2-Hexanone uG/L
54-87	11/18/87	4	5 U	5 U	5 U	NR	5 U	10 U	10 U
54-87	11/18/87	4	5 U	5 U	5 U	NR	5 U	10 U	10 U
54-87	11/18/87	4	5 U	5 U	5 U	10 U	5 U	10 U	10 U
54-87	02/10/88	1	DRY						
54-87	04/11/88	2	5 U	5 U	5 U	10 U	5 U	10 U	10 U
54-87	07/18/88	3	DRY						
54-87	10/21/88	4	DRY						

NR = Analyte not reported
U = Analyzed but not detected
* = Holding time not met
E = Estimated value
J = Present below detection limit
B = Present in laboratory blank
N = Batch spike not in 80-120% range

615174

603613-00001630-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS AT THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Tetrachloro ethene uG/L	1,1,2,2-Tetrachloro ethane(uG/L)	Toluene uG/L	Chloro benzene uG/L	Ethyl benzene uG/L	Styrene uG/L	Total Xylenes uG/L
54-87	11/18/87	4	5 U	5 U	5 U	5 U	5 U	5 U	5 U
54-87	11/18/87	4	3J	5 U	5 U	5 U	5 U	5 U	5 U
54-87	11/18/87	4	4 J	5 U	5 U	5 U	5 U	5 U	5 U
54-87	02/10/88	1	DRY						
54-87	04/11/88	2	5 U	5 U	5 U	5 U	5 U	5 U	5 U
54-87	07/18/88	3	DRY						
54-87	10/21/88	4	DRY						

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615175

603613-00001631-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Chloro methane uG/L	Bromo methane uG/L	Vinyl Chloride uG/L	Chloro ethane uG/L	Methylene Chloride uG/L	Acetone uG/L	Carbon Disulfide uG/L
64-86	09/13/86		DRY						
64-86	04/29/87	1	NR	NR	NR	NR	NR	NR	NR
64-86	05/28/87	2	NR	NR	NR	NR	NR	NR	NR
64-86	07/16/87	3	NR	NR	NR	NR	NR	NR	NR
64-86	10/12/87	4	DRY						
64-86	02/17/88	1	10 U	10 U	10 U	10 U	5 U	10 U	5 U
64-86	04/11/88	2	10 U	10 U	10 U	10 U	5 U	10 U	5 U
64-86	07/13/88	3	DRY						
64-86	10/21/88	4	DRY						
65-86	09/19/86		10 U	10 U	10 U	10 U	5 U	2 JB	5 U
65-86	09/19/86		10 U	10 U	10 U	10 U	5 U	10 U	5 U
65-86	05/13/87	1	NR	NR	NR	NR	NR	NR	NR
65-86	05/28/87	2	NR	NR	NR	NR	NR	NR	NR
65-86	07/16/87	3	NR	NR	NR	NR	NR	NR	NR
65-86	09/09/87	3	NR	NR	NR	NR	NR	NR	NR
65-86	10/19/87	4	DRY						
65-86	02/29/88	1	10 U	10 U	10 U	10 U	8	10 U	5 U
65-86	04/18/88	2	10 U	10 U	10 U	10 U	5 U	10 U	5 U

NR = Analyte not reported
U = Analyzed but not detected
* = Holding time not met
E = Estimated value
J = Present below detection limit
B = Present in laboratory blank
N = Batch spike not in 80-120% range

615176

603613-00001632-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	1,1-Dichloro ethene uG/L	1,1-Dichloro ethane uG/L	Trans-1,2-Di chloroethene uG/L	Chloroform uG/L	1,2-Dichloro ethane uG/L	2-Butanone uG/L	1,1,1-Tri chloroethane uG/L
64-86	09/13/86		DRY						
64-86	04/29/87	1	4 U	NR	4 U	4 U	4 U	NR	4 U
64-86	05/28/87	2	4 U	NR	4 U	4 U	4 U	NR	4 U
64-86	07/16/87	3	4 U	NR	4 U	4 U	4 U	NR	4 U
64-86	10/12/87	4	DRY						
64-86	02/17/88	1	5 U	5 U	5 U	5 U	5 U	10 U	5 U
64-86	04/11/88	2	5 U	5 U	5 U	5 U	5 U	10 U	5 U
64-86	07/13/88	3	DRY						
64-86	10/21/88	4	DRY						
65-86	09/19/86		5 U	5 U	5 U	5 U	5 U	10 U	5 U
65-86	09/19/86		5 U	5 U	5 U	5 U	5 U	10 U	5 U
65-86	05/13/87	1	4 U	NR	4 U	4 U	4 U	NR	4 U
65-86	05/28/87	2	4 U	NR	4 U	4 U	4 U	NR	4 U
65-86	07/16/87	3	4 U	NR	4 U	4 U	4 U	NR	4 U
65-86	09/09/87	3	5 U	NR	5 U	5 U	5 U	NR	5 U
65-86	10/19/87	4	DRY						
65-86	02/29/88	1	5 U	5 U	5 U	5 U	5 U	10 U	5 U
65-86	04/18/88	2	5 U	5 U	5 U	5 U	5 U	10 U	5 U

NR = Analyte not reported
U = Analyzed but not detected
* = Holding time not met
E = Estimated value
J = Present below detection limit
B = Present in laboratory blank
M = Batch spike not in 80-120% range

615177

603613-00001633-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Carbon Tetra chloride uG/L	Vinyl Acetate uG/L	Bromodichlo-romethane uG/L	1,2-Dichloro propane uG/L	Trans-1,3-Di chloropro-pene (uG/L)	Trichloro ethene uG/L	Dibromochlo-romethane uG/L
64-86	09/13/86		DRY						
64-86	04/29/87	1	4 U	NR	NR	NR	NR	4 U	NR
64-86	05/28/87	2	4 U	NR	NR	NR	NR	4 U	NR
64-86	07/16/87	3	4 U	NR	NR	NR	NR	4 U	NR
64-86	10/12/87	4	DRY						
64-86	02/17/88	1	5 U	10 U	5 U	5 U	5 U	5 U	5 U
64-86	04/11/88	2	5 U	10 U	5 U	5 U	5 U	5 U	5 U
64-86	07/13/88	3	DRY						
64-86	10/21/88	4	DRY						
65-86	09/19/86		5 U	10 U	5 U	5 U	5 U	5 U	5 U
65-86	09/19/86		5 U	10 U	5 U	5 U	5 U	5 U	5 U
65-86	05/13/87	1	4 U	NR	NR	NR	NR	4 U	NR
65-86	05/28/87	2	4 U	NR	NR	NR	NR	4 U	NR
65-86	07/16/87	3	4 U	NR	NR	NR	NR	4 U	NR
65-86	09/09/87	3	5 U	NR	NR	NR	NR	5 U	NR
65-86	10/19/87	4	DRY						
65-86	02/29/88	1	5 U	10 U	5 U	5 U	5 U	5 U	5 U
65-86	04/18/88	2	5 U	10 U	5 U	5 U	5 U	5 U	5 U

NR = Analyte not reported
U = Analyzed but not detected
* = Holding time not met
E = Estimated value
J = Present below detection limit
B = Present in laboratory blank
N = Batch spike not in 80-120% range

615178

603613-00001634-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	1,1,2-Tri chloroethane uG/L	Benzene uG/L	Cis-1,3-Di chloropro-pene (uG/L)	2-Chloro ethylvinyl ether (uG/L)	Bromoform uG/L	4-Methyl-2-pentanone uG/L	2-Hexanone uG/L
64-86	09/13/86		DRY						
64-86	04/29/87	1	4 U	NR	NR	NR	NR	NR	NR
64-86	05/28/87	2	4 U	NR	NR	NR	NR	NR	NR
64-86	07/16/87	3	4 U	NR	NR	NR	NR	NR	NR
64-86	10/12/87	4	DRY						
64-86	02/17/88	1	5 U	5 U	5 U	10 U	5 U	10 U	10 U
64-86	04/11/88	2	5 U	5 U	5 U	10 U	5 U	10 U	10 U
64-86	07/13/88	3	DRY						
64-86	10/21/88	4	DRY						
65-86	09/19/86		5 U	5 U	5 U	10 U	5 U	10 U	10 U
65-86	09/19/86		5 U	5 U	5 U	10 U	5 U	10 U	10 U
65-86	05/13/87	1	4 U	NR	NR	NR	NR	NR	NR
65-86	05/28/87	2	4 U	NR	NR	NR	NR	NR	NR
65-86	07/16/87	3	4 U	NR	NR	NR	NR	NR	NR
65-86	09/09/87	3	5 U	NR	NR	NR	NR	NR	NR
65-86	10/19/87	4	DRY						
65-86	02/29/88	1	5 U	5 U	5 U	10 U	5 U	10 U	10 U
65-86	04/18/88	2	5 U	5 U	5 U	10 U	5 U	10 U	10 U

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615179

603613-00001635-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Tetrachloro ethene uG/L	1,1,2,2-Tetrachloro ethane(uG/L)	Toluene uG/L	Chloro benzene uG/L	Ethyl benzene uG/L	Styrene uG/L	Total Xylenes uG/L
64-86	09/13/86		DRY						
64-86	04/29/87	1	4 U	NR	NR	NR	NR	NR	NR
64-86	05/28/87	2	4 U	NR	NR	NR	NR	NR	NR
64-86	07/16/87	3	4 U	NR	NR	NR	NR	NR	NR
64-86	10/12/87	4	DRY						
64-86	02/17/88	1	5 U	5 U	5 U	5 U	5 U	5 U	5 U
64-86	04/11/88	2	5 U	5 U	5 U	5 U	5 U	5 U	5 U
64-86	07/13/88	3	DRY						
64-86	10/21/88	4	DRY						
65-86	09/19/86		5 U	5 U	5 U	5 U	5 U	5 U	5 U
65-86	09/19/86		5 U	5 U	5 U	5 U	5 U	5 U	5 U
65-86	05/13/87	1	4 U	NR	NR	NR	NR	NR	NR
65-86	05/28/87	2	4 U	NR	NR	NR	NR	NR	NR
65-86	07/16/87	3	4 U	NR	NR	NR	NR	NR	NR
65-86	09/09/87	3	5 U	NR	NR	NR	NR	NR	NR
65-86	10/19/87	4	DRY						
65-86	02/29/88	1	5 U	5 U	5 U	5 U	5 U	5 U	5 U
65-86	04/18/88	2	5 U	5 U	5 U	5 U	5 U	5 U	5 U

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615180

603613-00001636-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Chloro methane uG/L	Bromo methane uG/L	Vinyl Chloride uG/L	Chloro ethane uG/L	Methylene Chloride uG/L	Acetone uG/L	Carbon Disulfide uG/L
65-86	07/19/88	3	DRY						
65-86	10/21/88	4	DRY						
66-86	09/25/86		DRY						
66-86	05/11/87	1	NR	NR	NR	NR	NR	NR	NR
66-86	05/28/87	2	NR	NR	NR	NR	NR	NR	NR
66-86	07/17/87	3	DRY						
66-86	10/19/87	4	DRY						
66-86	03/31/88	1	10 U	10 U	10 U	10 U	23	10 U	5 U
66-86	06/02/88	2	10 U	10 U	10 U	10 U	5 U	10 U	5 U
66-86	10/07/88		DRY						
66-86	12/23/88		DRY						
69-86	10/08/86		10 U	10 U	10 U	10 U	5 U	10 U	5 U
69-86	10/08/86		10 U	10 U	10 U	10 U	5 U	2 BJ	5 U
69-86	04/29/87	1	NR	NR	NR	NR	NR	NR	NR
69-86	05/26/87	2	NR	NR	NR	NR	NR	NR	NR
69-86	07/06/87	3	NR	NR	NR	NR	NR	NR	NR

NR = Analyte not reported
U = Analyzed but not detected
* = Holding time not met
E = Estimated value
J = Present below detection limit
B = Present in laboratory blank
N = Batch spike not in 80-120% range

615181

603613-00001637-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	1,1-Dichloro ethene uG/L	1,1-Dichloro ethane uG/L	Trans-1,2-Di chloroethene uG/L	Chloroform uG/L	1,2-Dichloro ethane uG/L	2-Butanone uG/L	1,1,1-Tri chloroethane uG/L
65-86	07/19/88	3	DRY						
65-86	10/21/88	4	DRY						
66-86	09/25/86		DRY						
66-86	05/11/87	1	4 U	NR	4 U	4 U	4 U	NR	4 U
66-86	05/28/87	2	4 U	NR	4 U	4 U	4 U	NR	4 U
66-86	07/17/87	3	DRY						
66-86	10/19/87	4	DRY						
66-86	03/31/88	1	5 U	5 U	5 U	5 U	5 U	10 U	5 U
66-86	06/02/88	2	5 U	5 U	5 U	5 U	5 U	10 U	5 U
66-86	10/07/88		DRY						
66-86	12/23/88		DRY						
69-86	10/08/86		5 U	5 U	5 U	5 U	5 U	10 U	5 U
69-86	10/08/86		5 U	5 U	5 U	5 U	5 U	10 U	5 U
69-86	04/29/87	1	4 U	NR	4 U	4 U	4 U	NR	4 U
69-86	05/26/87	2	4 U	NR	4 U	4 U	4 U	NR	4 U
69-86	07/06/87	3	4 U	NR	4 U	4 U	4 U	NR	4 U

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615182

603613-00001638-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Carbon Tetra chloride uG/L	Vinyl Acetate uG/L	Bromodichlo-romethane uG/L	1,2-Dichloro propane uG/L	Trans-1,3-Di chloropro-pene (uG/L)	Trichloro ethene uG/L	Dibromochlo-romethane uG/L
65-86	07/19/88	3	DRY						
65-86	10/21/88	4	DRY						
66-86	09/25/86		DRY						
66-86	05/11/87	1	4 U	NR	NR	NR	NR	4 U	NR
66-86	05/28/87	2	4 U	NR	NR	NR	NR	4 U	NR
66-86	07/17/87	3	DRY						
66-86	10/19/87	4	DRY						
66-86	03/31/88	1	5 U	10 U	5 U	5 U	5 U	5 U	5 U
66-86	06/02/88	2	5 U	10 U	5 U	5 U	5 U	5 U	5 U
66-86	10/07/88		DRY						
66-86	12/23/88		DRY						
69-86	10/08/86		5 U	10 U	5 U	5 U	5 U	5 U	5 U
69-86	10/08/86		5 U	10 U	5 U	5 U	5 U	5 U	5 U
69-86	04/29/87	1	4 U	NR	NR	NR	NR	4 U	NR
69-86	05/26/87	2	4 U	NR	NR	NR	NR	4 U	NR
69-86	07/06/87	3	4 U	NR	NR	NR	NR	4 U	NR

NR = Analyte not reported
U = Analyzed but not detected
* = Holding time not met
E = Estimated value
J = Present below detection limit
B = Present in laboratory blank
N = Batch spike not in 80-120% range

615183

603613-00001639-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	1,1,2-Tri chloroethane uG/L	Benzene uG/L	Cis-1,3-Di chloropro-pene (uG/L)	2-Chloro ethylvinyl ether (uG/L)	Bromoform uG/L	4-Methyl-2-pentanone uG/L	2-Hexanone uG/L
65-86	07/19/88	3	DRY						
65-86	10/21/88	4	DRY						
66-86	09/25/86		DRY						
66-86	05/11/87	1	4 U	NR	NR	NR	NR	NR	NR
66-86	05/28/87	2	4 U	NR	NR	NR	NR	NR	NR
66-86	07/17/87	3	DRY						
66-86	10/19/87	4	DRY						
66-86	03/31/88	1	5 U	5 U	5 U	NR	5 U	10 U	10 U
66-86	06/02/88	2	5 U	5 U	5 U	10 U	5 U	10 U	10 U
66-86	10/07/88		DRY						
66-86	12/23/88		DRY						
69-86	10/08/86		5 U	5 U	5 U	10 U	5 U	10 U	10 U
69-86	10/08/86		5 U	5 U	5 U	10 U	5 U	10 U	10 U
69-86	04/29/87	1	4 U	NR	NR	NR	NR	NR	NR
69-86	05/26/87	2	4 U	NR	NR	NR	NR	NR	NR
69-86	07/06/87	3	4 U	NR	NR	NR	NR	NR	NR

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615184

603613-00001640-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Tetrachloro ethene uG/L	1,1,2,2-Tetrachloro ethane(uG/L)	Toluene uG/L	Chloro benzene uG/L	Ethyl benzene uG/L	Styrene uG/L	Total Xylenes uG/L
65-86	07/19/88	3	DRY						
65-86	10/21/88	4	DRY						
66-86	09/25/86		DRY						
66-86	05/11/87	1	4 U	NR	NR	NR	NR	NR	NR
66-86	05/28/87	2	4 U	NR	NR	NR	NR	NR	NR
66-86	07/17/87	3	DRY						
66-86	10/19/87	4	DRY						
66-86	03/31/88	1	5 U	5 U	5 U	5 U	5 U	5 U	5 U
66-86	06/02/88	2	5 U	5 U	5 U	5 U	5 U	5 U	5 U
66-86	10/07/88		DRY						
66-86	12/23/88		DRY						
69-86	10/08/86		5 U	5 U	5 U	5 U	5 U	5 U	5 U
69-86	10/08/86		5 U	5 U	5 U	5 U	5 U	5 U	5 U
69-86	04/29/87	1	4 U	NR	NR	NR	NR	NR	NR
69-86	05/26/87	2	4 U	NR	NR	NR	NR	NR	NR
69-86	07/06/87	3	4 U	NR	NR	NR	NR	NR	NR

NR = Analyte not reported
U = Analyzed but not detected
* = Holding time not met
E = Estimated value
J = Present below detection limit
B = Present in laboratory blank
N = Batch spike not in 80-120% range

615185

603613-00001641-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Chloro methane uG/L	Bromo methane uG/L	Vinyl Chloride uG/L	Chloro ethane uG/L	Methylene Chloride uG/L	Acetone uG/L	Carbon Disulfide uG/L
69-86	10/07/87	4	NR	NR	NR	NR	NR	NR	NR
69-86	10/08/87		INSUFFICIENT SAMPLE FOR VOLATILE ORGANIC ANALYSIS						
69-86	02/10/88	1	10 U	10 U	10 U	10 U	5 U	10 U	5 U
69-86	04/11/88	2	10 U	10 U	10 U	10 U	5 U	10 U	5 U
69-86	07/18/88	3	10 U	10 U	10 U	10 U	5 U	10 U	5 U
69-86	10/20/88	4	10 U	10 U	10 U	10 U	5 U	10 U	5 U
02-87	05/29/87	2	INSUFFICIENT SAMPLE FOR VOLATILE ORGANIC ANALYSIS						
02-87	06/24/87	2	10U	10U	10U	10U	35 B	65 B	5U
02-87	07/09/87	3	NR	NR	NR	NR	NR	NR	NR
02-87	10/07/87	4	NR	NR	NR	NR	NR	NR	NR
02-87	10/08/87	4	INSUFFICIENT SAMPLE FOR VOLATILE ORGANIC ANALYSIS						
02-87	02/10/88	1	10 U	10 U	10 U	10 U	5 U	10 U	5 U
02-87	04/07/88	2	10 U	10 U	10 U	10 U	23	10 U	5 U
02-87	07/13/88	3	10 U	10 U	10 U	10 U	5 U	10 U	5 U
02-87	10/20/88	4	INSUFFICIENT SAMPLE FOR VOLATILE ORGANIC ANALYSIS						
02-87	11/14/88	4	10 U	10 U	10 U	10 U	4 JB	10 U	5 U
47-87	11/30/87	4	10 U	10 U	10 U	10 U	5 U	10 U	5 U

NR = Analyte not reported
U = Analyzed but not detected
* = Holding time not met
E = Estimated value
J = Present below detection limit
B = Present in laboratory blank
N = Batch spike not in 80-120% range

615186

603613-00001642-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	1,1-Dichloro ethene uG/L	1,1-Dichloro ethane uG/L	Trans-1,2-Di chloroethene uG/L	Chloroform uG/L	1,2-Dichloro ethane uG/L	2-Butanone uG/L	1,1,1-Tri chloroethane uG/L
69-86	10/07/87	4	5 U	NR	5 U	5 U	5 U	NR	5 U
69-86	10/08/87		INSUFFICIENT SAMPLE FOR VOLATILE ORGANIC ANALYSIS						
69-86	02/10/88	1	5 U	5 U	5 U	5 U	5 U	10 U	5 U
69-86	04/11/88	2	5 U	5 U	5 U	5 U	5 U	10 U	5 U
69-86	07/18/88	3	5 U	5 U	5 U	5 U	5 U	10 U	5 U
69-86	10/20/88	4	5 U	5 U	5 U	5 U	5 U	10 U	5 U
02-87	05/29/87	2	INSUFFICIENT SAMPLE FOR VOLATILE ORGANIC ANALYSIS						
02-87	06/24/87	2	5U	5U	5U	5U	5U	10U	5U
02-87	07/09/87	3	6	NR	4 U	4 U	4 U	NR	4 U
02-87	10/07/87	4	5 U	NR	5 U	5 U	5 U	NR	5 U
02-87	10/08/87	4	INSUFFICIENT SAMPLE FOR VOLATILE ORGANIC ANALYSIS						
02-87	02/10/88	1	5 U	5 U	5 U	5 U	5 U	10 U	5 U
02-87	04/07/88	2	5 U	5 U	5 U	5 U	5 U	10 U	5 U
02-87	07/13/88	3	5 U	5 U	5 U	5 U	5 U	10 U	5 U
02-87	10/20/88	4	INSUFFICIENT SAMPLE FOR VOLATILE ORGANIC ANALYSIS						
02-87	11/14/88	4	5 U	5 U	5 U	2 JB	5 U	10 U	5 U
47-87	11/30/87	4	5 U	5 U	5 U	5 U	5 U	10 U	5 U

NR = Analyte not reported
U = Analyzed but not detected
* = Holding time not met
E = Estimated value
J = Present below detection limit
B = Present in laboratory blank
N = Batch spike not in 80-120% range

615187

603613-00001643-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Carbon Tetra chloride uG/L	Vinyl Acetate uG/L	Bromodichlo-romethane uG/L	1,2-Dichloro propane uG/L	Trans-1,3-Di chloropro-pene (uG/L)	Trichloro ethene uG/L	Dibromochlo-romethane uG/L
69-86	10/07/87	4	5 U	NR	NR	NR	NR	5 U	NR
69-86	10/08/87		INSUFFICIENT SAMPLE FOR VOLATILE ORGANIC ANALYSIS						
69-86	02/10/88	1	5 U	10 U	5 U	5 U	5 U	5 U	5 U
69-86	04/11/88	2	5 U	10 U	5 U	5 U	5 U	5 U	5 U
69-86	07/18/88	3	5 U	10 U	5 U	5 U	5 U	5 U	5 U
69-86	10/20/88	4	5 U	10 U	5 U	5 U	5 U	5 U	5 U
02-87	05/29/87	2	INSUFFICIENT SAMPLE FOR VOLATILE ORGANIC ANALYSIS						
02-87	06/24/87	2	5U	10U	5U	5U	5U	5U	5U
02-87	07/09/87	3	4 U	NR	NR	NR	NR	4 U	NR
02-87	10/07/87	4	5 U	NR	NR	NR	NR	5 U	NR
02-87	10/08/87	4	INSUFFICIENT SAMPLE FOR VOLATILE ORGANIC ANALYSIS						
02-87	02/10/88	1	5 U	10 U	5 U	5 U	5 U	5 U	5 U
02-87	04/07/88	2	5 U	10 U	5 U	5 U	5 U	5 U	5 U
02-87	07/13/88	3	5 U	10 U	5 U	5 U	5 U	5 U	5 U
02-87	10/20/88	4	INSUFFICIENT SAMPLE FOR VOLATILE ORGANIC ANALYSIS						
02-87	11/14/88	4	5 U	10 U	5 U	5 U	5 U	5 U	5 U
47-87	11/30/87	4	5 U	10 U	5 U	5 U	5 U	5 U	5 U

NR = Analyte not reported
U = Analyzed but not detected
* = Holding time not met
E = Estimated value
J = Present below detection limit
B = Present in laboratory blank
N = Batch spike not in 80-120% range

615188

603613-00001644-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	1,1,2-Tri chloroethane uG/L	Benzene uG/L	Cis-1,3-Di chloropro-pene (uG/L)	2-Chloro ethylvinyl ether (uG/L)	Bromoform uG/L	4-Methyl-2-pentanone uG/L	2-Hexanone uG/L
69-86	10/07/87	4	5 U	NR	NR	NR	NR	NR	NR
69-86	10/08/87		INSUFFICIENT SAMPLE FOR VOLATILE ORGANIC ANALYSIS						
69-86	02/10/88	1	5 U	5 U	5 U	10 U	5 U	10 U	10 U
69-86	04/11/88	2	5 U	5 U	5 U	10 U	5 U	10 U	10 U
69-86	07/18/88	3	5 U	5 U	5 U	10 U	5 U	10 U	10 U
69-86	10/20/88	4	5 U	5 U	5 U	10 U	5 U	10 U	10 U
02-87	05/29/87	2	INSUFFICIENT SAMPLE FOR VOLATILE ORGANIC ANALYSIS						
02-87	06/24/87	2	5U	5U	5U	10U	5U	10U	10U
02-87	07/09/87	3	4 U	NR	NR	NR	NR	NR	NR
02-87	10/07/87	4	5 U	NR	NR	NR	NR	NR	NR
02-87	10/08/87	4	INSUFFICIENT SAMPLE FOR VOLATILE ORGANIC ANALYSIS						
02-87	02/10/88	1	5 U	5 U	5 U	10 U	5 U	10 U	10 U
02-87	04/07/88	2	5 U	5 U	5 U	10 U	5 U	10 U	10 U
02-87	07/13/88	3	5 U	5 U	5 U	10 U	5 U	10 U	10 U
02-87	10/20/88	4	INSUFFICIENT SAMPLE FOR VOLATILE ORGANIC ANALYSIS						
02-87	11/14/88	4	5 U	5 U	5 U	10 U	5 U	10 U	10 U
47-87	11/30/87	4	5 U	5 U	5 U	NR	5 U	10 U	10 U

NR = Analyte not reported
U = Analyzed but not detected
* = Holding time not met
E = Estimated value
J = Present below detection limit
B = Present in laboratory blank
N = Batch spike not in 80-120% range

615189

603613-00001645-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Tetrachloro ethene uG/L	1,1,2,2-Tetrachloro ethane(uG/L)	Toluene uG/L	Chloro benzene uG/L	Ethyl benzene uG/L	Styrene uG/L	Total Xylenes uG/L
69-86	10/07/87	4	5 U	NR	NR	NR	NR	NR	NR
69-86	10/08/87		INSUFFICIENT SAMPLE FOR VOLATILE ORGANIC ANALYSIS						
69-86	02/10/88	1	5 U	5 U	5 U	5 U	5 U	5 U	5 U
69-86	04/11/88	2	5 U	5 U	5 U	5 U	5 U	5 U	5 U
69-86	07/18/88	3	5 U	5 U	5 U	5 U	5 U	5 U	5 U
69-86	10/20/88	4	5 U	5 U	5 U	5 U	5 U	5 U	5 U
02-87	05/29/87	2	INSUFFICIENT SAMPLE FOR VOLATILE ORGANIC ANALYSIS						
02-87	06/24/87	2	5U	5U	5U	5U	5U	5U	5U
02-87	07/09/87	3	4 U	NR	NR	NR	NR	NR	NR
02-87	10/07/87	4	5 U	NR	NR	NR	NR	NR	NR
02-87	10/08/87	4	INSUFFICIENT SAMPLE FOR VOLATILE ORGANIC ANALYSIS						
02-87	02/10/88	1	5 U	5 U	5 U	5 U	5 U	5 U	5 U
02-87	04/07/88	2	5 U	5 U	5 U	5 U	5 U	5 U	5 U
02-87	07/13/88	3	5 U	5 U	5 U	5 U	5 U	5 U	5 U
02-87	10/20/88	4	INSUFFICIENT SAMPLE FOR VOLATILE ORGANIC ANALYSIS						
02-87	11/14/88	4	5 U	5 U	3 JB	5 U	5 U	5 U	5 U
47-87	11/30/87	4	5 U	5 U	5 U	5 U	5 U	5 U	5 U

NR = Analyte not reported
U = Analyzed but not detected
* = Holding time not met
E = Estimated value
J = Present below detection limit
B = Present in laboratory blank
N = Batch spike not in 80-120% range

615190

603613-00001646-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Chloro methane uG/L	Bromo methane uG/L	Vinyl Chloride uG/L	Chloro ethane uG/L	Methylene Chloride uG/L	Acetone uG/L	Carbon Disulfide uG/L
47-87	11/30/87	4	10 U	10 U	10 U	10 U	8 B	5 J	5 U
47-87	02/15/88	1	DRY						
47-87	04/13/88	2	DRY						
47-87	07/18/88	3	DRY						
47-87	10/21/88	4	DRY						
48-87	11/18/87	4	10 U	10 U	10 U	10 U	5 U	10 U	5 U
48-87	11/18/87	4	10 U	10 U	10 U	10 U	2 JB	4 JB	5 U
48-87	02/15/88	1	10 U	10 U	10 U	10 U	5 U	10 U	5 U
48-87	04/13/88	2	10 U	10 U	10 U	10 U	5 U	12	5 U
48-87	07/18/88	3	DRY						
48-87	10/21/88	4	DRY						
55-87	11/30/87	4	10 U	10 U	10 U	10 U	5 U	10 U	5 U
55-87	11/30/87	4	10 U	10 U	10 U	10 U	8 B	10 U	5 U
55-87	02/15/88	1	DRY						
55-87	04/11/88	2	DRY						
55-87	07/13/88	3	DRY						

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615191

603613-00001647-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	1,1-Dichloro ethene uG/L	1,1-Dichloro ethane uG/L	Trans-1,2-Di chloroethene uG/L	Chloroform uG/L	1,2-Dichloro ethane uG/L	2-Butanone uG/L	1,1,1-Tri chloroethane uG/L
47-87	11/30/87	4	5 U	5 U	5 U	1 J	5 U	10 U	5 U
47-87	02/15/88	1	DRY						
47-87	04/13/88	2	DRY						
47-87	07/18/88	3	DRY						
47-87	10/21/88	4	DRY						
48-87	11/18/87	4	5 U	5 U	5 U	5 U	5 U	10 U	5 U
48-87	11/18/87	4	5 U	5 U	5 U	5 U	5 U	10 U	5 U
48-87	02/15/88	1	5 U	5 U	5 U	5 U	5 U	10 U	5 U
48-87	04/13/88	2	5 U	5 U	5 U	5 U	5 U	10 U	5 U
48-87	07/18/88	3	DRY						
48-87	10/21/88	4	DRY						
55-87	11/30/87	4	5 U	5 U	5 U	5 U	5 U	10 U	5 U
55-87	11/30/87	4	5 U	5 U	5 U	5 U	5 U	10 U	5 U
55-87	02/15/88	1	DRY						
55-87	04/11/88	2	DRY						
55-87	07/13/88	3	DRY						

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615192

603613-00001648-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Carbon Tetra chloride uG/L	Vinyl Acetate uG/L	Bromodichlo-romethane uG/L	1,2-Dichloro propane uG/L	Trans-1,3-Di chloropro-pene (uG/L)	Trichloro ethene uG/L	Dibromochlo-romethane uG/L
47-87	11/30/87	4	5 U	10 U	5 U	5 U	5 U	5 U	5 U
47-87	02/15/88	1	DRY						
47-87	04/13/88	2	DRY						
47-87	07/18/88	3	DRY						
47-87	10/21/88	4	DRY						
48-87	11/18/87	4	5 U	10 U	5 U	5 U	5 U	5 U	5 U
48-87	11/18/87	4	5 U	10 U	5 U	5 U	5 U	5 U	5 U
48-87	02/15/88	1	5 U	10 U	5 U	5 U	5 U	5 U	5 U
48-87	04/13/88	2	5 U	10 U	5 U	5 U	5 U	5 U	5 U
48-87	07/18/88	3	DRY						
48-87	10/21/88	4	DRY						
55-87	11/30/87	4	5 U	10 U	5 U	5 U	5 U	5 U	5 U
55-87	11/30/87	4	5 U	10 U	5 U	5 U	5 U	5 U	5 U
55-87	02/15/88	1	DRY						
55-87	04/11/88	2	DRY						
55-87	07/13/88	3	DRY						

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615193

603613-00001649-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	1,1,2-Tri chloroethane uG/L	Benzene uG/L	Cis-1,3-Di chloropro-pene (uG/L)	2-Chloro ethylvinyl ether (uG/L)	Bromoform uG/L	4-Methyl-2-pentanone uG/L	2-Hexanone uG/L
47-87	11/30/87	4	5 U	5 U	5 U	10 U	5 U	10 U	10 U
47-87	02/15/88	1	DRY						
47-87	04/13/88	2	DRY						
47-87	07/18/88	3	DRY						
47-87	10/21/88	4	DRY						
48-87	11/18/87	4	5 U	5 U	5 U	NR	5 U	10 U	10 U
48-87	11/18/87	4	5 U	5 U	5 U	10 U	5 U	10 U	10 U
48-87	02/15/88	1	5 U	5 U	5 U	10 U	5 U	10 U	10 U
48-87	04/13/88	2	5 U	5 U	5 U	10 U	5 U	10 U	10 U
48-87	07/18/88	3	DRY						
48-87	10/21/88	4	DRY						
55-87	11/30/87	4	5 U	5 U	5 U	NR	5 U	10 U	10 U
55-87	11/30/87	4	5 U	5 U	5 U	10 U	5 U	10 U	10 U
55-87	02/15/88	1	DRY						
55-87	04/11/88	2	DRY						
55-87	07/13/88	3	DRY						

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615194

603613-00001650-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Tetrachloro ethene uG/L	1,1,2,2-Tetrachloro ethane(uG/L)	Toluene uG/L	Chloro benzene uG/L	Ethyl benzene uG/L	Styrene uG/L	Total Xylenes uG/L
47-87	11/30/87	4	5 U	5 U	5 U	5 U	5 U	5 U	5 U
47-87	02/15/88	1	DRY						
47-87	04/13/88	2	DRY						
47-87	07/18/88	3	DRY						
47-87	10/21/88	4	DRY						
48-87	11/18/87	4	5 U	5 U	5 U	5 U	5 U	5 U	5 U
48-87	11/18/87	4	5 U	5 U	5 U	5 U	5 U	5 U	5 U
48-87	02/15/88	1	5 U	5 U	5 U	5 U	5 U	5 U	5 U
48-87	04/13/88	2	5 U	5 U	5 U	5 U	5 U	5 U	5 U
48-87	07/18/88	3	DRY						
48-87	10/21/88	4	DRY						
55-87	11/30/87	4	5 U	5 U	5 U	5 U	5 U	5 U	5 U
55-87	11/30/87	4	5 U	5 U	5 U	5 U	5 U	5 U	5 U
55-87	02/15/88	1	DRY						
55-87	04/11/88	2	DRY						
55-87	07/13/88	3	DRY						

NR = Analyte not reported
U = Analyzed but not detected
* = Holding time not met
E = Estimated value
J = Present below detection limit
B = Present in laboratory blank
N = Batch spike not in 80-120% range

615195

603613-00001651-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Chloro methane uG/L	Bromo methane uG/L	Vinyl Chloride uG/L	Chloro ethane uG/L	Methylene Chloride uG/L	Acetone uG/L	Carbon Disulfide uG/L
55-87	10/21/88	4	DRY						

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615196

603613-00001652-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	1,1-Dichloro ethene uG/L	1,1-Dichloro ethane uG/L	Trans-1,2-Di chloroethene uG/L	Chloroform uG/L	1,2-Dichloro ethane uG/L	2-Butanone uG/L	1,1,1-Tri chloroethane uG/L
55-87	10/21/88	4	DRY						

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615197

603613-00001653-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Carbon Tetra chloride uG/L	Vinyl Acetate uG/L	Bromodichlo-romethane uG/L	1,2-Dichloro propane uG/L	Trans-1,3-Di chloropro-pene (uG/L)	Trichloro ethene uG/L	Dibromochlo-romethane uG/L
55-87	10/21/88	4	DRY						

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615198

603613-00001654-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	1,1,2-Tri chloroethane uG/L	Benzene uG/L	Cis-1,3-Di chloropro-pene (uG/L)	2-Chloro ethylvinyl ether (uG/L)	Bromoform uG/L	4-Methyl-2-pentanone uG/L	2-Hexanone uG/L
55-87	10/21/88	4	DRY						

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615199

603613-00001655-054

Groundwater Volatile Organic Results

For Wells at Rockwell (Rocky Flats)

ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE

Well Number	Date Sampled	Qtr.	Tetrachloro ethene uG/L	1,1,2,2-Tetrachloro ethane(uG/L)	Toluene uG/L	Chloro benzene uG/L	Ethyl benzene uG/L	Styrene uG/L	Total Xylenes uG/L
55-87	10/21/88	4	DRY						

NR = Analyte not reported
J = Present below detection limit
U = Analyzed but not detected
B = Present in laboratory blank
* = Holding time not met
N = Batch spike not in 80-120% range
E = Estimated value

615200

603613-00001656-054

APPENDIX 2

SUBSURFACE INVESTIGATION AND ENGINEERING ANALYSIS REPORT, AGUIRRE ENGINEERS, INC. JUNE 1988

603613-00001658-054

Geotechnical and Materials Consultants
13276 East Fremont Place • P.O. Box 3814 • Englewood, Colorado 80155-3814 • U.S.A. • (303) 779-7557

SUBSURFACE INVESTIGATION AND ENGINEERING ANALYSIS REPORT
INDUSTRIAL WASTE FACILITY
ROCKY FLATS PLANT
JEFFERSON COUNTY, COLORADO

PREPARED FOR:

ENGINEERING SCIENCES, INC.
1100 STOUT STREET, SUITE 1100
DENVER, COLORADO 80204

ATTENTION: MR. RICHARD ANDERTON

PROJECT NO. 18,023

JUNE 15, 1988

AGUIRRE ENGINEERS, INC.

615202

REVIEWED FOR CLASSIFICATION
By D.A. Gally (U)
Date 5-2-89

AGUIRRE ENGINEERS, INC.
Geotechnical and Materials Consultants

June 15, 1988

Engineering Sciences, Inc.
1100 Stout Street, Suite 1100
Denver, Colorado 80204

Attention: Mr. Richard Anderton

Subject: Subsurface Investigation and Engineering Analysis Report
Industrial Waste Facility
Rocky Flats Plant
Jefferson County, Colorado
Our Project No. 18,023

Gentlemen:

Aguirre Engineers, Inc. is pleased to present this Subsurface Investigation and Engineering Analysis Report for the subject project.

Briefly, the findings of this study indicate that the proposed storage tank structures may be supported on a mat or pad foundation system bearing on the stiff to very stiff, gravelly CLAY.

Field permeability tests in the area of the proposed exfiltration trench indicate k values on the order of 1.25 to 1.7 x 10^{-7} cm/sec. Laboratory permeability tests are currently being run on select soil samples in this area. (Note: At the printing of this report, the results of these tests are not yet complete.)

Based on the boring hole information and our understanding of the required excavation depths, difficult excavation of the overburden for the proposed pipe lines is generally not anticipated. Excavation of trenches in sandy or gravelly soils may require shoring or excavating trenches with side slopes of about 2 (two) Horizontal (H) and 1 (one) vertical (V).

Additional detailed design and construction recommendations are included in the attached report. We appreciate the opportunity to have

615203

13276 East Fremont Place • P.O. Box 3814 • Englewood, Colorado 80155-3814 • U.S.A. • (303) 799-TEST

been of service to you on this phase of the project and look forward to serving you on future aspects of this project.

Very truly yours,

AGUIRRE ENGINEERS, INC.

Joseph A. Hess, E.I.T
Staff Engineer

J. Richard Rhudy, P.E.
Project Manager

JAH:pet

Enc: Report

cc: 3 sent

615204

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1.0 CONCLUSIONS

The subsurface conditions encountered at the site are fairly erratic. Our borings generally encountered TOPSOIL, FILL MATERIAL and/or NATURAL SOILS overlying WEATHERED BEDROCK. NATURAL SOILS were encountered underlying the TOPSOIL or FILL MATERIAL and overlying WEATHERED BEDROCK. At the location of the proposed water tank pad area, the WEATHERED BEDROCK was not encountered to its terminal depth of 20 (twenty) feet. Along the proposed infiltration pipeline alignment, the depth to the top of WEATHERED BEDROCK varied from 4 (four) to 36 (thirty-six) feet, and averaged approximately 18 (eighteen) feet below the existing ground surface. WEATHERED BEDROCK was not encountered in the borings along the proposed exfiltration pipeline.

Groundwater was encountered in Borings 1, 8, 9 and 13 at depths of 9 (nine) to 28 (twenty-eight) feet, respectively, below the existing ground surface, at the time of drilling operations (May 19, 24 and 25, 1988). Where possible, groundwater levels were rechecked on May 25, 1988. This corresponds to either 7 (seven) days or 1 (day) after completion of drilling operations. At this time, the groundwater in Borings 3 through 5, 8 and 9 ranged from depths of 3 (three) to 4 (four) feet. Groundwater levels could not be rechecked for Borings 1, 6, and 13 through 16, because of backfill requirements by Rockwell International. No groundwater was encountered in Borings 7 and 10 through 12.

It is our opinion that the proposed tank structures may be supported on a mat or pad foundation system bearing on the stiff to very stiff, gravelly CLAY. No expansive soils were encountered at this proposed tank structure location.

Field permeability tests, in the area of the proposed exfiltration trench, indicate k values on the order of 1.25 to 1.7 x 10^{-7} cm/sec. These values are indicative of material with a very low rate of permeability. As requested, laboratory permeability tests are currently being run on select soil samples retrieved from the same area. At the printing of this report, the results of these tests are not yet complete. Preliminary results indicate that the permeability rates of these laboratory samples will be similar (on the order of magnitude) to the field permeability tests.

Based on the boring information, and our understanding of required excavation depths, difficult excavation of the over-burden soils for the proposed pipeline trenches is generally not anticipated. Construction of the proposed infiltration pipeline trench will encounter WEATHERED CLAYSTONE BEDROCK at depths of from 4 (four) to 36 (thirty-six) feet below the existing ground surface. The excavation condition of this material is anticipated to be mostly in the medium hard range.

Due to the cohesionless nature of some of the NATURAL SOILS and high groundwater conditions along portions of the pipeline alignment, consideration should be given to the trench side slope stability. The trench sidewalls can be either shored or sloped to angles of about 2 (two) Horizontal (H) to 1 (one) Vertical (V).

Additional design and construction recommendations are contained in various sections of this report.

2.0 SCOPE OF STUDY

This report presents the results of our Subsurface Investigation and Engineering Analysis at the site of the proposed Industrial Waste Facility, to be located at the Rocky Flats Plant, Jefferson County, Colorado (see Plate 1). This project will consist of the installation of pipe for infiltration and exfiltration trenches. Additionally, a sump and pipeline system will transport the collected groundwater to the treatment facilities in Building 830. A pad to support three 15,000 (fifteen thousand) gallon storage tanks which will be constructed just south of Building 830.

The scope of this study was to:

A) Explore the subsurface conditions within the project area and collect samples.

B) Test the samples recovered.

C) Analyze and evaluate the data obtained.

D) Recommend the most suitable types and depths of foundation for the proposed water tank structures.

E) Provide recommendations for installation of the proposed pipelines.

F) Determine the permeability of the soils in the area of the proposed exfiltration trench.

G) Evaluate groundwater conditions, soils construction sequences and procedures.

The field work consisted of drilling a series of exploratory borings, in order to obtain disturbed and relatively undis-

turbed samples for laboratory testing. The samples recovered were visually inspected, and various laboratory tests were performed on them to evaluate their physical and mechanical properties.

The soil and rock parameters that we defined, in conjunction with results of observations made on the site, and past experience with similar subsurface conditions, under similar loading conditions were analyzed in order to reach the "Conclusions" presented in this report.

3.0 FIELD INVESTIGATION

The field investigation consisted of drilling 1 (one) exploratory boring at the proposed storage tank structure location and 15 (fifteen) borings along the proposed route of the infiltration/exfiltration trenches (Plate 2) and associated pipelines. The borings were drilled on May 18, 19, 24 and 25, 1988 using a truck-mounted, auger-type drilling rig.

Our drilling rig was equipped with 4 (four) inch diameter, solid stem, continuous flight power augers. The augers were used in cleaning the hole to the depth at which a sample and/or Penetration Test (PT) was desired. The augers were then removed, and a 2 (two) inch inside diameter (I.D.) California Spoon Sampler was subsequently driven with blows of a standard hammer weighing 140 (one hundred forty) pounds and falling a distance of 30 (thirty) inches.

The sampler was first seated 1 (one) inch into the bottom of the hole, and then driven an additional 12 (twelve) inches. The number of blows required to drive the sampler the last foot, or a fraction thereof, constitutes the PT.

This PT is similar to the Standard Penetration Test (SPT) described in ASTM Designation D 1586-67 (Reapproved 1974). The PT, when properly evaluated, is an index of the soil strength

and density of the material tested. The PT results are shown on the Log of Exploratory Borings, Plates 3 through 5.

The Boring locations were physically surveyed in the field by Aguirre Engineers, Inc. by taping or pacing distances from staked locations provided along the proposed pipelines and infiltration trench. (Note: The proposed exfiltration trench stationing is taken off the provided stationing for the infiltration trench. See Plates 3 through 5 for stationing offsets.) Boring elevations were interpolated from the site plan provided to us by Engineering Science, Inc.

These boring elevations and locations are adequate for the purpose of this report, but should be considered as only approximate for any other use.

4.0 SITE CONDITIONS

The proposed Industrial Waste Facility, which includes storage tanks along with associated infiltration and exfiltration pipelines, will be located at the Rocky Flats Plant, located in Jefferson County, Colorado. The specific area in which the Industrial Waste Facility will be located is known as the 881 Hillside, located immediately south of the Rocky Flats Plant.

The proposed storage tanks will be located directly south of Building 830. The proposed storage tanks will be bounded on the east by a small service road and to the west by a rather steep hillside.

The topography of the storage tanks site generally consists of a moderate slope from west to the east and south. The exact location of the storage tank pad was not known at the time of our exploration. The approximate elevations of this area ranged from 5,972 (five thousand nine hundred seventy-two) feet to approximately 5,976 (five thousand nine hundred seventy-six) feet.

The proposed pipelines will run east from the storage tanks and then will branch off in a southerly direction to either the proposed infiltration or exfiltration tranches.

The topography of the proposed pipelines consists of varied slopes ranging from gentle to moderate, generally in a south to southeasterly direction. Elevations ranged from approximately 5,986 (five thousand nine hundred eight-six) feet to approximately 5,894 (five thousand eight hundred ninety-four) feet.

A man-made drainage ditch, runs approximately parallel to, and immediately south of the proposed exfiltration trench. At the time of this investigation, the ditch contained approximately 2 (two) to 3 (three) inches of water flowing in an easterly direction.

An underground gas line ran approximately parallel to, and in the immediate vicinity of the proposed infiltration trench alignment. It is our understanding that this line is abandoned. Another underground gas line was located in the vicinity of Boring 5. Overhead powerlines run along the existing fence line as well as across the proposed infiltration trench in the vicinity of Boring 10. Additional utilities may be on the site and all their locations should be verified prior to construction.

5.0 SUBSURFACE CONDITIONS

The subsurface conditions encountered at the site are fairly erratic. Our borings generally encountered TOPSOIL; FILL MATERIAL and/or NATURAL SOILS underlain by WEATHERED BEDROCK. The generalized subsurface conditions encountered by our test borings are graphically represented on the Log of Borings (see Plates 3 through 5). The Legend and Notes necessary to interpret these Logs are contained on Plates 6A and 6B.

Each of the subsurface materials and groundwater conditions we encountered are described in the following subsections.

5.1 TOPSOIL: was encountered in all of the borings at the ground surface to approximately 0.5 to 1 (one) foot in depth. This material is not suitable for support of structural loads or use as backfill and should be removed.

5.2 FILL MATERIAL: was encountered in Borings 6 through 10 and Boring 14. The FILL MATERIAL was variable consisting of gravelly CLAY to clayey GRAVEL. This FILL MATERIAL contained some sandy lenses, occasional rootlets as well as areas of severely weathered claystone bedrock fragments. This FILL MATERIAL was found to be moist to very moist, medium stiff to very stiff, and gray to brown to orange in color. According to the Unified Soil Classification System (USGS), this FILL MATERIAL classified as CL or GC material. The

thickness of the FILL MATERIAL ranged from 5 (five) to 21.5 feet with an average thickness of approximately 14 (fourteen) feet.

5.3 NATURAL SOILS: which consisted of some gravel to gravelly CLAY; some sand to sandy CLAY; SAND and GRAVEL; and CLAY (severely weathered claystone bedrock).

The NATURAL SOILS were found underlying the TOPSOIL or FILL MATERIAL, and overlying the WEATHERED BEDROCK. The thickness of the NATURAL SOIL in the area of the storage tank structures was not fully penetrated to the boring's maximum depth of 20 (twenty) feet. The thickness of the NATURAL SOILS (where penetrated) along the proposed pipelines and infiltration and exfiltration trenches, ranged from 1 (one) to 21.5 feet with an average thickness of approximately 7 (seven) feet.

The gravelly CLAY, which was encountered in Borings 1, 4 through 8 and 10 through 12, contained a trace to some sand, occasional rootlets, and was moist to wet. This CLAY material was found to be stiff to very stiff and black to dark brown to gray in color. In accordance with the USCS this gravelly CLAY classified as CL material.

The sandy CLAY, which was encountered in Borings 2, 12, 13, 15, and 16, contained occasional gravels, occasional sand lenses, and was moist to very moist. This CLAY material was found to be stiff to very stiff and brown in color. In accordance with the USCS, this material classified as CL-CH material.

The SAND and GRAVEL, which was encountered in Borings 1, 3 and 5, varied from containing some clay to being clayey and was moist to wet. This SAND and GRAVEL material was found to be medium dense to dense and light brown to dark brown in color. In accordance with the USCS, this material classified as SC-SP and GC-GP material.

The CLAY (severely weathered claystone bedrock), which was encountered in Borings 8, 9, 12, 13, and 16, contained a trace to little sand, trace gravel and was slightly calcareous. This CLAY material was found to be very moist, stiff to very stiff and brown to gray with orange in color. In accordance with the USCS, this material classified as CL material.

5.4 <u>WEATHERED BEDROCK</u>: consisted of WEATHERED CLAYSTONE BEDROCK. Within the proposed storage tank pad area, WEATHERED BEDROCK was not encountered to the boring's terminal depth of 20 (twenty) feet. Along the proposed pipelines and in-

filtration/exfiltration trenches, where WEATHERED BEDROCK was encountered, the depth to the top of WEATHERED BEDROCK varied from 4 (four) to 36 (thirty-six) feet, and averaged approximately 14.5 feet below the existing ground surface.

The WEATHERED CLAYSTONE BEDROCK, which was encountered in all borings, except Borings 1 and 13 through 16, contained a trace to little sand, was slightly calcareous with iron-stains noted in the fractures, and was very moist. This material was found to be hard to very hard and was gray to brown with orange in color.

5.5 GROUNDWATER: was encountered in Borings 1, 8, 9 and 13, at depths of 12, 28, 13.5 and 9 feet, respectively, below the existing ground surface, during drilling operations (May 19, 24 and 25, 1988). No groundwater was encountered in the remaining borings at the time of drilling (May 18, 19, 24 and 25, 1988).

Groundwater levels in Borings 3 through 5, and 7 through 12, were rechecked on May 25, 1988, which corresponds to either 1 (one) day or 7 (seven) days after completion of drilling operations. At that time, the groundwater levels had stabilized in Borings 8 and 9 at depths of 4 (four) and 3 (three) feet, respectively, below the existing ground surface. Also at that time, groundwater was encountered in

Borings 3 through 5, at depths ranging from 3 (three) to 4 (four) feet below the existing ground surface. The remaining borings had remained dry.

Groundwater levels could not be rechecked for Borings 1, 6, and 13 through 16, because of backfill requirements by Rockwell International.

During wet season periods, the groundwater levels at the site are expected to rise somewhat due to surface water infiltration and subsurface groundwater seepage. More erratic variations may result from short term changes in the drainage located near proposed exfiltration trench. It is our opinion that these seasonal changes in groundwater levels should be considered during design and construction phases of the project.

6.0 LABORATORY AND FIELD TESTING

All soil and weathered bedrock samples recovered were physically inspected and visually classified in the laboratory by the Project Geotechnical Engineer. Representative samples were then selected for laboratory tests to help define the geotechnical properties of the subsurface materials. The testing program consisted of performing the following tests: Swell/Consolidation, Gradation Analysis, Natural Dry Density, Natural Moisture Content, Atterberg Limits, Laboratory Permeability and Field Permeability.

A Swell/Consolidation Test (see Plate 7) was performed in order to estimate the swell or consolidation potential of specific subsurface materials.

Gradation Analysis Tests (see Plates 8 through 20) were performed to estimate the grain size distribution of the soils which could be used to aid in classifying the soil, estimating the load carrying capacity of the materials tested, as well as estimate the permeability of this material. This test is also useful in evaluating the swell potential of the material tested.

Natural Dry Density and Natural Moisture Content Tests (see Table 1), were performed to determine the density and moisture

content of the soils encountered, to evaluate some of their compaction characteristics, and to correlate their swell potential with other tests.

Atterberg Limits Tests (see Table 1) were performed to determine the water contents which define the various stages of soil consistency. These are the Liquid Limit (LL), where the soil behaves as a viscous liquid, and the Plastic Limit (PL), where the soil begins to break apart and crumble and is no longer plastic. The difference between the LL and PL, defined as the Plasticity Index (PI), represents the range in water contents through which the soil is in the plastic state. These properties are also useful in classifying the soil according to the various soil classification systems.

Laboratory Permeability Tests are currently in progress on selected samples along the infiltration and exfiltration trenches. The samples have been set under a constant water pressure in order to: first, saturate the soil; and secondly, determine a permeability or "k" value for each sample. At the writing of this report, the laboratory tests are not yet complete. (Note: Samples have been subject to a constant water pressure head since June 2, 1988 and are not yet saturated.)

Falling Head Field Permeability Tests were run in Borings 14 and

15, along the proposed exfiltration trench route. A monitor tube and screen was installed using bentonite seals above and below a screen and sand filter to isolate the test zone.

7.0 PROPOSED DEVELOPMENT

Our understanding of the proposed project is based on information provided to us by Mr. Richard Anderton of Engineering Science, Inc.

The proposed storage tank facility will consist of a pad or mat foundation system supporting three 15,000 (fifteen thousand) gallon tanks. The pad or mat will measure approximately 20 (twenty) by 20 (twenty) feet. It is anticipated that this pad or mat will be placed at or close to grade.

The project will also include the installation of approximately 2,800 (two thousand eight hundred) lineal feet of pipe in trenches for infiltration and exfiltration. It is our understanding that the infiltration trench will be keyed into the WEATHERED BEDROCK a minimum of 2 (two) feet and act similar to a french drain. Additionally, a sump and pipeline system (approximately 1,600 lineal feet) will transport the collected groundwater from the infiltration piping to the treatment facilities in Building 830.

8.0 FOUNDATION SLAB RECOMMENDATIONS FOR THE WATER STORAGE FACILITY

Beneath a thin layer of TOPSOIL, the boring at the storage tank facility encountered gravelly CLAY to 9 (nine) feet underlain by approximately 10 (ten) feet of SAND and GRAVEL.

Based on the laboratory test results and our analysis, it is our opinion that the storage tanks can be satisfactorily supported on the proposed pad or mat foundation. We recommend a maximum allowable net bearing pressure of 2,500 (two thousand five hundred) psf be used bearing on the gravelly CLAY material.

Based on the above design pressure and assuming a relatively stable bearing surface is established, total settlements should be minimal.

No expansive soils were encountered in the borings at the storage tank facility. Groundwater was present at approximately 12 (twelve) feet below the existing ground surface. It is not anticipated that the existing groundwater level will interfere with construction or the support function of the tank facility foundation.

The foundation excavation should not be left open for extanded periods of time. All soft, wet, very loose, or otherwise disturbed materials should be removed prior to concrete placement.

The base of the excavation should be observed by Aguirre Engineers, Inc. to see that the soil type encountered is as assumed and that adequate bearing conditions exist.

9.0 INFILTRATION/EXFILTRATION TRENCHES AND ASSOCIATED PIPELINES

9.1 General

The borings along the proposed infiltration/exfiltration trenches and associated pipeline alignments were intended to evaluate the subsurface conditions including permeability tests along the exfiltration trench. The detailed site and subsurface conditions are presented in Section 5.0.

9.2 Permeability of Proposed Exfiltration Trench Material

As discussed previously, Falling Head Field Permeability Tests were run in Borings 14 and 15 along the proposed exfiltration trench alignment.

The Field Permeability Test results are as follows:

Boring Location	Permeability (k)
14	1.7×10^{-7} cm/sec
15	1.25×10^{-7} cm/sec

Laboratory Permeability Tests are currently being run on select soil samples in the areas of both the infiltration as well as the exfiltration trenches. At the printing of this report, the results from these tests are not yet complete. Based upon the time at which it is taking to saturate the laboratory samples, laboratory permeability rates will probably be similar (on the order of magnitude) to the field permeability rates.

In summary, based upon these preliminary results, the permeability of the material in the area of the exfiltration trench should be considered poor to practically impermeable. It is not anticipated that laboratory results will vary drastically from the field permeability results.

9.3 Infiltration Trench

As discussed previously, it is our understanding that the infiltration trench will be keyed into the WEATHERED BEDROCK approximately 2 (two) feet. WEATHERED BEDROCK was encountered in all the borings along the proposed infiltration trench at depths ranging from 4 (four) feet to 36 (thirty-six) feet below the existing ground surface. This corresponds to WEATHERED BEDROCK elevations ranging from approximately 5,967 (five thousand nine hundred sixty-seven) feet (Boring 6) to 5,882 (five thousand eight hundred eighty-two) feet (Boring 12). For specific WEATHERED BEDROCK depths, refer to the Log of Borings (Borings 6 through 12), Plates 3 and 4.

9.4 General Trench Excavations

In most areas of the pipeline, the proposed pipelines may be safely supported on the NATURAL SOILS, FILL MATERIAL or WEATHERED BEDROCK. In these areas, normal construction and placement of BEDDING MATERIAL, can be followed.

The recommended gradation for this BEDDING MATERIAL is as follows:

Sieve Designation or Size	Percent Passing
1"	100
3/4"	90 to 100
3/8"	20 to 55
No. 4	0 to 10
No. 8	0 to 5

Along portions of the proposed pipeline, the trench invert level will be excavated into WEATHERED BEDROCK. In areas where the trench is to be excavated into the WEATHERED BEDROCK, the Contractor should be prepared to excavate medium hard WEATHERED CLAYSTONE BEDROCK material.

In the vicinity of borings where groundwater was encountered at the time of drilling, groundwater seepage into the trench excavations should be expected. For trench excavations penetrating groundwater by only a few feet, pumping from sumps should provide adequate drainage. For excavations that penetrate the groundwater by more than a few feet, a more extensive system may be required.

If in certain areas the bottom of the excavation starts "pumping", or appears soft, the problem soils should be excavated and replaced with a thickened, improved bedding

layer. The improved bedding should consist of 1 (one) to 2 (two) feet of 1 (one) to 2 (two) inch size crushed stone.

9.5 Trench Side Slopes

Cuts in the in-situ WEATHERED BEDROCK may stand on nearly vertical slopes for a brief period of time. However, near vertical cuts in sandy or gravelly materials cannot be considered safe, even for short durations. The majority of the NATURAL SOILS along the pipeline alignment consists of gravelly or sandy CLAY material.

The trench sidewalls can either be cut vertically and properly sheeted and braced, or sloped back to a safe angle in conformance with applicable OSHA regulations.

It is the Contractor's responsibility to provide a trench which is safe for his men to work in.

Generally, a dry excavation cut in a granular soil can safely stand at slopes ranging from 2 (two) (H) to 1 (one) (V). However, flatter slopes may be required based on the consistency of the in-situ soils.

10.0 MISCELLANEOUS

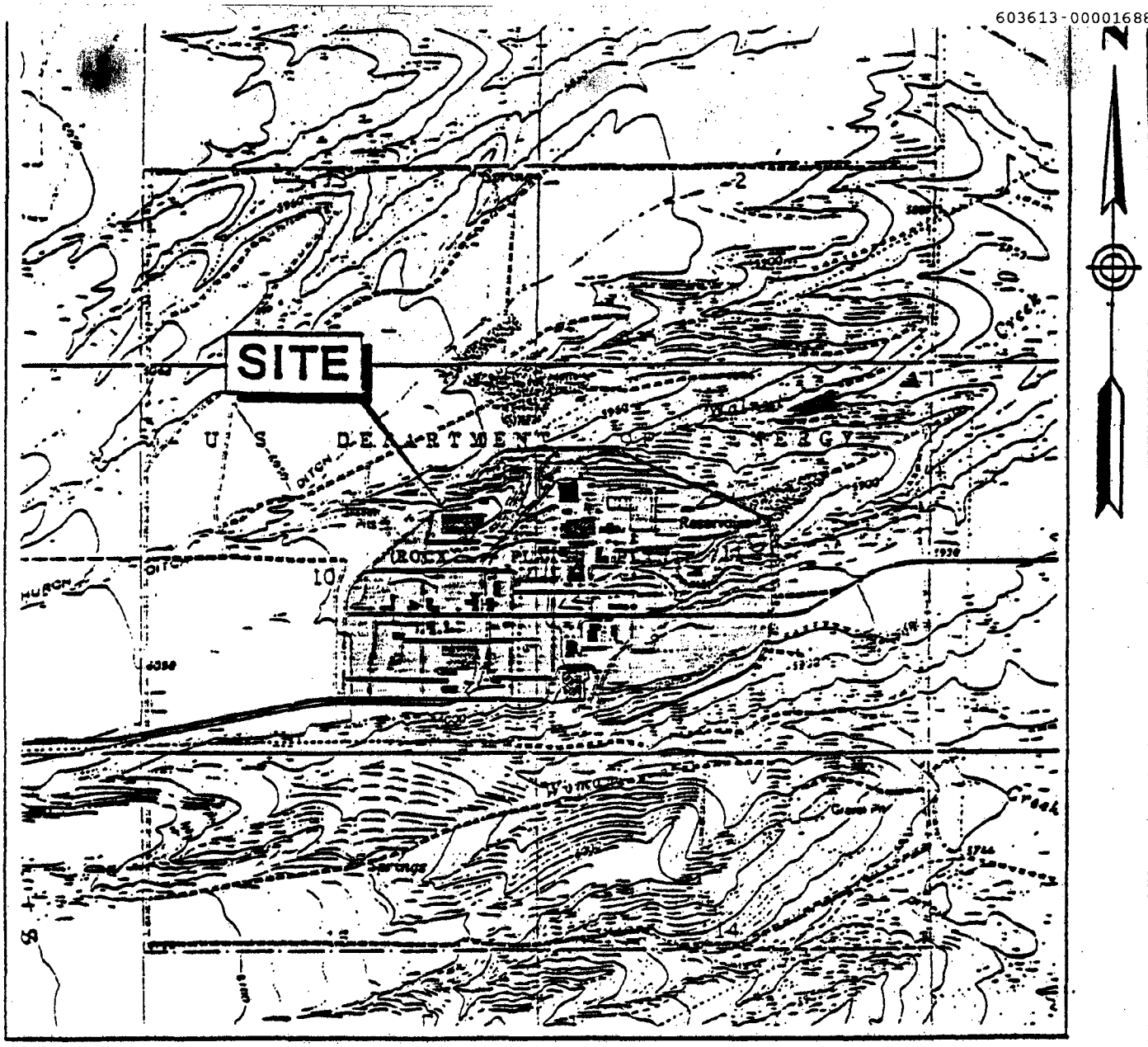
The analysis and recommendations submitted in this report are based upon the data obtained from the 1 (one) soil boring at the proposed storage-tank pad and the 15 (fifteen) soil borings along the proposed infiltration and exfiltration pipeline alignments performed at the locations indicated on Plate 2.

In any soils investigation, it is necessary to assume that soil conditions do not change greatly from those indicated by our Exploratory Borings. This report does not reflect any variations which may occur between these borings.

The nature and extant of variations between borings may not become evident until the course of construction. For this reason, we recommend that the Aguirre Engineers, Inc. observe the excavation and backfill operations and provide appropriate recommendations at that time, based on observation and testing.

If variations in subsurface conditions are encountered during construction, then it may be necessary for a re-evaluation of the recommendations contained in this report. If any unforeseen subsurface conditions are encountered, the contractor should notify Aguirre Engineers, Inc. prior to proceeding with the construction.

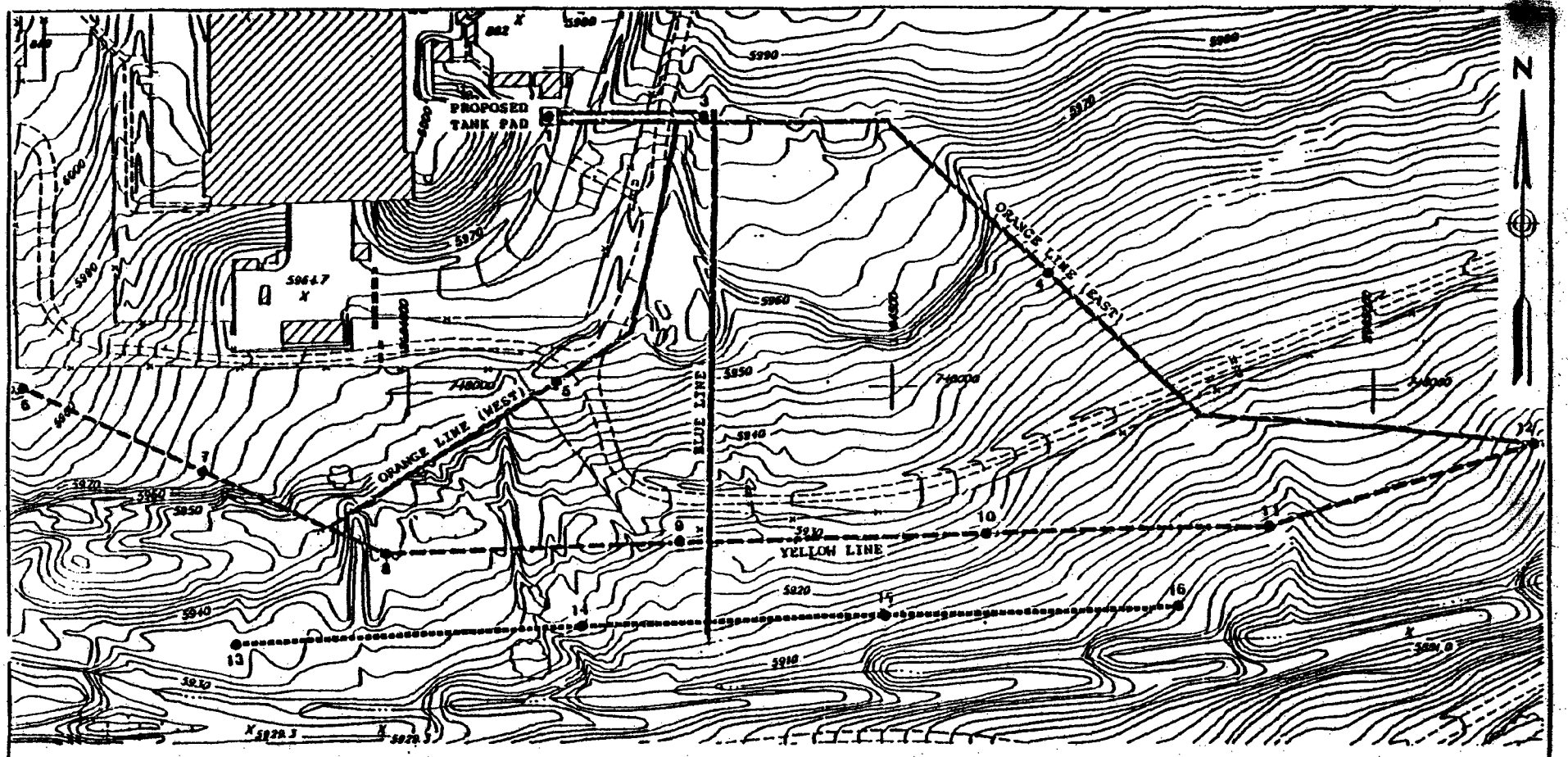
In the present report, we have presented judgments based partly on our understanding of the proposed development and partly on the data we have obtained. This report meets professional standards expected for reports of this type in this area. Our company is not responsible for the conclusions, opinions or recommendations made by others based on the data we have presented.



Taken from U.S.G.S. Louisville, Colorado Quadrangle, 1965 (photorevised 1979).

SITE LOCATION PLAN	AGUIRRE ENGINEERS, INC. Geotechnical and Materials Consultants	P.O. Box 3814 Englewood, Colorado 80155-3814 U.S.A.
SUBSURFACE INVESTIGATION AND ENGINEERING ANALYSIS REPORT INDUSTRIAL WASTE FACILITY ROCKY FLATS PLANT JEFFERSON COUNTY, COLORADO	DRAWN BY: NG CHECKED BY: JAH DATE: 6/10/88	SCALE Vertical N/A Horizontal 1" = +2,000' JOB NO. 18,023 PLATE 1

615232



LEGEND

- ● BORING LOCATIONS
- PIPELINE
- PROPOSED INFILTRATION TRENCH
- PROPOSED EXFILTRATION TRENCH

615233

NOTE: Boring 2 was eliminated

PLOT PLAN

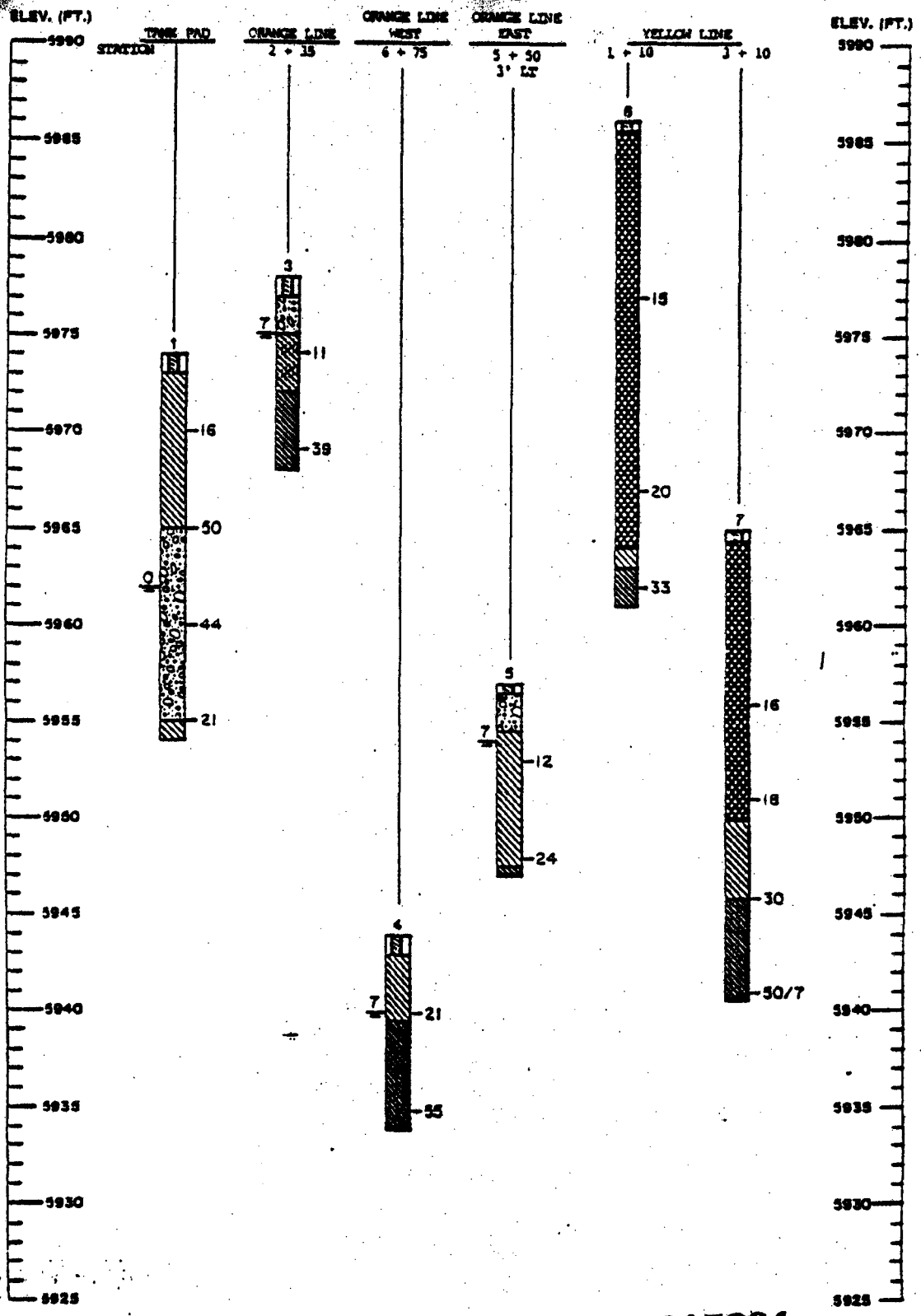
SUBSURFACE INVESTIGATION AND ENGINEERING ANALYSIS REPORT
INDUSTRIAL WASTE FACILITY
ROCKY FLATS PLANT
JEFFERSON COUNTY, COLORADO

EN GUIRRE ENGINEERS, INC.
Geotechnical and Materials Consultants
P.O. Box 3814
Englewood, Colorado
80155-3814 U.S.A.

DRAWN BY: NG	SCALE: Vertical N/A	
CHECKED BY: [illegible]	Horizontal 1" = 100'	
DATE 6/16/88	JOB NO. 18,823	PLATE 2

603613-00001689-054

BORINGS

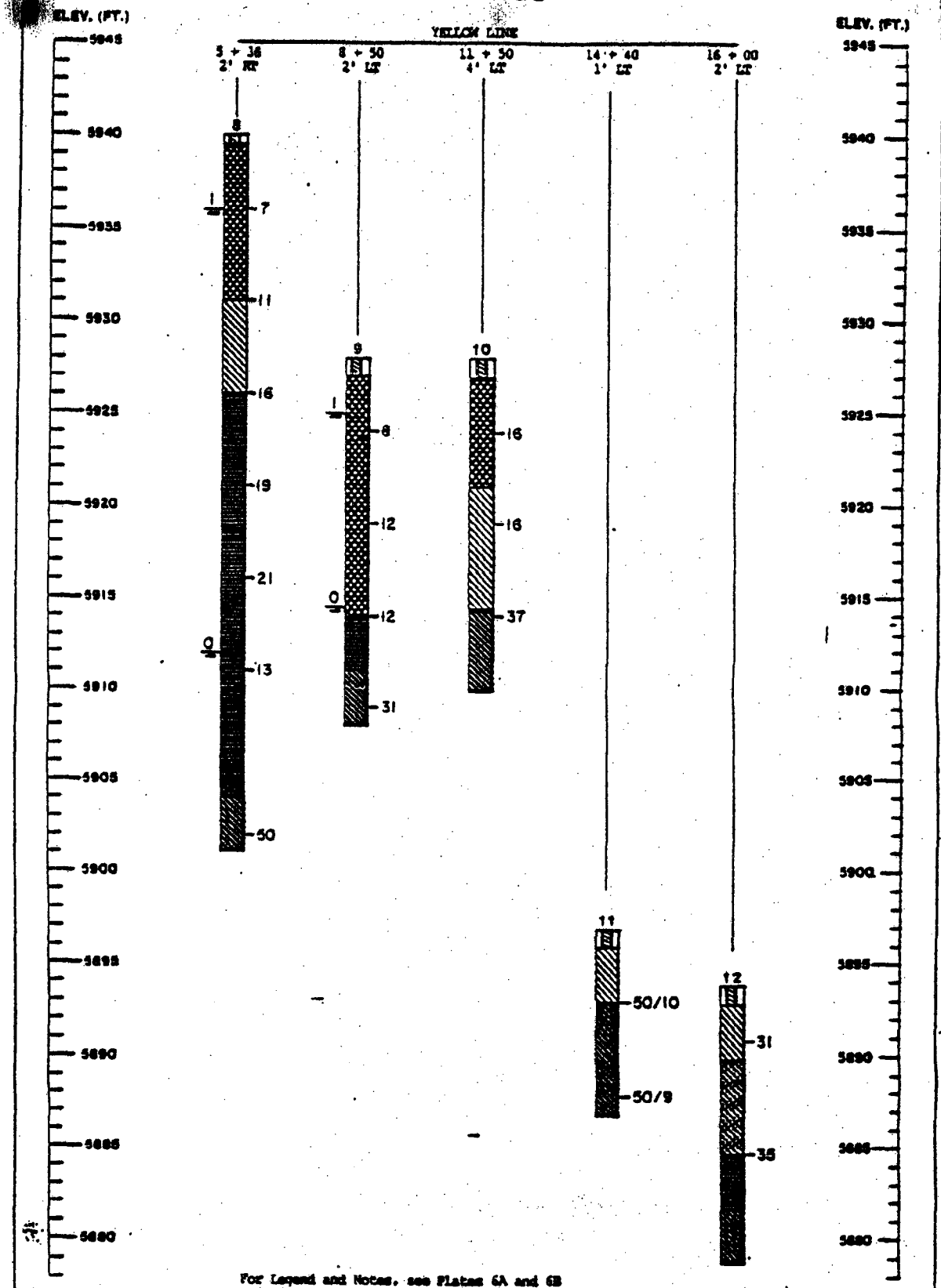


For Legend and Notes, see Plates 6A and 6B

615234

LOG OF BORINGS 1 THROUGH 7	AGUIRRE ENGINEERS, INC. Geotechnical and Materials Consultants	P.O. Box 3814 Englewood, Colorado 80155-3814 U.S.A.
SUBSURFACE INVESTIGATION AND ENGINEERING ANALYSIS REPORT INDUSTRIAL WASTE FACILITY ROCKY FLATS PLANT JEFFERSON COUNTY, COLORADO	DRAWN BY: NG	SCALE: Vertical 1" = 5'
	CHECKED BY: JNE	Horizontal N/A
	DATE: 6/16/88	JOB NO. 18,023 — PLATE 3

BORINGS

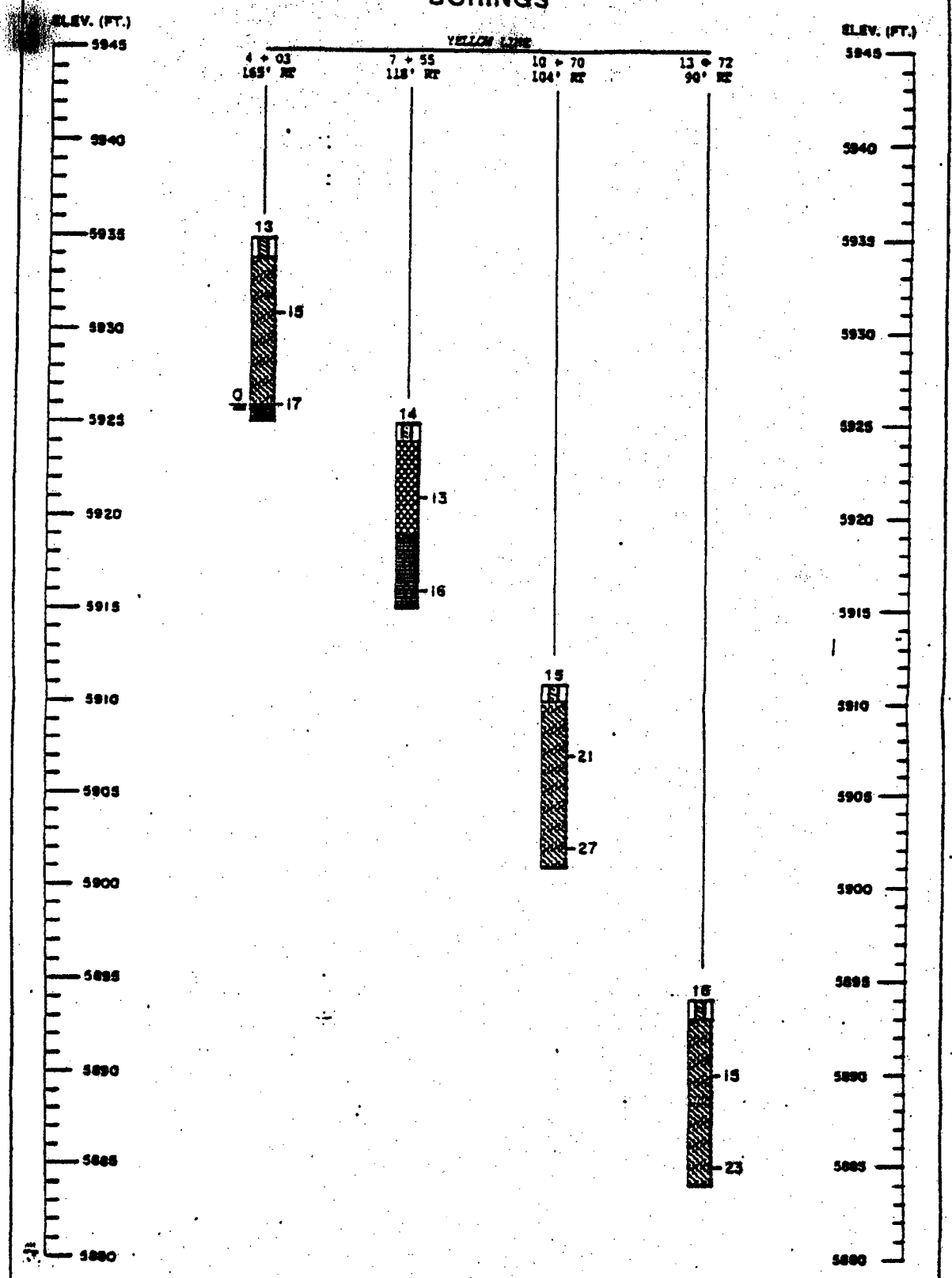


For Legend and Notes, see Plates 6A and 6B

LOG OF BORINGS 8 THROUGH 12	AGUIRRE ENGINEERS, INC. Geotechnical and Materials Consultants — P.O. Box 3614, Englewood, Colorado 80155-3614 U.S.A.
SUBSURFACE INVESTIGATION AND ENGINEERING ANALYSIS REPORT INDUSTRIAL WASTE FACILITY ROCKY FLATS PLANT JEFFERSON COUNTY, COLORADO	DRAWN BY: NG — SCALE: Varies 1" = 5' CHECKED BY: JAE — Horizontal N/A DATE: 6/10/88 — JOB NO. 15,023 — PLATE 4

615235

BORINGS

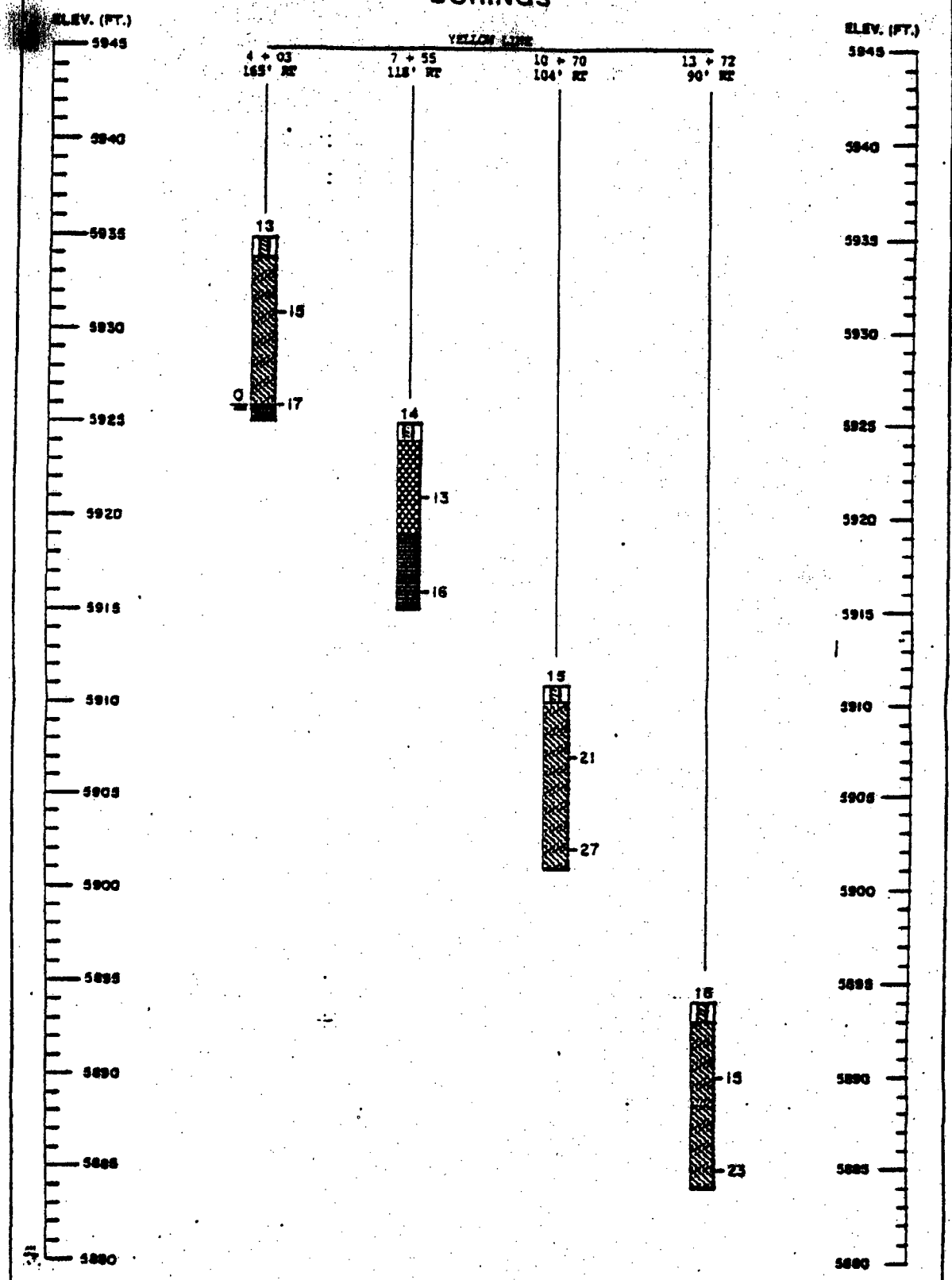


For Legend and Notes, see Plates 6A and 6B

LOG OF BORINGS 13 THROUGH 16	AGUIRRE ENGINEERS, INC. Geotechnical and Materials Consultants — P.O. Box 3614, Englewood, Colorado 80150-3614 U.S.A.
SUBSURFACE INVESTIGATION AND ENGINEERING ANALYSIS REPORT INDUSTRIAL WASTE FACILITY ROCKY FLATS PLANT JEFFERSON COUNTY, COLORADO	DRAWN BY: NG — SCALE: Vertical 1" = 5' CHECKED BY: JMS — Horizontal N/A DATE: 6/10/88 — JOB NO. 18,023 — PLATE 5

615236

BORINGS



For Legend and Notes, see Plates 6A and 6B

LOG OF BORINGS 13 THROUGH 16	AGUIRRE ENGINEERS, INC. Geotechnical and Materials Consultants	P.O. Box 3814 Englewood, Colorado 80155-3814 U.S.A.
SUBSURFACE INVESTIGATION AND ENGINEERING ANALYSIS REPORT INDUSTRIAL WASTE FACILITY ROCKY FLATS PLANT JEFFERSON COUNTY, COLORADO	DRAWN BY: NG CHECKED BY: JNE DATE: 6/10/88	SCALE: Vertical 1" = 5' Horizontal N/A JOB NO. 18,023 PLATE 5

615236

LEGEND

TOPSOIL

FILL MATERIAL: consisting of CLAY, gravelly to GRAVEL, clayey, some sandy lenses, some severely weathered claystone bedrock fragments, occasional rootlets, moist to very moist, medium stiff to very stiff, gray to brown to orange (CL, GC).

CLAY: some gravel to gravelly, trace to some sand, occasional rootlets, moist to wet, stiff to very stiff, black to dark brown to gray (CL).

CLAY: some sand to sandy, occasional gravels, occasional sand lenses, moist to very moist, stiff to very stiff, brown (CL-CH).

SAND and GRAVEL: some clay to clayey, moist to wet, medium dense to dense, light brown to dark brown (SP-SC to GP-GC).

CLAY (severely weathered claystone bedrock): trace to little sand, trace gravel, slightly calcareous, very moist, stiff to very stiff, brown to gray with orange (CL).

CLAYSTONE BEDROCK: weathered, trace to little sand, slightly calcareous, iron stains noted in fractures, very moist, hard to very hard, gray to brown with orange.

Water Table Elevation: At number of days, indicated, after drilling.

NOTES

1) The borings were drilled on May 18, 19, 24 and 25, 1988, with a 4 (four) inch diameter, continuous flight, power auger (Note: because of access difficulties, Boring 2 location was eliminated).

(Continued on Plate 4B)

LEGEND AND NOTES	AGUIRRE ENGINEERS, INC. Geotechnical and Materials Consultants	P.O. Box 3814 Englewood, Colorado 80155-3814 U.S.A.
SUBSURFACE INVESTIGATION AND ENGINEERING ANALYSIS REPORT INDUSTRIAL WASTE FACILITY ROCKY FLATS PLANT JEFFERSON COUNTY, COLORADO	DRAWN BY: NG CHECKED BY: JAH DATE 6/10/88	SCALE Vertical N/A Horizontal N/A JOB NO. 18,023 PLATE 6A

615237

NOTES (Continued from Plate 4A)

2) 16 (sixteen) indicates that 16 (sixteen) blows of a 140 (one hundred forty) pound hammer falling 30 (thirty) inches were required to drive the sampler 12 (twelve) inches (or number of inches indicated).

3) 3' LT indicates the boring was offset from the stationing 3 (three) feet to the left.

4) The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

5) The boring logs show subsurface conditions at the dates and locations indicated, and it is not warranted that they are representative of subsurface conditions at other locations and times.

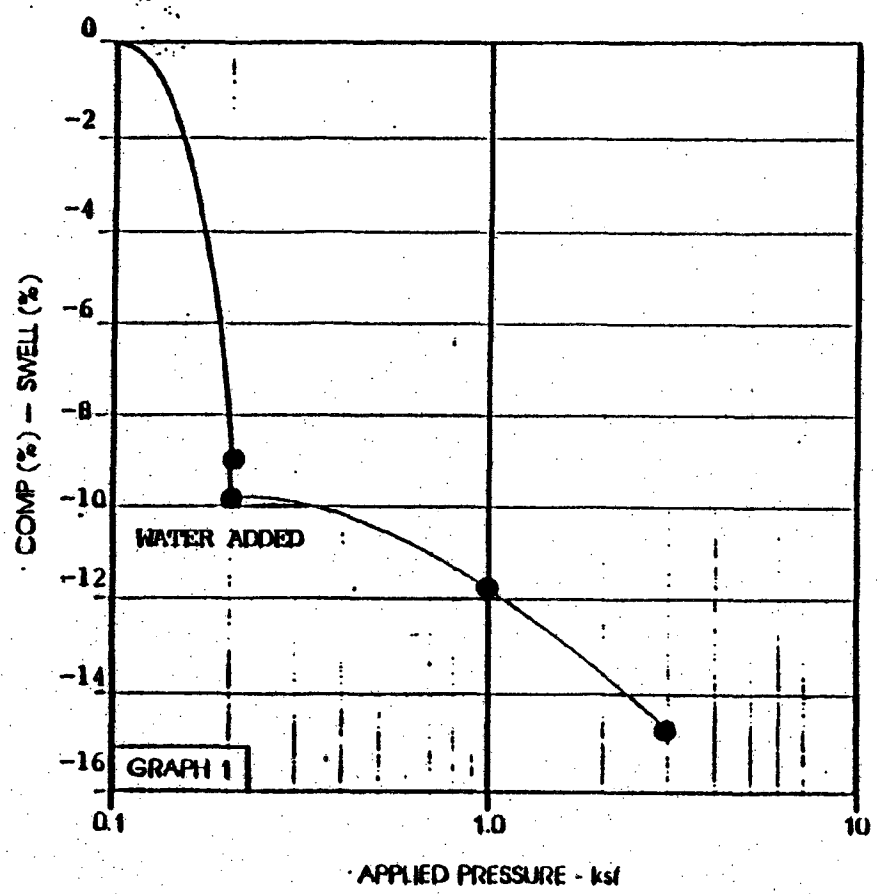
6) The Boring locations were physically surveyed in the field by Aguirre Engineers, Inc. by taping or pacing distances from staked locations provided along the proposed pipelines and infiltration trench. Boring elevations were interpolated from the site plan provided to us by Engineering Science, Inc. These boring locations and elevations are adequate for the purpose of this report, but should be considered as only approximate for any other use.

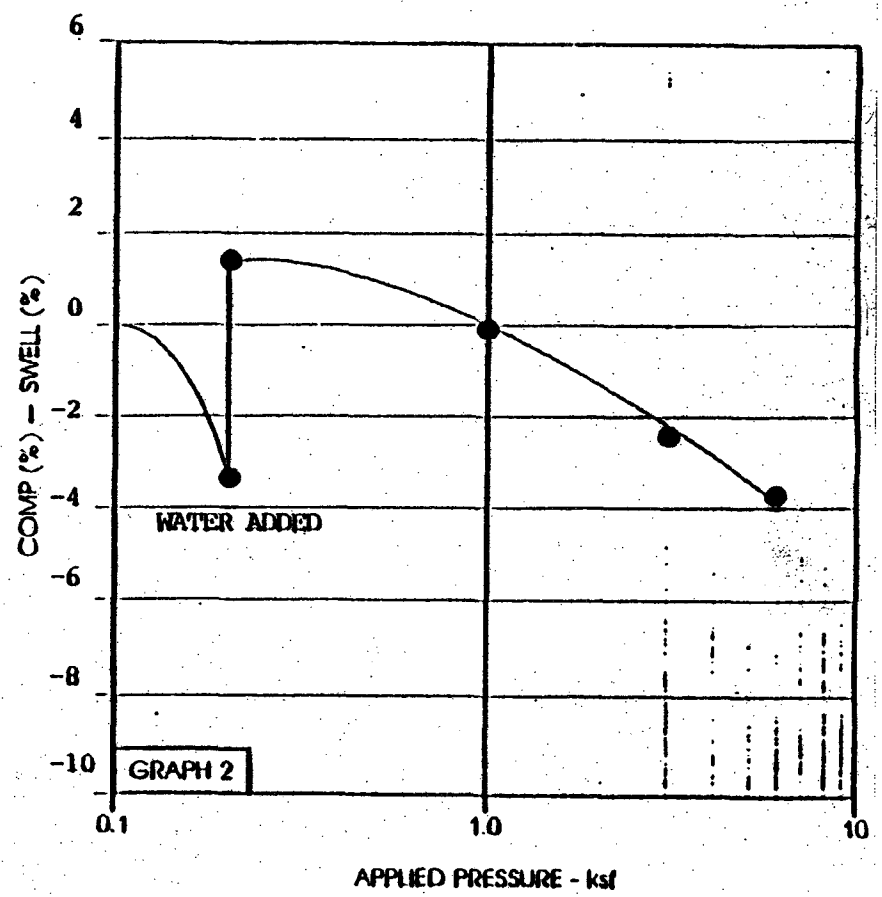
7) Groundwater was encountered in Borings 1, 8, 9, and 13, during drilling operations (May 19, 24, and 25, 1988), at depths of from 9 (nine) to 28 (twenty-eight) feet below the existing ground surface.

Where possible, groundwater levels were rechecked on May 25, 1988. This corresponds to either 7 (seven) days or 1 (one) day after completion of drilling operations. Groundwater levels could not be rechecked for Borings 1, 6, and 13 through 16, because of backfill requirements by Rockwell International.

LEGEND AND NOTES	AGUIRRE ENGINEERS, INC. Geotechnical and Materials Consultants	P.O. Box 3814 Englewood, Colorado 80155-3814 U.S.A.
SUBSURFACE INVESTIGATION AND ENGINEERING ANALYSIS REPORT INDUSTRIAL WASTE FACILITY ROCKY FLATS PLANT JEFFERSON COUNTY, COLORADO	DRAWN BY: NG CHECKED BY: JAH DATE: 6/10/88	SCALE: Vertical N/A Horizontal N/A JOB NO. 18,023 — PLATE 6B

615238





GRAPH NO.	BORING NO.	SAMPLE NO.	DEPTH (FEET)	NATURAL DRY DENSITY (PCF)	NATURAL MOISTURE (%)	SOIL DESCRIPTION
1	1		4	114.7	15.1	CLAY, some gravel, little sand, dark brown (CL)
2	6		24	114.4	16.2	CLAYSTONE BEDROCK, weathered, gray

INGUERRE ENGINEERS, INC.

SWELL-CONSOLIDATION TES

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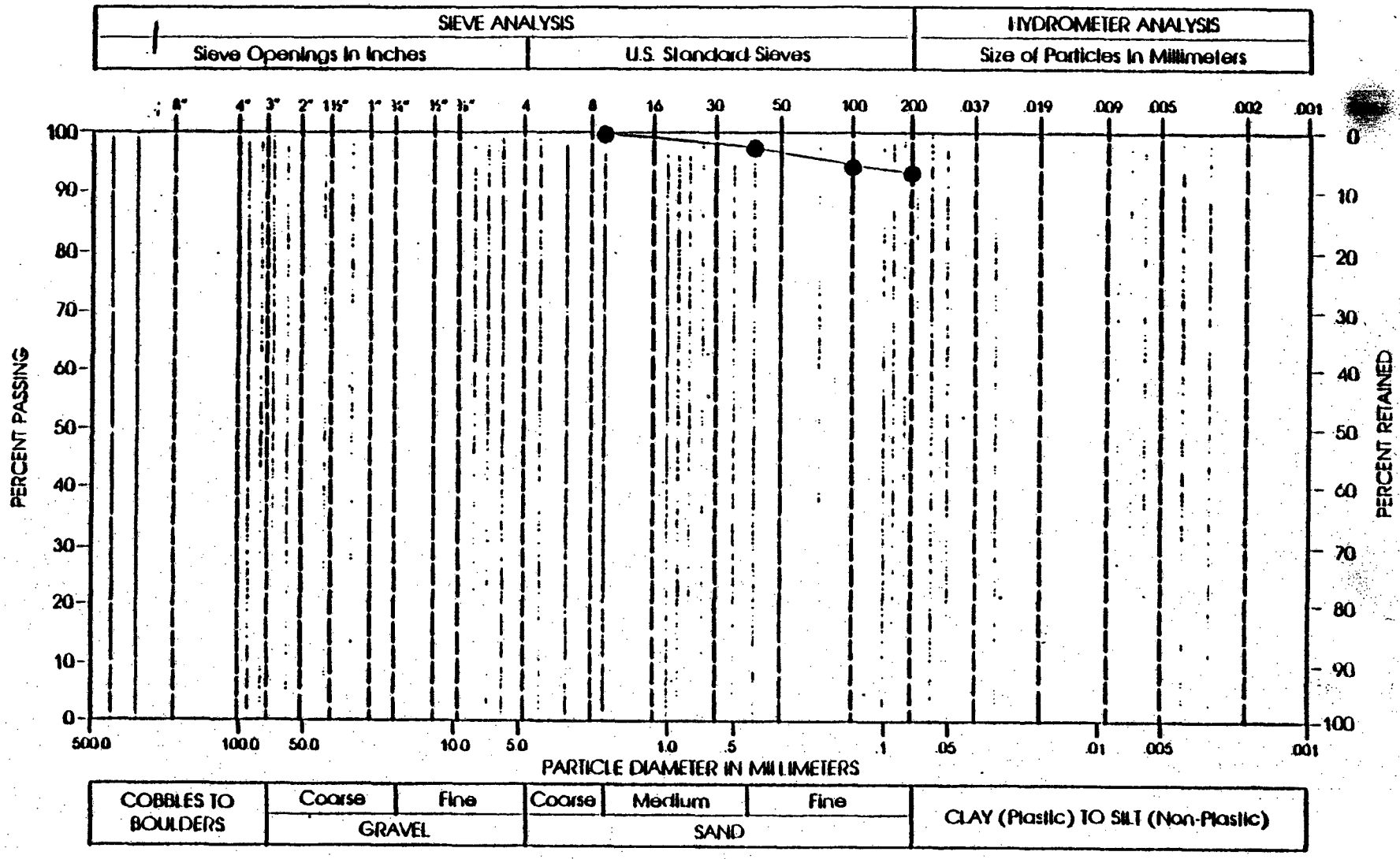
DATE: 6/13/88

JOB NO. 18,023

PLATE 7

615239

603613-00001695-054



GRAPH NO.	BORING NO.	SAMPLE NO.	DEPTH (FEET)	NATURAL DRY DENSITY (PCF)	NATURAL MOISTURE (%)	PL	PI	LL	SOIL DESCRIPTION
	4		4						CLAY, trace sand, gray to dark brown (CL)

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GRADATION ANALYSIS

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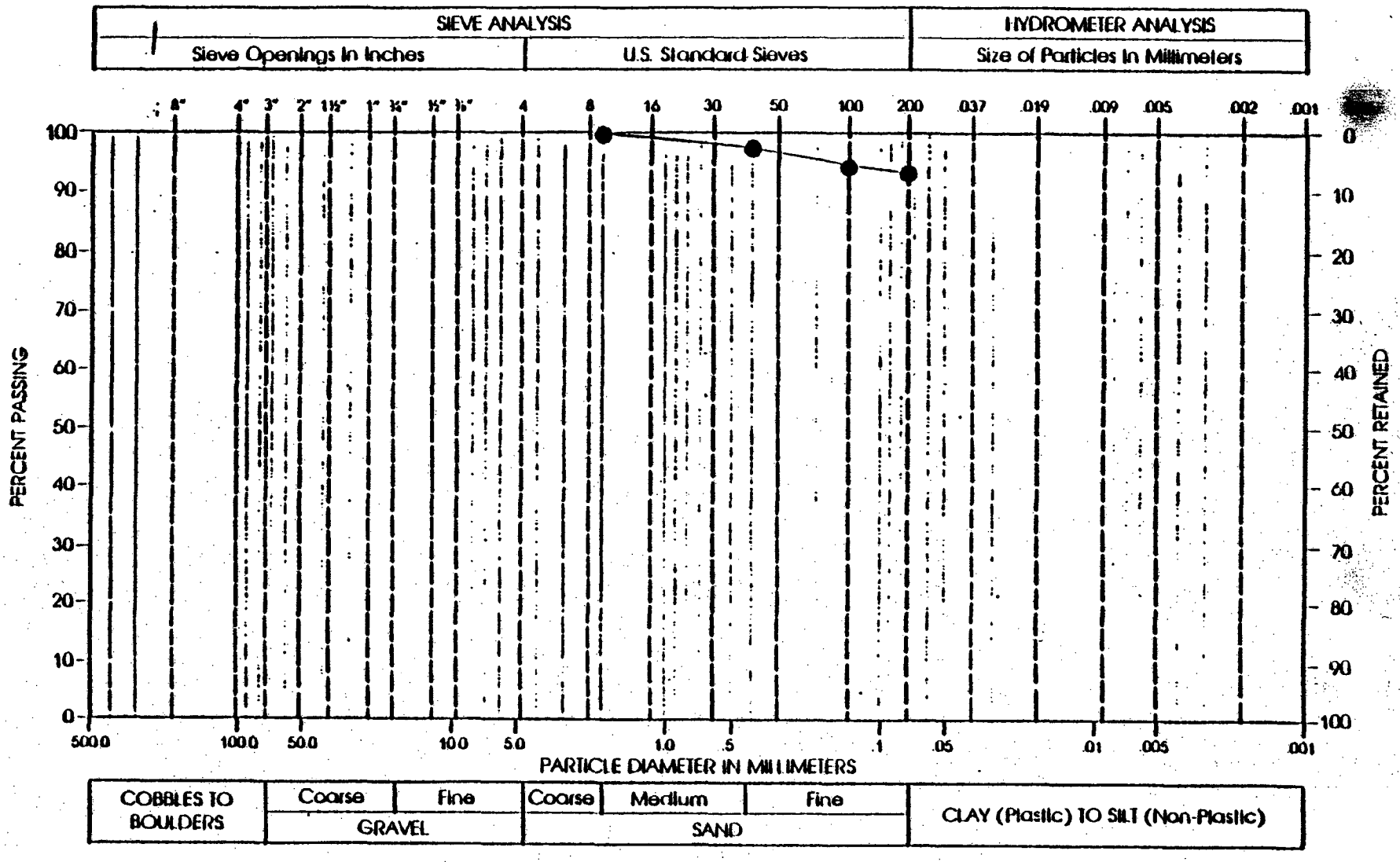
DATE: 6/10/88

JOB NO. 18,023

PLATE 8

603613-00001696-054

615240



GRAPH NO.	BORING NO.	SAMPLE NO.	DEPTH (FEET)	NATURAL DRY DENSITY (PCF)	NATURAL MOISTURE (%)	PL	PI	LL	SOIL DESCRIPTION
	4		4						CLAY, trace sand, gray to dark brown (CL)

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GRADATION ANALYSIS

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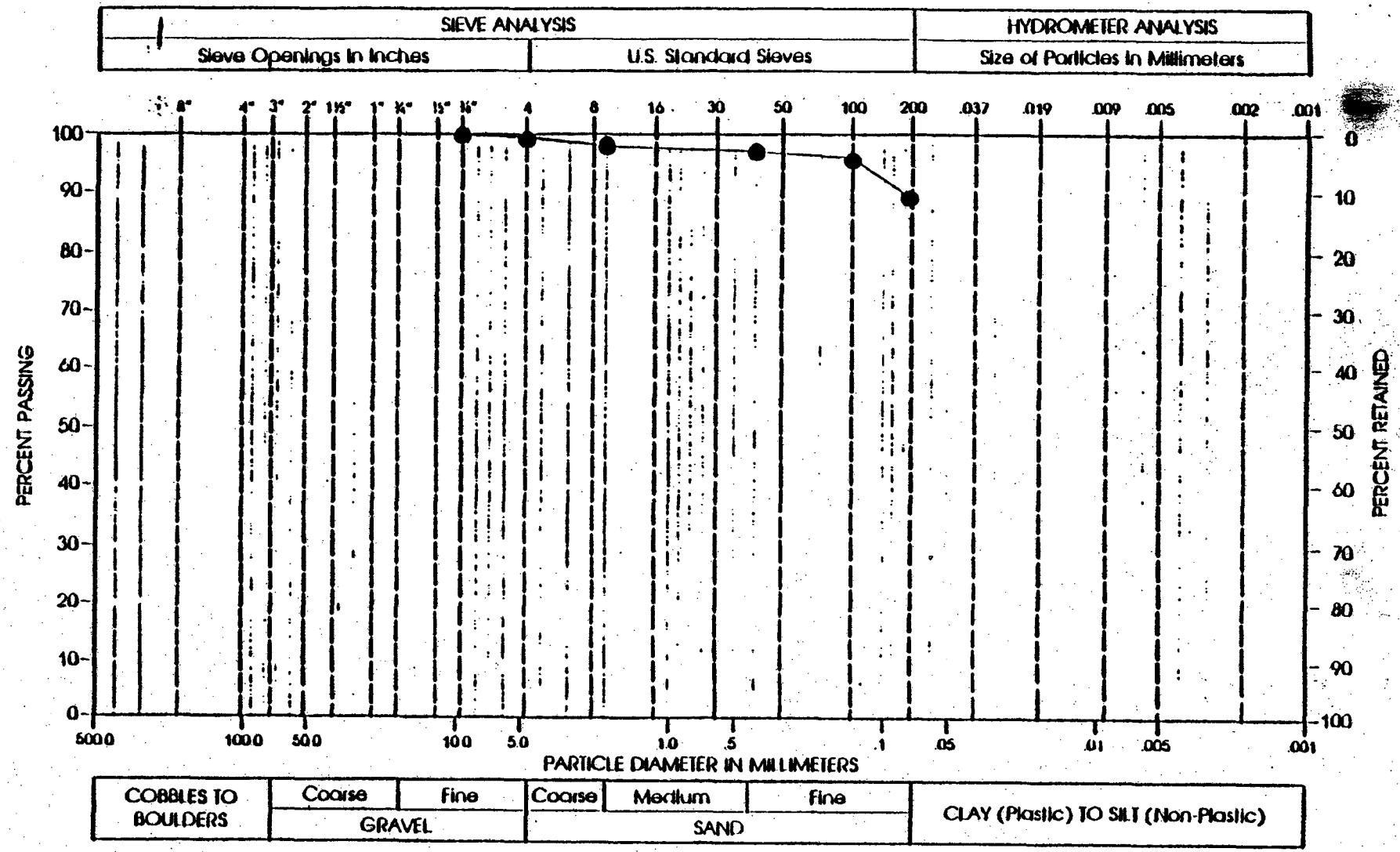
CHECKED BY: JAH
DATE: 6/10/88

JOB NO. 18,023

PLATE 8

603613-00001696-054

01520



GRAPH NO.	BORING NO.	SAMPLE NO.	DEPTH (FEET)	NATURAL DRY DENSITY (PCF)	NATURAL MOISTURE (%)	PL	PI	LL	SOIL DESCRIPTION
	5		4	106.9	21.8				CLAY, little sand, trace gravel (CL)

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GRADATION ANALYSIS

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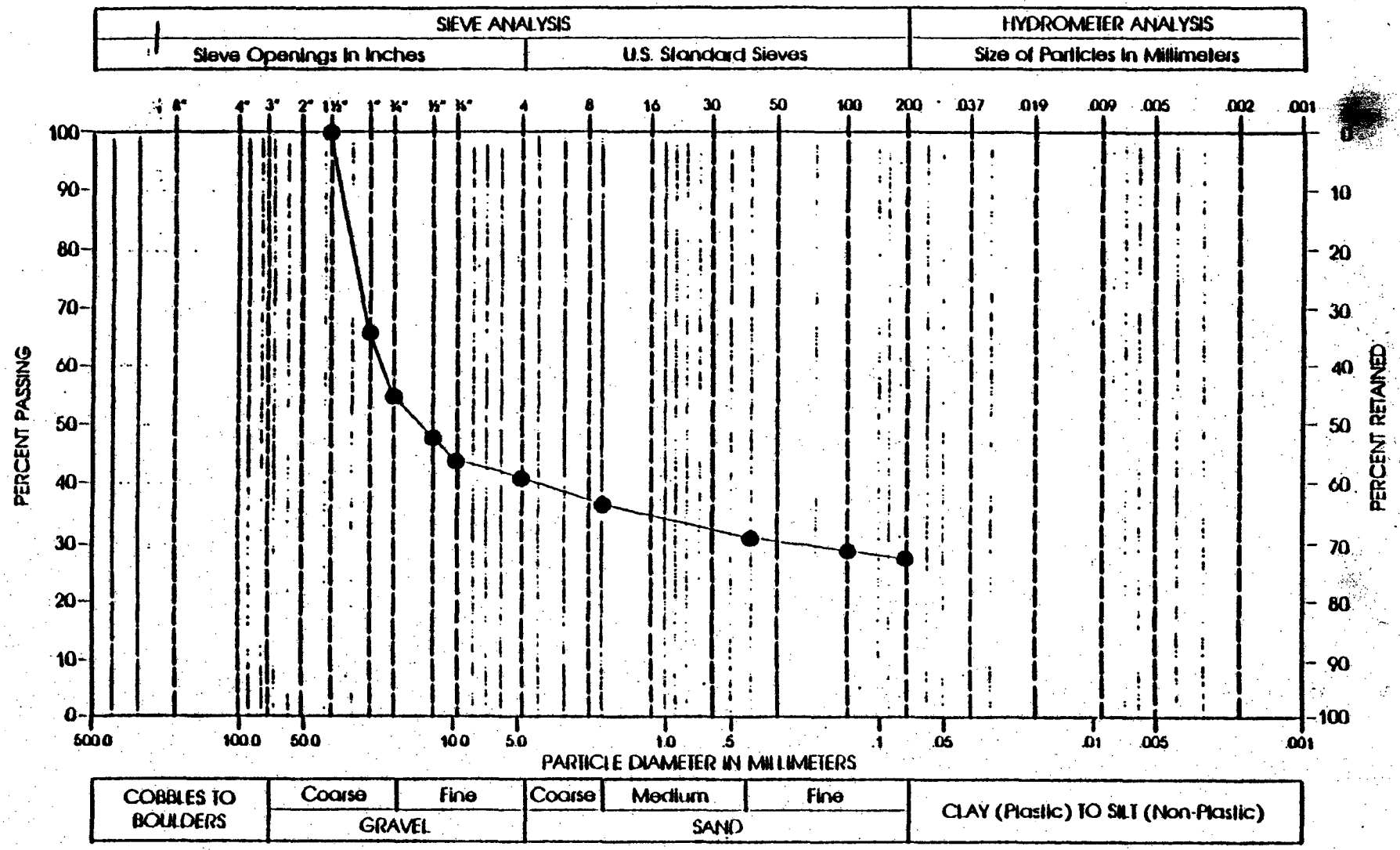
DATE: 6/10/88

JOB NO. 18,023

PLATE 9

615241

603613-00001697-054



GRAPH NO.	BORING NO.	SAMPLE NO.	DEPTH (FEET)	NATURAL DRY DENSITY (PCF)	NATURAL MOISTURE (%)	PL	PI	LL	SOIL DESCRIPTION
	6		19						FILL MATERIAL, consisting of gravel, clayey, little sand, gray to brown (GC)

INGUERRE ENGINEERS, INC.

GRADATION ANALYSIS

DRAWN BY: PDP
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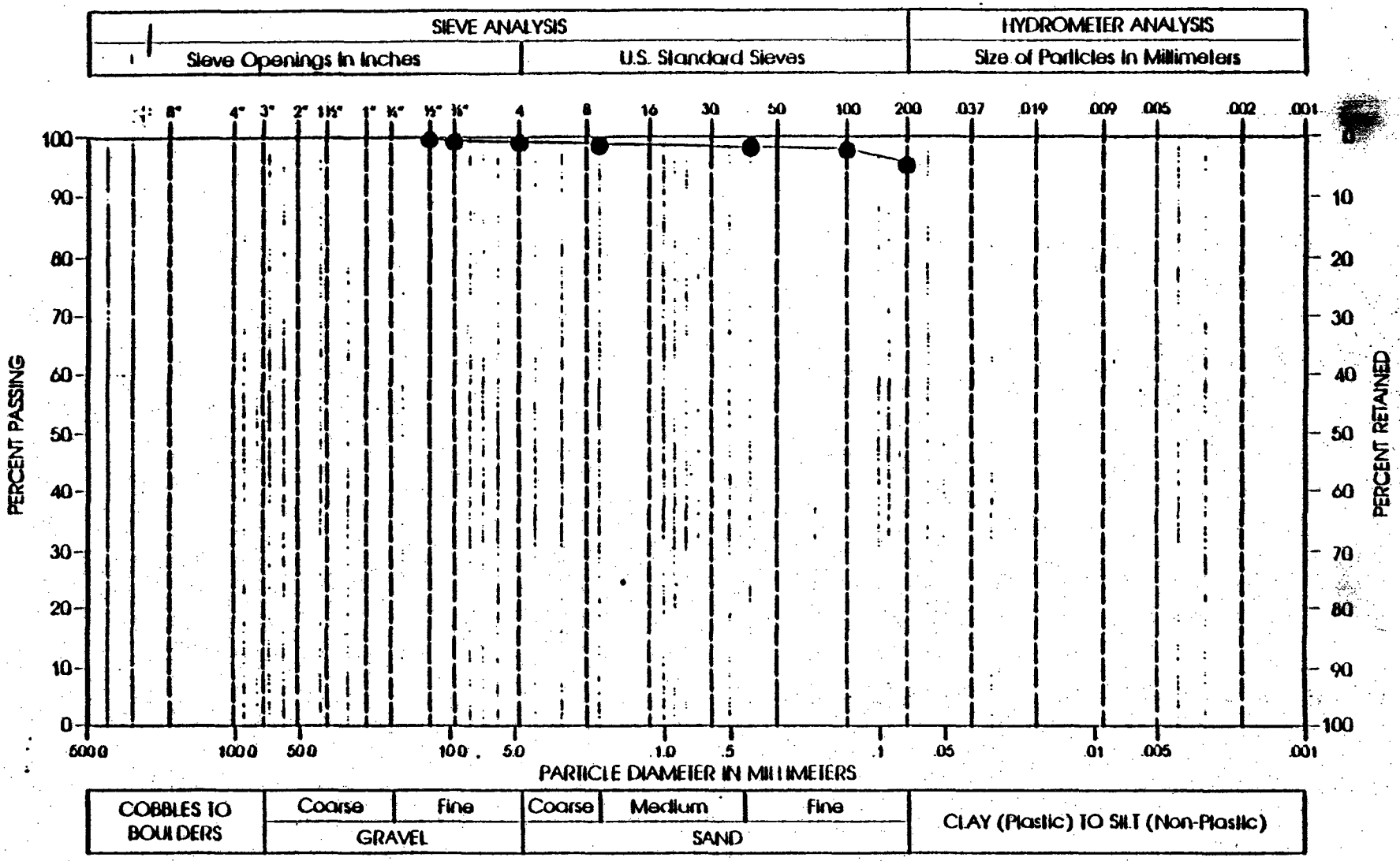
DATE: 6/20/88

JOB NO. 18,023

PLATE 10

615242

603613-00001698-054



GRAPH NO.	BORING NO.	SAMPLE NO.	DEPTH (FEET)	NATURAL DRY DENSITY (PCF)	NATURAL MOISTURE (%)	PL	PI	LL	SOIL DESCRIPTION
	7		14						FILL MATERIAL; consisting of clay and severely weathered claystone bedrock fragments, trace sand, orange to brown

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GRADATION ANALYSIS

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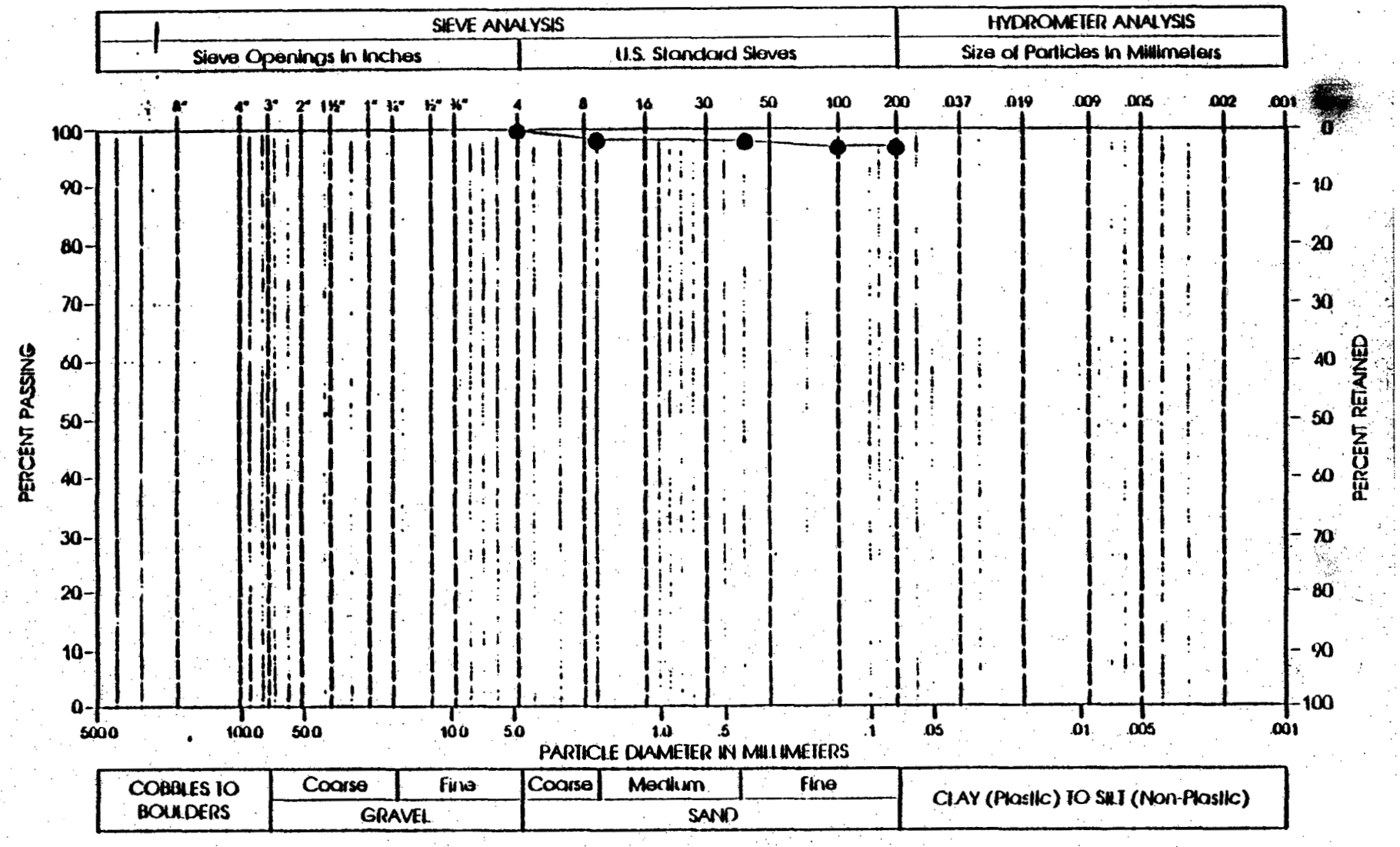
DATE: 6/10/88

JOB NO. 18,022

PLATE 11

615243

603613-00001699-054



615244

GRAPH NO.	BORING NO.	SAMPLE NO.	DEPTH (FEET)	NATURAL DRY DENSITY (PCF)	NATURAL MOISTURE (%)	PL	PI	LL	SOIL DESCRIPTION
	7		19	111.7	16.9				CLAYSTONE BEDROCK, weathered, trace sand, gray to brown with orange

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GRADATION ANALYSIS

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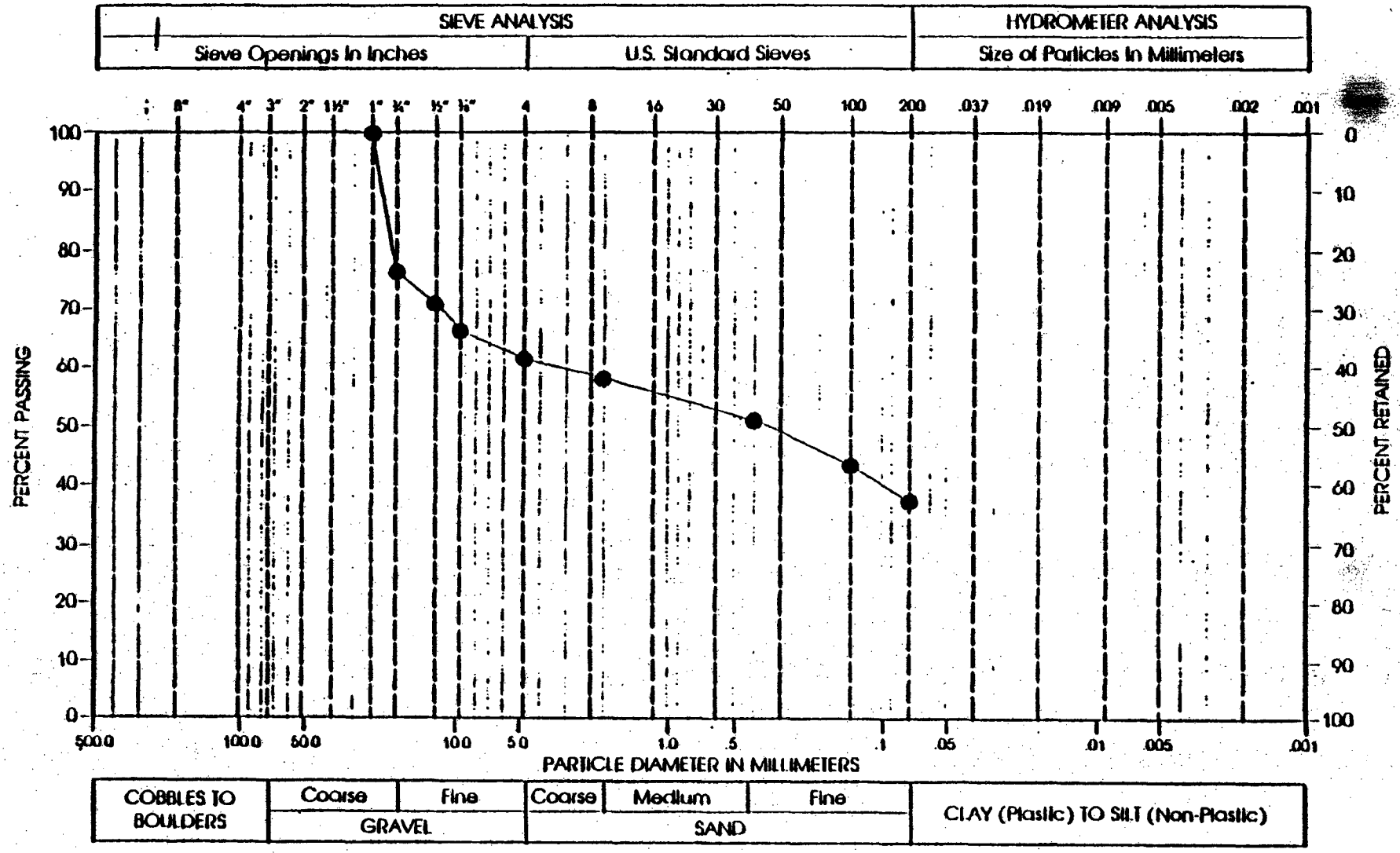
DATE: 6/10/88

JOB NO. 18,023

PLATE 12

603613-00001700-054



GRAPH NO.	BORING NO.	SAMPLE NO.	DEPTH (FEET)	NATURAL DRY DENSITY (PCF)	NATURAL MOISTURE (%)	PL	PI	LL	SOIL DESCRIPTION
	8		9						FILL MATERIAL, consisting of gravel, clayey, some sand, brown (GC)

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GRADATION ANALYSIS

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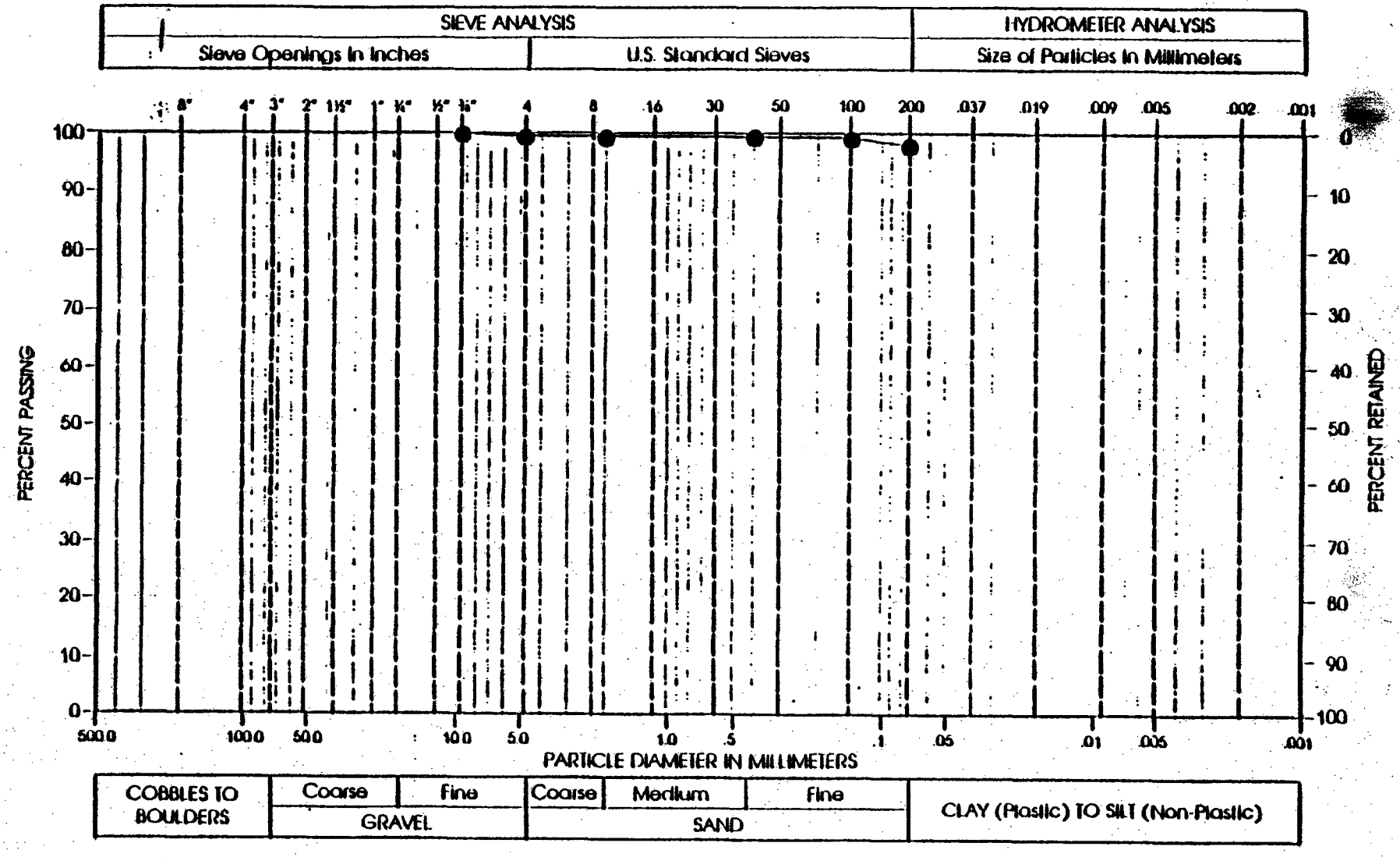
DATE 6/10/88

JOB NO. 18,023

PLATE 13

615245

603613-00001701-054



GRAPH NO.	BORING NO.	SAMPLE NO.	DEPTH (FEET)	NATURAL DRY DENSITY (PCF)	NATURAL MOISTURE (%)	PL	PI	LL	SOIL DESCRIPTION
	8		19						CLAY (severely weathered claystone bedrock), trace sand, brown to gray with orange (CL)

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GRADATION ANALYSIS

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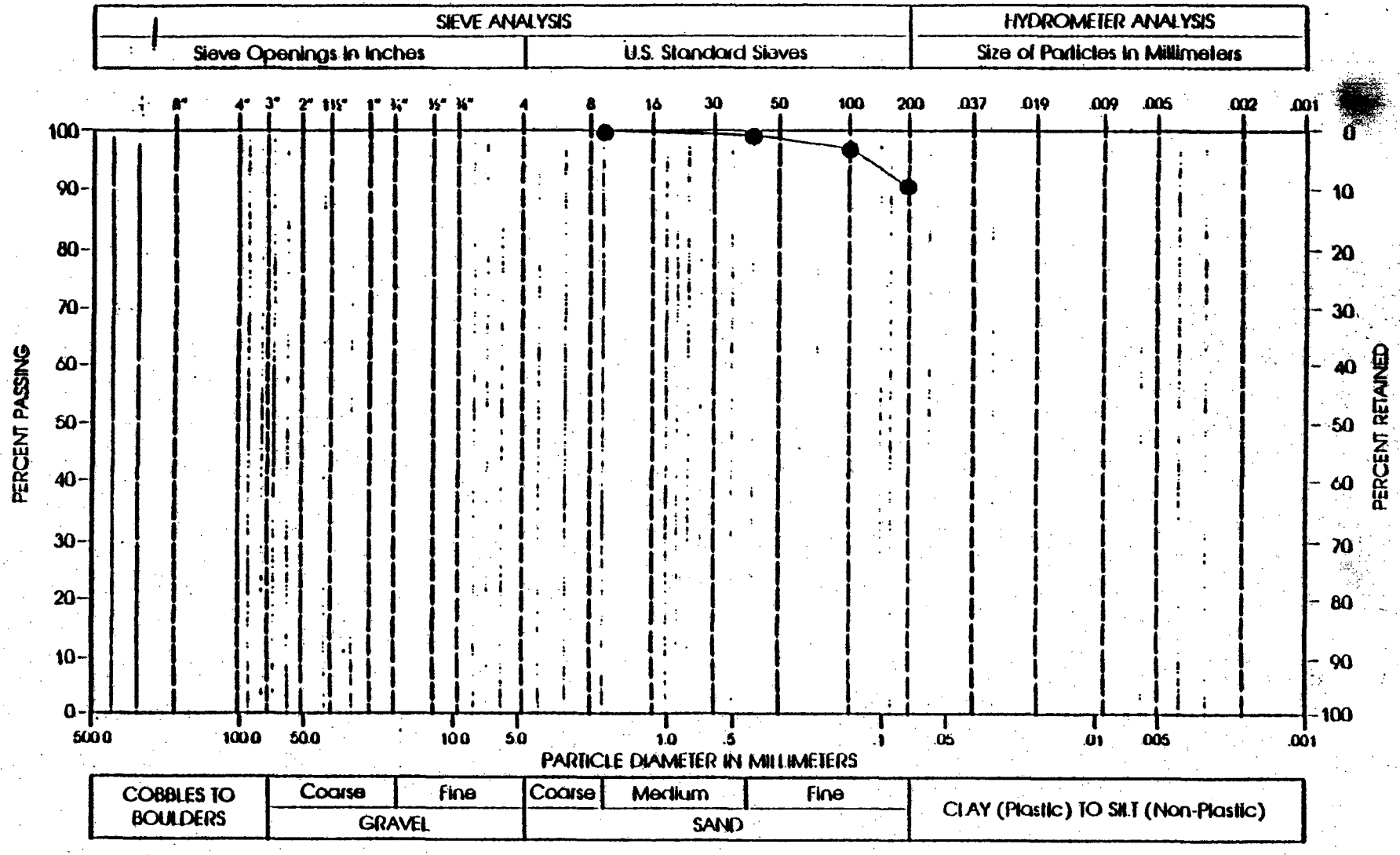
DATE: 6/10/88

JOB NO. 18,023

PLATE 14

615246

603613-00001702-054



GRAPH NO	BORING NO	SAMPLE NO.	DEPTH (FEET)	NATURAL DRY DENSITY (PCF)	NATURAL MOISTURE (%)	PI	PI	LL	SOIL DESCRIPTION
	8		24						CLAY (severely weathered claystone bedrock), trace sand, brown with orange (CL)

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GRADATION ANALYSIS

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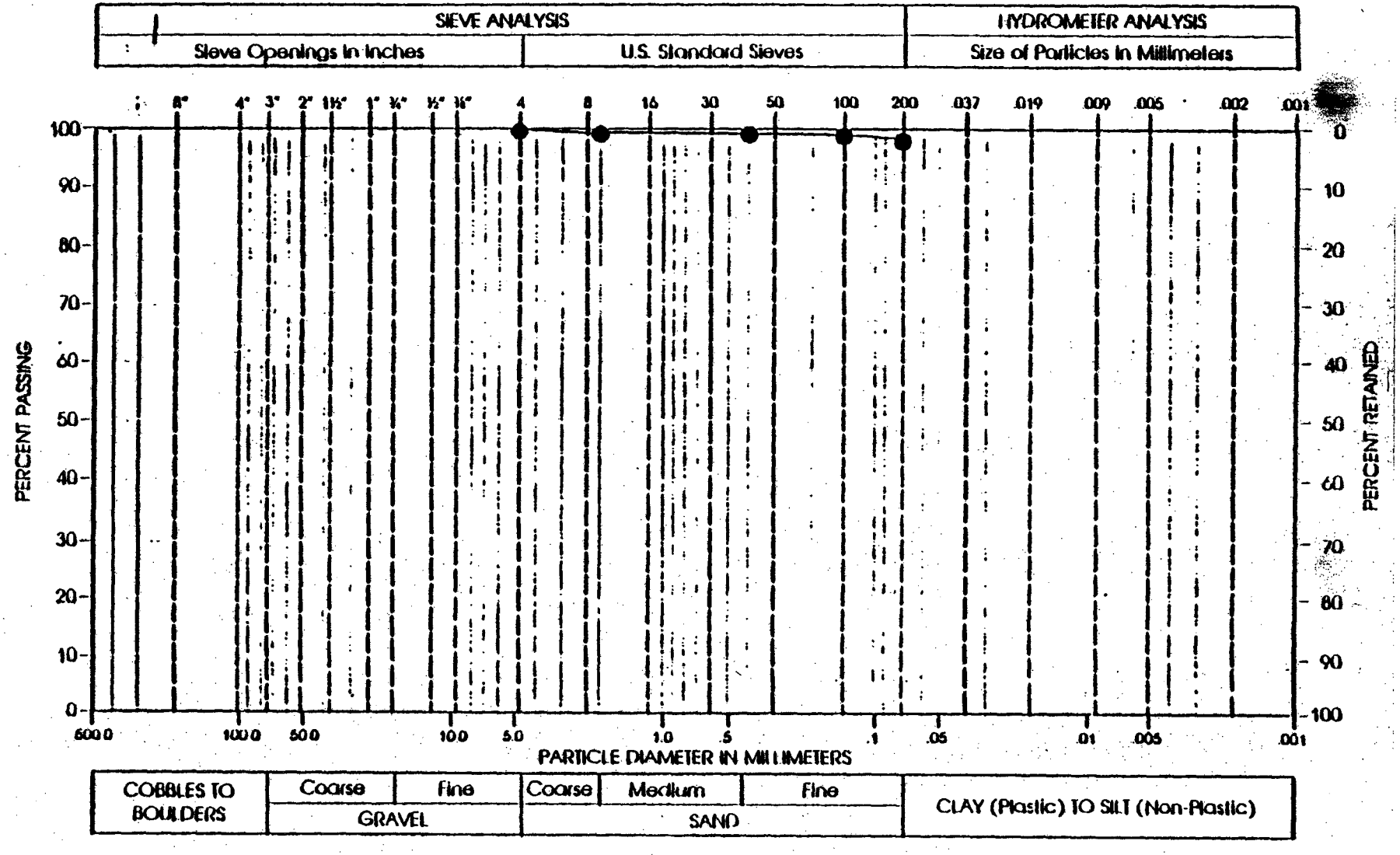
JOB NO. 18,023

PLATE 15

615247

603613-00001703-054



GRAPH NO.	BORING NO.	SAMPLE NO.	DEPTH (FEET)	NATURAL DRY DENSITY (PCF)	NATURAL MOISTURE (%)	PL	PI	LL	SOIL DESCRIPTION
	9		14						CLAY (severely weathered claystone bedrock), trace sand, brown to gray with orange (CL)

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GRADATION ANALYSIS

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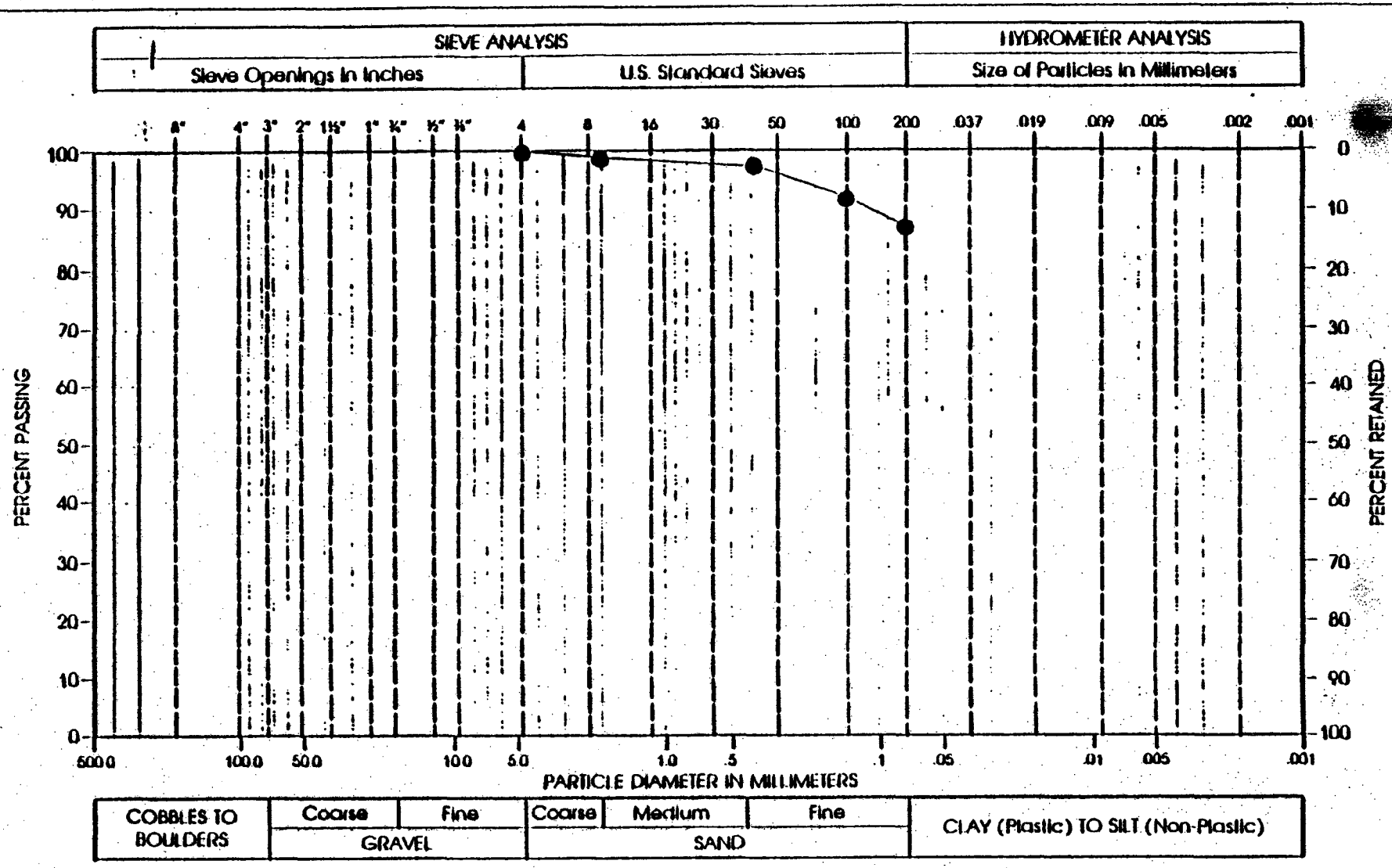
JOB NO. 18,027

PLATE 16

615248

603613-00001704-054



GRAPH NO.	BORING NO.	SAMPLE NO.	DEPTH (FEET)	NATURAL DRY DENSITY (PCF)	NATURAL MOISTURE (%)	PL	PI	LL	SOIL DESCRIPTION
	11		4						CLAYSTONE BEDROCK, weathered, little sand, gray to brown

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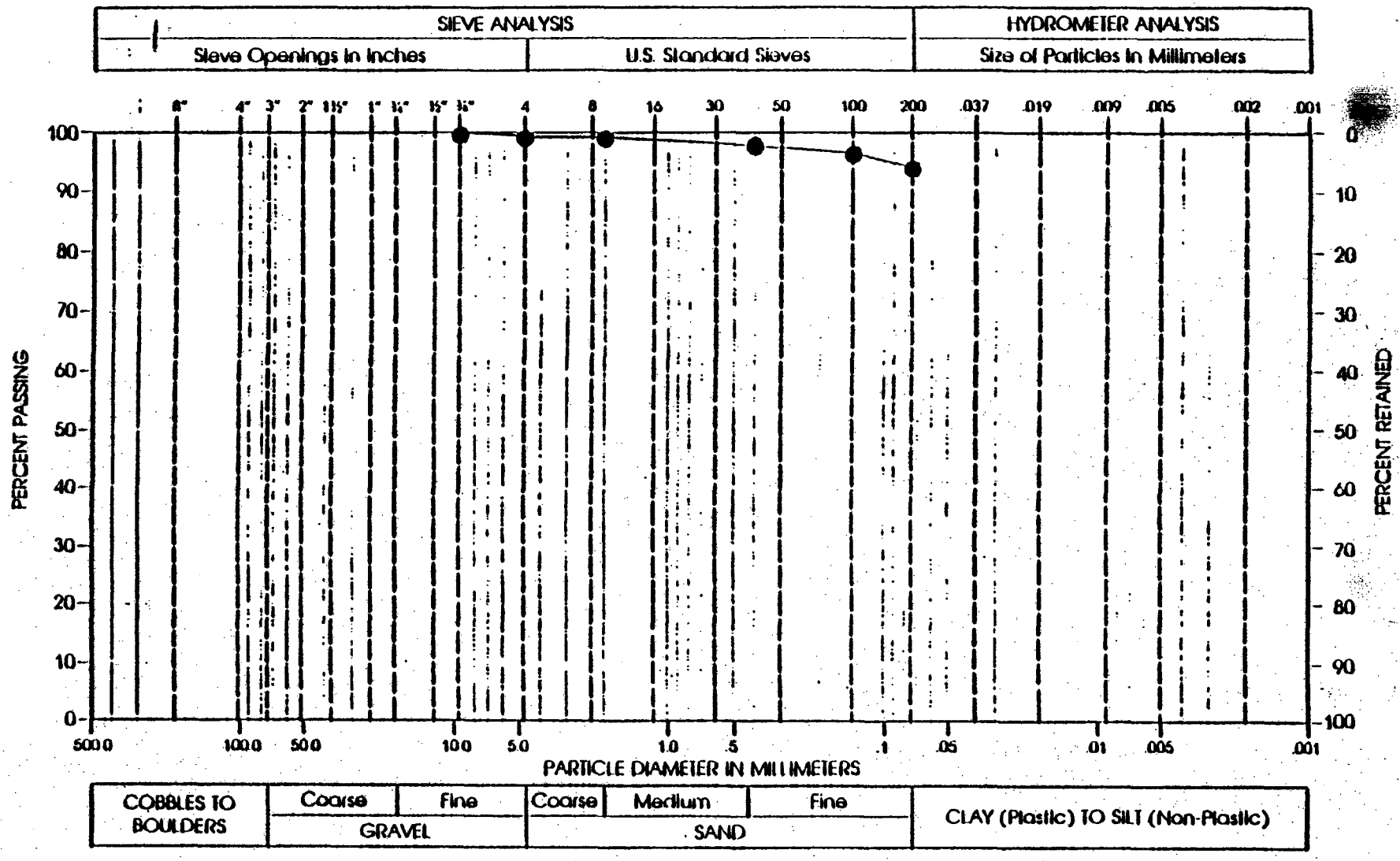
JOB NO. 18,023

PLATE 17

615249

603613-00001705-054



GRAPH NO.	BORING NO.	SAMPLE NO.	DEPTH (FEET)	NATURAL DRY DENSITY (PCF)	NATURAL MOISTURE (%)	PL	PI	LL	SOIL DESCRIPTION
	13		9						CLAY (severely weathered claystone bedrock), trace sand, brown (CL)

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GRADATION ANALYSIS

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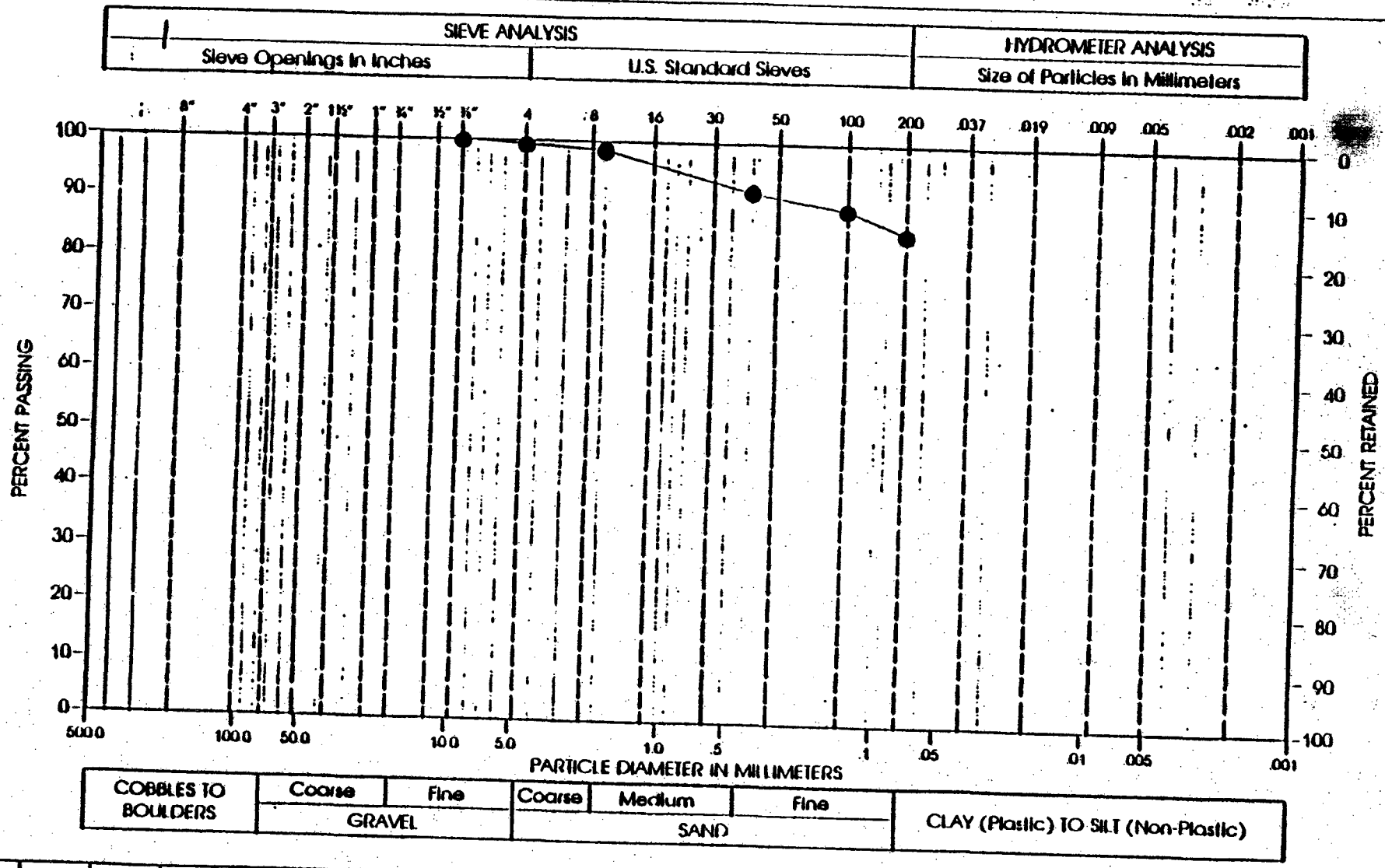
DATE: 6/10/88

JOB NO. 18,023

PLATE 18

615250

603613-00001706-054



GRAPH NO	BORING NO	SAMPLE NO	DEPTH (FEET)	NATURAL DRY DENSITY (PCF)	NATURAL MOISTURE (%)	PL	PI	LL	SOIL DESCRIPTION
	14		9						CLAY (severely weathered claystone bedrock), little sand, trace gravel, brown to gray with orange (CL)

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GRADATION ANALYSIS

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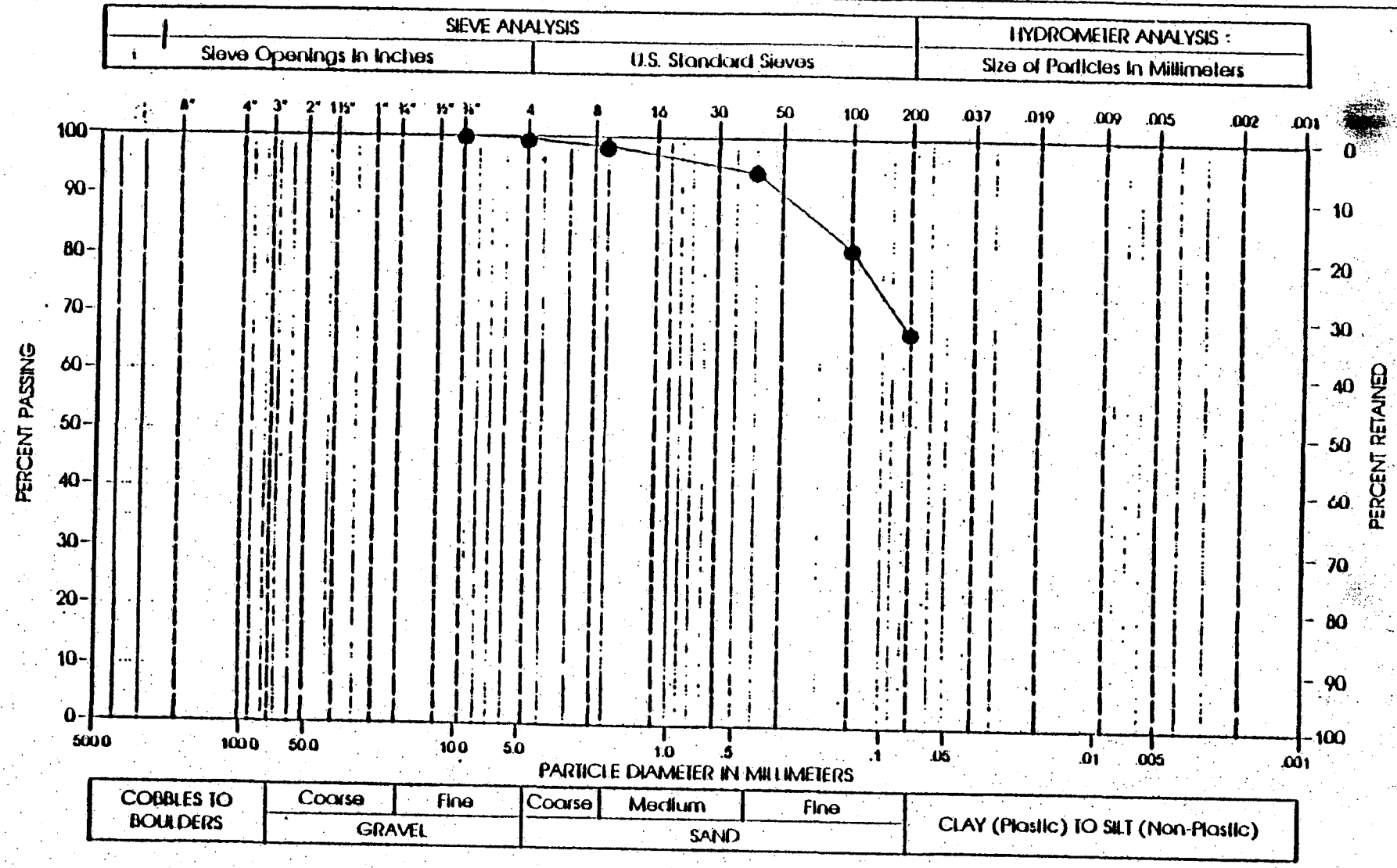
DATE: 6/10/88

JOB NO. 18,023

PLATE 19

615251

603613-00001707-054



GRAPH NO.	BORING NO.	SAMPLE NO.	DEPTH (FEET)	NATURAL DRY DENSITY (PCF)	NATURAL MOISTURE (%)	PL	PI	LL	SOIL DESCRIPTION
	15		4						CLAY, sandy, trace gravel, brown (CL)

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GRADATION ANALYSIS

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DATE: 6/10/88

JOB NO. 18,023

PLATE 20

615252

603613-00001708-054

BORING NO.	SAMPLE NO.	DEPTH (FEET)	SAMPLE TYPE (SEE NOTE 1)	NATURAL DRY DENSITY (pcf)	NATURAL MOISTURE (%)	FINES (%)	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	ATTERBERG LIMITS LL	UNCONFINED COMPRESSIVE STRENGTH (psf)	SWELL INDEX (%)	WATER SOLUBLE SULFATES (%)	ADDITIONAL TEST RESULTS ATTACHED (SEE NOTE 2)	SOIL DESCRIPTION	UNIFIED SOIL CLASSIFICATION
1		4	CA	114.7	15.1						-0.9		SW	CLAY, some gravel, little sand, dark brown	CL
3		4	CA				21	30	51					CLAY, trace gravel, sand lenses, brown	CL-CH
3		9	CA	119.6	13.6									CLAYSTONE BEDROCK, weathered, gray with orange	
4		4	CA			93.9							GA	CLAY, trace sand, gray to dark brown	CL
5		4	CA	106.9	21.8	89.7							GA	CLAY, little sand, trace gravel	CL
6		9	CA				20	23	43					FILL MATERIAL; consisting of clay, gravelly, some claystone bedrock fragments, brown	CL
6		19	CA			27.8							GA	FILL MATERIAL; consisting of gravel, clayey, little sand, gray to brown	GC

NOTE 1 - SAMPLE TYPE
AD - Air Dried
AS - Auger Sample
BS - Bag Sample
CA - California Sample
HD - Hand Drive
SS - Standard Spoon
ST - Shelby Tube Sample
RM - Remolded Sample

NOTE 2 -ADDITIONAL TEST RESULTS ATTACHED
C_1 - Unconfined Compression
C_2 - Miniature Vane Shear
C_3 - Pocket Penetrometer
C_4 - Pocket Vane
CI - Consolidation Test
GA - Gradation Analysis
PT - Proctor
SW - Swell-Consolidation Test
TT - Triaxial Test

PERM - Lab Permeability Tests (test results not available at this writing)

INGUIRRE ENGINEERS, INC.
Geotechnical and Materials Consultants

SUMMARY OF LABORATORY TEST RESULT

PROJECT NO. 18,023

TABLE 1 | PAGE 1 OF 5 PAG

603613-00001709-054

615253

BORING NO.	SAMPLE NO.	DEPTH (FEET)	SAMPLE TYPE (SEE NOTE 1)	NATURAL DRY DENSITY (pcf)	NATURAL MOISTURE (%)	FINES (%)	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	ATTERBERG LIMITS LL	UNCONFINED COMPRESSIVE STRENGTH (psf)	SWELL INDEX (%)	WATER SOLUBLE SULFATES (%)	ADDITIONAL TEST RESULTS ATTACHED (SEE NOTE 2)	SOIL DESCRIPTION	UNIFIED SOIL CLASSIFICATION
6		24	CA	114.4	16.2						+4.8		SW	CLAYSTONE BEDROCK, weathered, gray	
7		9	CA				15	19	34					FILL MATERIAL; consisting of clay, gravelly, some sand lenses, brown	CL
7		14	CA			95.7							GA	FILL MATERIAL; consisting of clay and severely weathered claystone bedrock fragments, trace sand, orange to brown	CL
7		19	CA	111.7	16.9	96.3							GA	CLAYSTONE BEDROCK, weathered, trace sand, gray to brown with orange	
8		4	CA	102.6	18.3		21	29	50					FILL MATERIAL; consisting of clay and severely weathered claystone bedrock fragments, trace sand, orange to brown	CL
8		9	CA			37.4							GA	FILL MATERIAL; consisting of gravel, clayey, some sand, brown	GC

NOTE 1 - SAMPLE TYPE
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NOTE 2 -ADDITIONAL TEST RESULTS ATTACHED
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PI - Proctor
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TI - Triaxial Test

PERM - Lab Permeability Tests (test results not available at this writing)

AGUIRRE ENGINEERS, INC.
Geotechnical and Materials Consultants

SUMMARY OF LABORATORY TEST RESULT

PROJECT NO. 18,023

TABLE 1

615254

603613-00001710-054

BORING NO.	SAMPLE NO.	DEPTH (FEET)	SAMPLE TYPE (SEE NOTE 1)	NATURAL DRY DENSITY (pcf)	NATURAL MOISTURE (%)	FINES (%)	ATTERBERG LIMITS PL	PI	LL	UNCONFINED COMPRESSIVE STRENGTH (psf)	SWELL INDEX (%)	WATER SOLUBLE SULFATES (%)	ADDITIONAL TEST RESULTS ATTACHED (SEE NOTE 2)	SOIL DESCRIPTION	UNIFIED SOIL CLASSIFICATION
8		14	CA	106.8	18.2									CLAY (severely weathered claystone bedrock), trace sand	CL
8		19	CA			98.7							GA	CLAY (severely weathered claystone bedrock), trace sand, brown to gray with orange	CL
8		24	CA			90.2							GA	CLAY (severely weathered claystone bedrock), trace sand, brown with orange	CL
8		29	CA	118.7	14.2		18	25	43					CLAY (severely weathered claystone bedrock), little sand, brown to gray with orange	CL
9		4	CA	102.8	22.6		20	19	39					FILL MATERIAL; consisting of clay, gravelly, some sand lenses, brown	CL
9		9	CA										PERM	FILL MATERIAL; consisting of clay, gravelly, some sand lenses, brown	CL

NOTE 1 - SAMPLE TYPE
AD - Air Dried
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CA - California Sample
HD - Hand Drive
SS - Standard Spoon
ST - Shelby Tube Sample
RM - Remolded Sample

NOTE 2 -ADDITIONAL TEST RESULTS ATTACHED
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C_4 - Pocket Vane
CI - Consolidation Test
GA - Gradation Analysis
PI - Proctor
SW - Swell-Consolidation Test
TT - Triaxial Test

PERM - Lab Permeability Tests (test results not available at this writing)

INGUIRRE ENGINEERS, INC.
Geotechnical and Materials Consultants

SUMMARY OF LABORATORY TEST RESUL

PROJECT NO. 18,023

TABLE 1

603613-00001711-054

615255

BORING NO.	SAMPLE NO.	DEPTH (FEET)	SAMPLE TYPE (SEE NOTE 1)	NATURAL DRY DENSITY (pcf)	NATURAL MOISTURE (%)	FINES (%)	ATTERBERG LIMITS PL	PI	LL	UNCONFINED COMPRESSIVE STRENGTH (psf)	SWELL INDEX (%)	WATER SOLUBLE SULFATES (%)	ADDITIONAL TEST RESULTS ATTACHED (SEE NOTE 2)	SOIL DESCRIPTION	UNIFIED SOIL CLASSIFICATION
9		14	CA			99.0							GA	CLAY (severely weathered claystone bedrock), trace sand, brown to gray with orange	CL
10		4	CA	99.0	26.8		22	26	48				PERM	FILL MATERIAL; consisting of clay, gravelly with severely weathered claystone bedrock fragments, gray to brown	CL
10		9	CA				20	26	46					CLAY, some gravel, some sand, dark brown to gray	CL
10		14	CA	116.6	12.5									CLAYSTONE BEDROCK, weathered, slightly calcareous, gray to brown	
11		4	CA			86.7							GA	CLAYSTONE BEDROCK, weathered, little sand, gray to brown	
11		9	CA	117.9	12.6									CLAYSTONE BEDROCK, weathered, trace sand, gray to brown	

NOTE 1 - SAMPLE TYPE
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HD - Hand Drive
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NOTE 2 -ADDITIONAL TEST RESULTS ATTACHED
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C_4 - Pocket Vane
CT - Consolidation Test
GA - Gradation Analysis
PT - Proctor
SW - Swell-Consolidation Test
TT - Triaxial Test

PERM - Lab Permeability Tests (test results not available at this writing)

AGUIRRE ENGINEERS, INC.
Geotechnical and Materials Consultants

SUMMARY OF LABORATORY TEST RESU

PROJECT NO. 18,023

TABLE 1 | PAGE 4 OF 5

615256

603613-00001712-054

BORING NO.	SAMPLE NO.	DEPTH (FEET)	SAMPLE TYPE (SEE NOTE 1)	NATURAL DRY DENSITY (pcf)	NATURAL MOISTURE (%)	FINES (%)	ATTERBERG LIMITS PL	PI	LL	UNCONFINED COMPRESSIVE STRENGTH (psf)	SWELL INDEX (%)	WATER SOLUBLE SULFATES (%)	ADDITIONAL TEST RESULTS ATTACHED (SEE NOTE 2)	SOIL DESCRIPTION	UNIFIED SOIL CLASSIFICATION
13		4	CA	111.4	16.1									CLAY, some sand, brown	CL
13		9	CA			94.8							GA	CLAY (severely weathered claystone bedrock), trace sand, brown	CL
14		4	CA	107.1	19.4		20	28	48					FILL MATERIAL; consisting of clay, gravelly, some severely weathered claystone bedrock fragments, gray to brown	CL
14		9	CA			84.4							GA	CLAY (severely weathered claystone bedrock), little sand, trace gravel, brown to gray with orange	CL
15		4	CA			67.7							GA PERM	CLAY, sandy, trace gravel, brown	CL
15		9	CA			70.1								CLAY, sandy, brown	CL
16		4	CA			58.3							GA PERM	CLAY, some sand, brown	CL-CH

NOTE 1 - SAMPLE TYPE
AD - Air Dried
AS - Auger Sample
BS - Bag Sample
CA - California Sample
HD - Hand Drive
SS - Standard Spoon
ST - Shelby Tube Sample
RM - Remolded Sample

NOTE 2 -ADDITIONAL TEST RESULTS ATTACHED
C_1 - Unconfined Compression
C_2 - Miniature Vane Shear
C_3 - Pocket Penetrometer
C_4 - Pocket Vane
CI - Consolidation Test
GA - Gradation Analysis
PT - Proctor
SW - Swell-Consolidation Test
TT - Triaxial Test

PERM - Lab Permeability Tests (test results not available at this writing)

AGUIRRE ENGINEERS, INC.
Geotechnical and Materials Consultants

SUMMARY OF LABORATORY TEST RESU

PROJECT NO. 18,023

TABLE 1

615257

6036 13-00001713-054

APPENDIX 3

TITLE II DESIGN SUMMARY AND CIVIL ENGINEERING DRAWINGS

TABLE OF CONTENTS

VOLUME I

SECTION 1 TITLE II DESIGN SUMMARY

INTRODUCTION	1-1
1.1 Scope	1-1
1.2 Purpose of Project	1-1
1.3 Location of Work	1-2
1.4 Design Criteria	1-2
1.5 Work Included	1-3
1.6 Component Checkout and Systems Operating Test Procedures	1-4
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SECTION 1
INTRODUCTION

1.1 SCOPE

This Title II Report provides the plans and specification for construction of facilities to implement the Building 881 Hillside Remedial Action Plan. This report expands upon information developed in the Title I, Preliminary Design Basis Document for the 881 Remedial Action Plan, dated 16 June 1988. The scope of the Title II report covers the design development of contract drawings and specifications, purchase specification for government furnished equipment, component checkout (cc) and system operations (so) test procedures, and a quality acceptance criteria checklist. A detailed cost estimate is included under separate cover.

1.2 PURPOSE OF PROJECT

The primary objective of the Building 881 Hillside Remedial Action Plan (Project) is to isolate, collect, treat and re-inject ground water contaminated with a variety of volatile organic compounds. A conceptual design for the project has been developed as a result of Remedial Investigation/Feasibility Study (RI/FS) procedures. A Health Risk Assessment performed in conjuction with the RI/FS concluded that a small but identifiable health risk to the public would occur in the future if no remedial action was performed at the site. Implementation of the recommended remedial action will eliminate the future risk and result in the removal of the contaminants identified as contributing to the risk.

Preliminary process design and selection was performed as a part of the RI/FS and subsequently verified through independent treatability studies initiated by Rockwell and performed by a manufacturer of the selected system. The selected process for treatment of the volatile organics is an ultraviolet light (UV)/hydrogen peroxide (H_2O_2) system and is discussed in detail in the referenced RI/FS.

The Title I report included preliminary design of a french drain ground water interceptor system, sumps and sump pumps, installation and equipping of interceptor well 1-88, influent piping, modification of exising building 830 to accomodate the treatment unit, erection of a combination storage tank/secondary containment pad, storage tanks for the influent and effluent, and an effluent re-injection system.

This Title II report completes the design of the remedial facilities and presents drawings and specifications suitable for bidding by qualified contractors.

1.3 LOCATION OF WORK

The location of this work is the 881 Hillside area. This area lies immediately south and east of the Building 881 near the perimeter of the plant site. The UV/hydrogen peroxide treatment unit will be located within Building 830 which formerly housed the Building 881 Isolated Power System. The storage tanks and tank pad will be located adjacent to Building 830 as an extension of the existing loading dock. The french drain ground water collection system and the re-injection trench will be located several hundred feet south of Building 881 on the hillside. The floor elevation of Building 830 is approximately 5,978.5 feet above mean sea level. The french drain and re-injection are approximately 60 to 85 feet lower in elevation.

1.4 DESIGN CRITERIA

The Title II Design Document conforms to all preliminary requirements as stated in the Preliminary Design Basis Document dated 16, June 1988, RI/FS Volume I dated 1 March 1988, and the Design Criteria for Remedial Action 881 Hillside, Volume 3 dated 31 May 1988. Modification to the preliminary design were made during final design. Those changes are discussed below. The design information contained in this document represents requirements as described in Volumes 1 and 2 of the Design Criteria Manual for the Rocky Flats Plant.

1.5 WORK INCLUDED

A new and functional ground water collection, treatment and re-injection system is provided. The treatment process is housed in Building 830 which has been modified to accommodate the unit. Work covered in the construction documents inlcude:

(a) Approximately 1,800 linear feet of french drain ground water interceptor trench;

(b) Two french drain collection wells and dual well pumps to pump the collected ground water to the influent storage tanks;

(c) A collection well and dual well pumps to collect drainage from the Building 881 foundation footing drain;

(d) A new interceptor well, 1-88, approximately 36 inches in diameter with a 12-inch casing and approximately 20 feet in depth equipped with a submersible well pump;

(e) Piping to connect the facilities described in items (a) through (d) above to the influent storage tanks;

(f) Four tanks located in a reinforced concrete pad and secondary containment structure. Two of the tanks shall be used as influent storage tanks and two shall normally be used for effluent storage. Provisions have been made to use all four tanks for effluent storage;

(g) Influent pumping to the treatment unit from the storage tanks;

(h) UV/hydrogen peroxide pre-engineered treatment system complete with control unit;

(i) Modifications as required to Building 830 to house the treatment unit, hydrogen peroxide feed unit and a small utility area of approximately 144 square feet;

(j) Effluent piping to deliver the treated water to the infiltration gallery; and

(k) A ground water infiltration gallery downgradient of the french drain system.

1.6 COMPONENT CHECKOUT AND SYSTEMS OPERATING TEST PROCEDURES

Component checkout (CC) test procedures have been defined for each item of work. These requirements appear in a "Field Quality Control" paragraph in the Part 3 - Execution section of each technical specification section. Detailed systems operating (SO) test procedures have been prepared for the new collection, treatment and re-injection system as a part of this final design effort. The Contractor's responsibilities and building operations responsibilities during system operating tests are clearly defined in the technical specifications.

1.7 REGULATORY COMPLIANCE

The contract specifications for construction are consistent with Federal Statutes, Regulations and Interpretative Rules; and specifically reference the Contractor's responsbilities to partcipate in components of the Remedial Action Process, as described in Superfund Remedial Design and Remedial Action Guidance, OSWER Directive 9355.0-4A, June 1986. Upon completion of construction the Contractor shall be required to participate in required activities including: the Prefinal Construction Conference, the Prefinal Inspection and Final Inspection and Certification.

The Buyer shall provide a full time onsite inspector with expertise in federal construction projects and proceedings.

BASIS FOR DESIGN

1.8 GENERAL

1.8.1 Design Documents

The documents listed below form the basis for the Facilities Engineering design of the Building 881 Remedial Action Plan:

(a) Design Criteria Manual, Volumes 1 and 2, Rocky Flats Plant.

(b) Design Criteria for Remedial Action 881 Hillside, Rocky Flats Plant, Volume 3.

(c) Feasibility Study Report for High Priority Sites, (881 Hillside Area) Volume I.

(d) Preliminary Design Basis Document for the 881 Hillside Remedial Action, Engineering-Science, Inc.

(e) Rocky Flats Plant Standards Manual, Volumes I, II, and III.

1.8.2 Quality Assurance

This design incorporates applicable regulatory requirements and design basis for structures, modifications, additions, systems and components such that they are correctly translated into specifications, drawings, procedures and instructions. The following are those attributes included in the design:

(1) Facilitate inspectability of equipment during fabrication, shipping, construction, testing, operation and maintenance modes;

(b) Performance and acceptance criteria;

(c) Monitoring instrumentation and control requirements including instruments, controls, and alarms required for operating, testing and maintenance of the facility and process equipment;

(d) Accomodations for equipment handling, protection, storage, and shipping;

(e) Optimization of maintainability/serviceability of equipment;

(f) Specify material requirements including such items as compatibility, electrical insulation properties, protective coating and corrosion resistance;

(g) Material traceability through drawing and/or specification callouts, and;

(h) Personnel safety, and protection of economic investment.

The Quality Acceptance Criteria Checklist is included as Section 5 of this document.

1.8.3 Design Requirements/Codes and Standards

All facilities are designed and sized for operation at the site elevation of approximately 6,000 feet above mean sea level. Facilities design has considered the impact of committing the use of existing Building 830 to the Building 881 Remedial Action Plan and its impact on future site utilization.

The facilities have been designed with regard to the following codes and standards as they apply:

(a) ACI - American Concrete Institute

(b) AISC - American Institute of Steel Construction

(c) ANSI - American National Standards Institute

(d) ASTM - American Society for Testing and Materials

(e) AWS - American Welding Society

(f) AWWA - American Water Works Association

(g) IEEE - Institute of Electrical and Electronics Engineers

(h) IPCEA - Insulated Power Cable Engineers Association

(i) ISA - Instrument Society of America

(j) NEC - National Electric Code

(k) NEMA - National Electrical Manufacturers Assoc.

(l) OSHA - Occupational Safety & Health Act of 1970

(m) UBC - Uniform Building Code

(n) UPC - Uniform Plumbing Code

(o) U/L - Underwriters Laboratory

1.8.4 Special Considerations

1. Contamination Control. The Contractor has been instructed that all excavated materials shall be handled in such a manner to minimize contaminant dispersion via aeolian dispersion or leaching. No excavated materials will be transported or stored downgradient of the proposed french drain. He is instructed to place it as a surface fill in the area of known contamination. Prior to excavation, soils will be wetted to a moisture content exceeding optimum moisture as defined by Standard Proctor Compaction Testing, ASTM D-698. In general, during handling, the excavated materials will be thoroughly wetted but will not contain moisture to the extent which would interfere with the Contractor's handling equipment. Excavated materials in stockpiles will be immediately stabilized by covering or other approved means immediately upon conclusion of work at that particular stockpile. During final placement of waste excavated material the surface will be stabilized by compaction and such covering as may be necessary so that aeolian dispersion is minimized. No earthwork will be permitted during periods in which the wind velocity exceeds 30 mph. Long-term erosion protection will be provided by seeding and irrigation as required or other means approved by the Buyer. Irrigation will not begin until after the french drain and treatment unit are functional. Earthwork operations will be planned and conducted in a manner to promote maximum handling efficiency. Materials will be immediately placed and compacted after initial excavation where practicable.

   The concrete base supporting the influent storage tanks has been designed to provide secondary containment with a capacity greater than the volume of one tank.

Any excavated materials, as determined by the Buyer's Health Physics representative (Radiation Monitor) exceeding the criteria for placement as fill will be immediately segregated from other uncontaminated materials and placed in containers provided by the Buyer. The Buyer shall arrange for removal and disposal of these containers.

2. Safety Requirements. The Contractor is instructed to conform to Chapter 1 of DOE Order 5480.1, "Environmental Protection, Safety, and Health Protection Standards" and National Fire Protection Association (NFPA) No 241, "Safeguarding Building Construction and Demolition Operations". All visitors and construction personnel are required to adhere to all regulations and receive indoctrinations which pertain to them.

3. Safeguards and Security. Construction of these facilities will be performed in compliance with the established Rocky Flats Plant Security Program. Most of this project is not located in a secured area. Unless the successful bidder can provide "Q" cleared personnel to perform all work within the 881 Security Area, the Buyer shall provide Guard Escorts during all operations within the 881 Security Area.

   The Contractor will obtain an approved "Land Use Request" for access control prior to entry into the buffer zone in accordance with HSE 20.01.

4. Health, Safety, and Environment. The Contractor is required to adhere to the procedures established in the Rocky Flats Plant Health, Safety, and Environment (HS&E) Manual, and the Plant Policy Manual where applicable. In particular, the Contractor is required to adhere to Plant Policy HMS 3-050, which requires that all personnel allowed on the plant site participate in applicable radiation exposure measurement programs. All personnel

working on the project are required to be fully briefed on HS&E rules and regulations that must be followed on the project and are required to attend all applicable safety training indoctrinations.

The Specifications explicitly reference appropriate worker health and safety standards.

The Specifications include a site safety plan, in accordance with HSE 24.01.

A full time Radiation Monitor will be provided by the Buyer during all excavation.

5. Operation Interruptions. The Contractor is required to perform all service and utility disconnects and tie-ins during normal working hours, insofar as it is practicable. The Contractor is required to schedule disconnects and tie-ins to minimize downtime and interruptions to other facilities, and is required to schedule all work with Buyer prior to the start of work.

1.9 REMOVALS

The following removals are detailed in the Drawings and Specifications in support of implementation of the Building 881 Hillside Remedial Action Plan:

(a) The entire floor, including equipment mounting pads, will be removed in Building 830 in order to facilitate installation of new facilities. A new floor and equipment pads will be constructed.

(b) Abandoned wires and cables in existing conduit runs in Building 830 will be removed in order to facilitate installation of new cables and wires into conduits to support electrical requirements.

1.10 PROCESS DESIGN

The treatment process has previously been selected as UV/Hydrogen Peroxide. Rockwell has confirmed this process as appropriate for the destruction of volatile organics contained in the contaminated ground water. Two manufacturers will be asked to submit bids under a Government Furnished Equipment (GFE) specification and the equipment selected will be installed by the Contractor. The GFE specification is the subject of Section 3 of this document.

1.11 CIVIL DESIGN

1.11.1 General

The civil engineering design encompassed the construction of the french drain system, the infiltration gallery, collection well 1-88, and interconnecting pipelines in addition to minor earthwork at the site. The following sections provide clarification of these items.

Finished grades will be as close as practicable to the existing.

All buried pipes and utilities shall be protected from future mechanical damage by buried warning tapes.

Final plans and specifications require the installation of physical surface monuments at significant points along all buried structures. They shall include: end points, points of curvature, tangent points, and the location of branches.

Final plans and specifications include compaction specifications for all fill materials including waste fill, drain rock, pipe bedding, and filters.

All surfaces within the required excavation limits will be cleared and grubbed. The top 12" of soil will be stripped and stockpiled uphill of the proposed french drain in an area not proposed for fill placement. This topsoil shall be used for reclamation of surface areas within the zone of expected

ground water and soil contamination (upgradient of the french drain).

1.11.2 French Drain

The french drain shall be excavated so that it penetrates at least 2' of continuous (uninterrupted by permeable members) claystone bedrock. Permeable bedrock members encountered in the french drain excavation shall not be considered in determination of the design depth. The downstream face of the drain and exposed bedrock surfaces shall be lined with an impermeable synthetic membrane. The impermeable membrane shall be designed to prevent communication between exposed bedrock members and to limit flow beyond the drain during periods of high discharge or if mechanical failure of the pump system is experienced. Slush grouting of the exposed bedrock surfaces shall be preformed if it is determined during construction that faults exist in the bedrock members. A 6" diameter perforated drainpipe shall be installed at or near the bottom of the drain. The drainpipe and upstream face of the drain shall be protected with a geotextile filter, as appropriate. A collection sump shall be provided at the low point of the drain. The design depth of the sump was selected to provide sufficient storage to produce pumping cycles compatible with the mechanical equipment selected.

1.11.3 Well 1-88

Well 1-88 shall be approximately 20 feet deep. The well hole shall be logged during drilling by an experienced engineering geologist or geotechnical engineer to document the lithology. The well shall be at least 36" in diameter to impermeable bedrock and 16" in diameter for an additional 5 feet. It shall be cased for its full length with 12" diameter stainless steel well casing, capped at the bottom and provided with surface sanitary seals and completion details. The well shall have a screened interval extending between the bottom of the pitless adaptor and the bedrock surface. The well shall be

ground water and soil contamination (upgradient of the french drain).

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The french drain shall be excavated so that it penetrates at least 2' of continuous (uninterrupted by permeable members) claystone bedrock. Permeable bedrock members encountered in the french drain excavation shall not be considered in determination of the design depth. The downstream face of the drain and exposed bedrock surfaces shall be lined with an impermeable synthetic membrane. The impermeable membrane shall be designed to prevent communication between exposed bedrock members and to limit flow beyond the drain during periods of high discharge or if mechanical failure of the pump system is experienced. Slush grouting of the exposed bedrock surfaces shall be preformed if it is determined during construction that faults exist in the bedrock members. A 6" diameter perforated drainpipe shall be installed at or near the bottom of the drain. The drainpipe and upstream face of the drain shall be protected with a geotextile filter, as appropriate. A collection sump shall be provided at the low point of the drain. The design depth of the sump was selected to provide sufficient storage to produce pumping cycles compatible with the mechanical equipment selected.

1.11.3 Well 1-88

Well 1-88 shall be approximately 20 feet deep. The well hole shall be logged during drilling by an experienced engineering geologist or geotechnical engineer to document the lithology. The well shall be at least 36" in diameter to impermeable bedrock and 16" in diameter for an additional 5 feet. It shall be cased for its full length with 12" diameter stainless steel well casing, capped at the bottom and provided with surface sanitary seals and completion details. The well shall have a screened interval extending between the bottom of the pitless adaptor and the bedrock surface. The well shall be

grouted for its entire length below top of bedrock with neat cement grout containing additives to prevent shrinkage.

1.11.4 Infiltration Gallery

The infiltration gallery has been designed to re-inject treated ground water into the shallow aquifer immediately downgradient from the french drain system. The gallery will generally consist of an excavated trench, lined with a porous geotextile and backfilled with drain rock. Within the drain rock a 6" perforated drainpipe will be installed. The total length of the infiltration gallery was based upon the need to re-inject all of the ground water potentially extracted from the french drain system and therefore is as long as the french drain system with an appropriate factor of safety involved to account for system and soil variances. The system consists of a multiple pipes network.

1.11.5 Collection Sumps

Collection sumps are located on the french drain system and the Building 881 foundation footing drain system. The sumps shall consist of pre-cast concrete sumps suitable for installation of dual submersible pumps and shall have hinged lids with locking hasp.

1.12 ARCHITECTURAL DESIGN

The UV/hydrogen peroxide treatment system will be housed in existing Building 830. This building was previously used to house the Building 881 Isolated Power System. A sheltered storage area was subsequently erected adjacent to this facility to store gas bottles. The facility is now used as a storage shed and all previous mechanical equipment has been removed. As directed, the existing building was assumed to meet all existing design codes and standards for roof, floor and seismic loading and appropriate wind loads. The existing floor and equipment mounting pads will be removed. The new floor and equipment mounting pads have been designed for anticipated loads.

Remodeling consists of building an office/utility facility at one end of the existing building. This room will have an approximate area of 144 square feet and will be insulated and heated. The remainder of the building will house the treatment unit and hydrogen peroxide feed unit. The office/utility area will include a utility sink, an electric unit heater, a ventilator, and emergency eye wash/shower and a work bench and storage shelves. A new door and window will be installed into the treatment area and a new door will be installed to the exterior. The double door entrance to the existing building will be retained as the main entrance to the treatment area. The office/ utility space will have insulated walls and ceiling with an R factor of 11. Cold water will be supplied to the laboratory space and electrical outlets will be supplied as appropriate. A sump shall be provided in the treatment area with pump discharge directed to one of the contaminated water influent tanks. Drainage from the utility sink facility will be routed to the nearest sanitary sewer. The safety shower/eye wash station has been designed in accordance with Rocky Flats Plant Standard SMU 101 and HSE 7.04.

1.12.1 Utility and Equipment Supports

Supports and anchorages for items such as pipes and electrical conduits and equipment are provided as required. All supports are designed for the appropriate dead and live loads.

1.12.2 Finishes

Existing exterior building finishes and interior finishes in the treatment plant area will not be altered as a part of this work. Areas damaged by construction activities will be repaired in like and kind materials and finish. The new office/utility walls will consist of steel stud construction finished with 5/8 inch wall board sealed and primed and given two coats of an appropriate interior finish with color to be selected by Building Operations. Interior cabinetry will be given two coats of an appropriate white enamel paint. Metal, i.e. doors, shall be cleaned, primed and given two coats of

paint consistent with environment and use. The floor of the laboratory area will be finished with floor tile.

1.13 STRUCTURAL DESIGN

Structural design elements of the work involve primarily the tank storage pad and secondary containment structure. The tank storage pad consists of spread footing foundations and pad to distribute overall loading within design guidelines as prescribed by the geotechnical design report. The pad will support four 15,000 gallon tanks. The pad will have side walls to act as a secondary containment for the contents of one tank. The design is consistent with current practice and standards.

Concrete reinforcement is designed and will be placed in accordance with Chapter 7 of ACI Standard 318. Reinforcement bars conform to American Society for Testing and Materials (ASTM) A-615.

1.14 MECHANICAL DESIGN

1.14.1 General

Mechanical design will include storage tanks, the treatment facility specification, hydrogen peroxide feed system specification (as a part of the GFE), the french drain sumps, Building 881 foundation footing sump, well 1-88 and influent transfer pumps to the treatment unit.

1.14.2 Storage Tanks

Four tanks will be provided near the treatment unit. Two tanks shall be influent storage tanks and two shall provide effluent storage. The use of insulation on immersion heaters for these tanks has been included to prevent freezing. Horizontal ASME welded steel tanks have been selected and sized at 15,000 gallons each (9 feet in diameter by approximately 32 feet shell length.).

1.14.3 Treatment Plant and Hydrogen Peroxide Feed System

Refer to Section 3 for the Specification of these items.

1.14.4 Well 1-88

Well 1-88 will be provided with a submersible well pump of approximately 1/3 HP with a approximate 1" diameter riser pipe. The well shall be provided with a "pitless adapter" and the installation shall provide for replacement or servicing of the pump and motor. The pump selected is capable of delivering the total well capacity to the influent storage tanks.

1.14.5 Sump Pumps

The french drain collection sump shall be provided with two submersible sump pumps, each with sufficient capacity to deliver the entire discharge of the french drain to the treatment unit. The pumps will have level switches set so that one pump functions as a backup unit. Pumps will be equipped with fittings so that they may be removed for servicing or replacement without entering the sump.

The Building 881 foundation drain collection sump shall be mechanically equipped similar to the french drain collection sump.

All collection structures shall be equipped with totalizing flow meters with surface readouts mounted above the ground surface.

1.14.6 Influent Transfer Pumps

The influent tanks and piping is equipped with two floor mounted end suction centrifugal transfer pumps designed to transfer contaminated influent from the storage tanks to the treatment unit. The pumps are controlled from the treatment unit control panel and set so that one pump functions as a standby.

1.14.7 Building 830 HVAC

Building 830 HVAC system is designed to provide two zones compatible with the occupancies of both rooms. The treatment

unit room is designed in accordance with the recommendations of the treatment equipment manufacturer. The office/utility space is insulated separately from other interior space. The office/utility room will maintain a minimum temperature of 69°F with a ventilating fan for summer use.

The treatment unit bay will not be heated. Ventilation is provided by the existing ventilation louvers located above the existing double door entry.

1.15 PIPING

1.15.1 General

Piping covered under this section includes influent piping from the sumps to the influent storage tanks, piping to and from the storage tanks, piping from the effluent storage tank to the infiltration gallery and process and utility piping interior to Building 830.

1.15.2 Influent Piping

All below grade piping installed outside the known area of contamination (approximately 500 feet upgradient of the french drain) used to convey contaminated water to the influent storage tanks is double wall containment pipe. Each collection sump (not including the Building 830 sump) is equipped with a check valve, a manual shutoff valve and a frost proof hydrant installed within five feet of the facility to allow sampling. In addition each sump in the collection system is equipped with a totalizing flow meter with above ground readout/indication on the sump pump control panel.

1.15.3 Transfer Piping

Transfer piping to and from the storage tank area and the treatment facility is single wall PVC solvent welded pipe below grade. Above grade pipe is galvanized steel which is heat traced to prevent freezing.

1.15.4 Effluent Piping

Piping from the treated effluent storage tank to the infiltration gallery is single wall below grade PVC pipe sized to accomodate expected peak flow. Above grade pipe is galvanized steel.

1.15.5 Utility Piping

Utility piping internal to Building 830 is sized to accommodate required flows. Below grade utility water piping is galvanized steel with a shutoff located inside the laboratory area. All utility water piping located within Building 830 is copper with soldered joints. Utility piping from the sump and drains to the influent tank is PVC.

1.16 ELECTRICAL

1.16.1 General

An electrical power supply system design is provided for the new treatment facility and the sump and well pumps. All electrical equipment is suitable for operation at 6,000 feet elevation. All electric installation meets current (latest edition) National Electric Code (NEC). New power lines are installed to supply power to Building 830. New conduits are run in an orderly manner and grouped in banks wherever possible. Conduit is steel with appropriate fittings and connections.

1.16.2 Power Sources

Power for the new treatment unit will be obtained from within Building 881, designation SWGR81-2. New conduit will be run from this panel to Building 830. An existing conduit and cables currently provide power to the Building 830 lighting panel and appears to be adequate for building utility lighting and power receptacles. This system will remain in service.

Power for collection stations will be provided through buried cables from Building 830.

1.16.3 Motors

All motors are rated at 6,000 feet above mean sea level and are provided with an insulation Class B or F. Motors have a minimum rated service factor of 1.15 and are selected based upon intended use and type of service. Motors smaller than I HP are furnished with lubricated for life bearings. Motors used with pumps are provided as an integral assembly with the pump under a single supplier responsbility. Compatibility of pumps and motors are the responsibility of the single supplier.

1.16.4 Lighting and Receptacles

Power for lighting and receptacles will be provided as described in Section 2.9.2. Existing flourescent lighting in Building 830 will be rearranged and removed as required to support the treatment plant installation and the new laboratory area. Likewise, existing receptacles will be rearranged or removed to accomodate new facilities. Receptacles are equipped with ground fault interrupters.

1.16.5 Grounding

A grounding conductor will be pulled through all conduits per Rocky Flats Standard SE-103, "Electrical Wiring". The new treatment system will be grounded to the existing Building 830 grounding system.

1.16.6 Wiring and Identification

Wiring will be in accordance with Rocky Flats Standard SE-103, "Electrical Wiring". Electrical systems will be identified in accordance with Rocky Flats Standard SE-104, "Identification of Electrical Systems". Wire markers will be provided at the ends and intermediate pull boxes and junction boxes of each single conductor; multiconductor cable jacket and each individual conductor; shielded cable jacket; and multicable jacket and each individual cable. Each wire marking will be

unique and of a developed system which may be carried throughout the entire building facility.

1.17 ALARMS AND INSTRUMENTATION

1.17.1 General

Instruments are industrial grade equipment from established manufacturers; state of the art type instruments are provided. Selection of instruments was based on maintainability, provisions for field calibration, flexible operating characteristics, and materials of construction.

In general, high level alarms are provided on all tanks and malfunction alarms are provided for all pumps.

1.17.2 Treatment Plant Control Panel UCP-1

The UV/hydrogen peroxide treatment unit is provided with a Unit Control Panel which provides for complete operation and control of the treatment plant functions in accordance with the manufacurers requirements and includes: high temperature alarms and shutoffs for the reactor vessel and lamp drive unit, temperature gauges for the reactor vessel and lamp drive unit, high pressure shutoff and alarm for the reactor vessel and pressure gauge for the reactor vessel, a lamp drive moisture indicator and shutoff, a low flow indicator and shutoff, high and low water level (from probes in the influent tanks) alarm and shutoff, a high water level alarm and shutoff (from a probe in the effluent tank), integrated transfer pump control and hydrogen peroxide feed unit control, run time indicator, instantaneous and totalizing flow indicator, amperage and on/off switches for each lamp or banks of lamps, an adjustable flow control valve, and a solenoid shut-off valve. UCP-1 is also equipped with a tank selector switch indicating which influent tank is being used (manually selected by the operator) and connecting the appropriate probes to the alarm and shutoff circuits. Refer to Section 3 for unit specifications.

1.17.3 Hydrogen Peroxide Unit Control Panel UCP-2

The hydrogen peroxide feed control unit is operated and controlled from the treatment plant unit control panel, UCP-1. Individual on/off/auto switches are provided for each metering pump. In the auto mode, control will be from UCP-1. Refer to Section 3 for equipment specifications.

1.17.4 Building 830 Control Panel MCC-1

The main control center for Building 830 will include a main power switch and switches for UCP-1 and UCP-2 in addition to switches for the transfer pumps, office unit heater and fan motor and Building 830 sump pumps.

1.17.5 Sump Pump Control Panels

Each collection sump pump shall be equipped with an above ground control panel with an on/off/auto switch. Also included in the remote control panel will be the flow totalizer. Collection sump pumps will be configured to be selectable between active and standby. The active pump shall be controlled by level sensors, with a low water shutoff and a high water on. The control panel will be housed in a NEMA 3R weather tight enclosure.

1.17.6 Well 1-88 Control Panel

The control panel for well 1-88 shall be similar to that described for the sump pumps in Section 2.10.5, except that only one submersible pump will be installed and hence no active/standby switching is necessary. Pump operation shall be controlled by a low water shutoff and a high water on probe installed in the well casing.

1.17.7 Building 830 Sump Pumps

The sump in Building 830 shall be controlled similar to those described in Section 2.10.5 except that the control panel shall be mounted in conjunction with MCC-1 in Building 830 and no flow indication will be provided.

1.17.8 Tank Level Indication and Pump Alarm Panel MCP-1

The two influent storage tanks shall be equipped with both high and low water level probes. The probes shall provide a high and low water signal to MCP-1 and UCP-1 respectively, and, depending upon which tank is selected at UCP-1, shall provide a low water (unit shutoff) signal at UCP-1 or a high water (alarm) signal at MCP-1. The effluent tanks will be equipped with a high water probe to be connected to UCP-1 and MCP-1 and shall provide a high effluent level alarm and signal equipment shutdown. Additionally, a conductive strip level element and level indicator will be provided for each tank with the indicators mounted on MCP-1. Sump and well pump malfunction will be sent via buried cable to MCP-1 with indicators signaling the location of the alarm. All alarm signals will activate an automatic rotary type telephone dialer to alert the appropriate personnel of the alarm condition.

1.18 FIRE PROTECTION

Fire protection for Building 830 and the laboratory area is provided by installation of two 25 pound dry chemical type extinguishers, wall mounted, in the treatment unit area and in the laboratory area.

All mandoors are provided with illuminated exit signs in accordance with Rocky Flats Plant Standard SE-204.

The building is noncombustible construction throughout and will normally be unoccupied. Combustible contents, other than minimal necessary files and records, shall not be maintained within the building.

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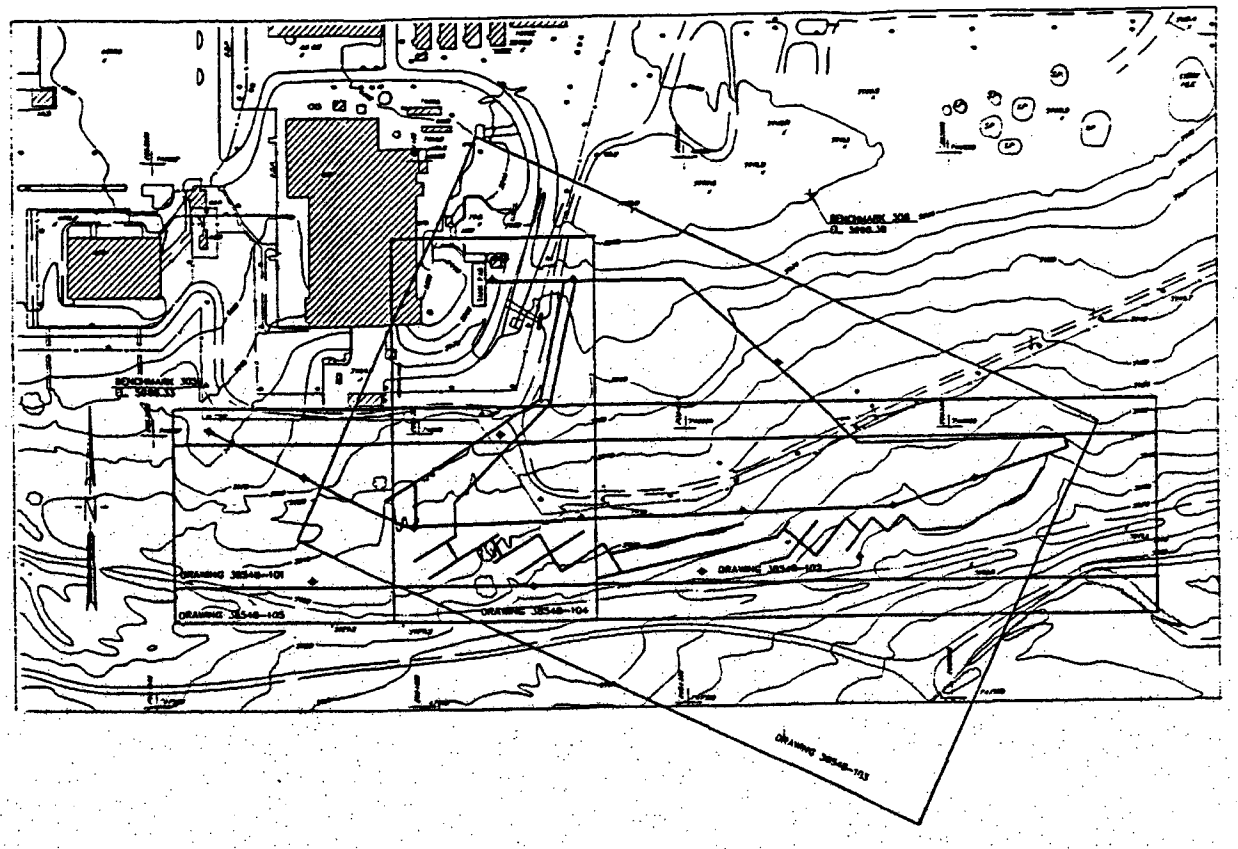

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881 Hillside Remedial Action

General Site Plan

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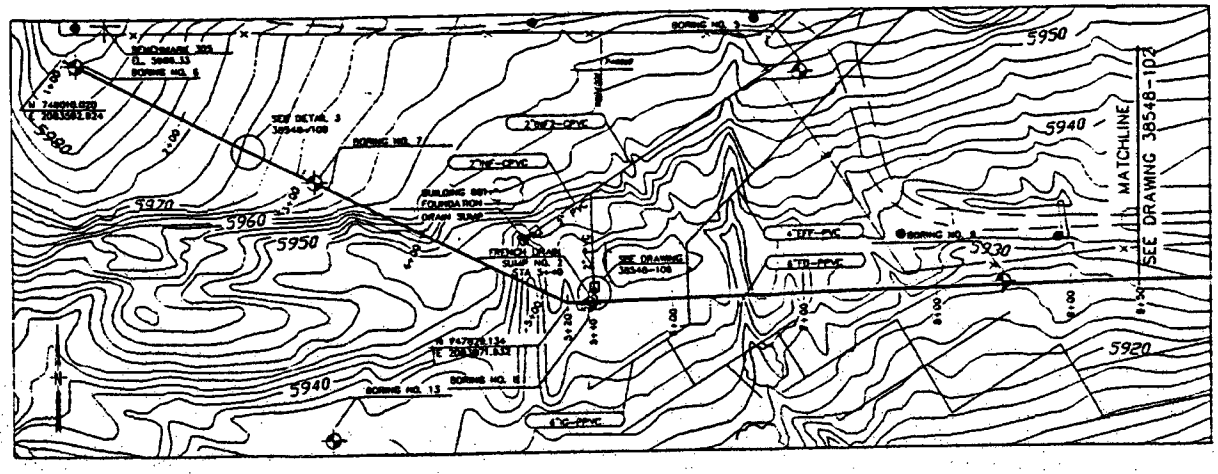
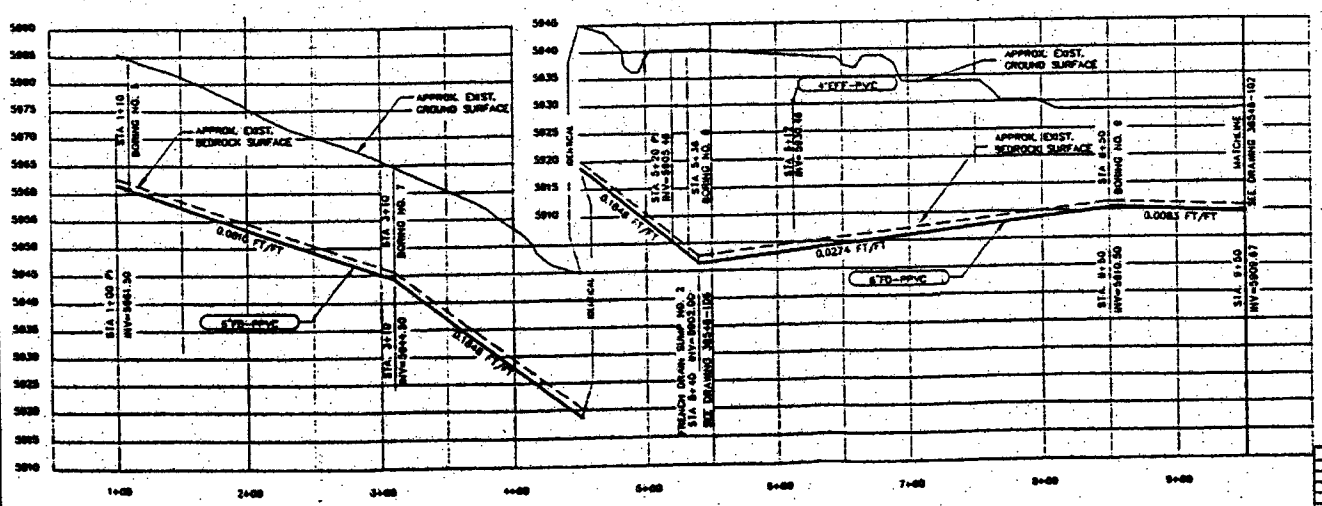




40 FEET

FOR TITLE & REVIEW NOT FOR CONSTRUCTION

A	ORIGINAL ISSUE		

ENGINEERING-SCIENCE
Denver, Colorado

ES

SST

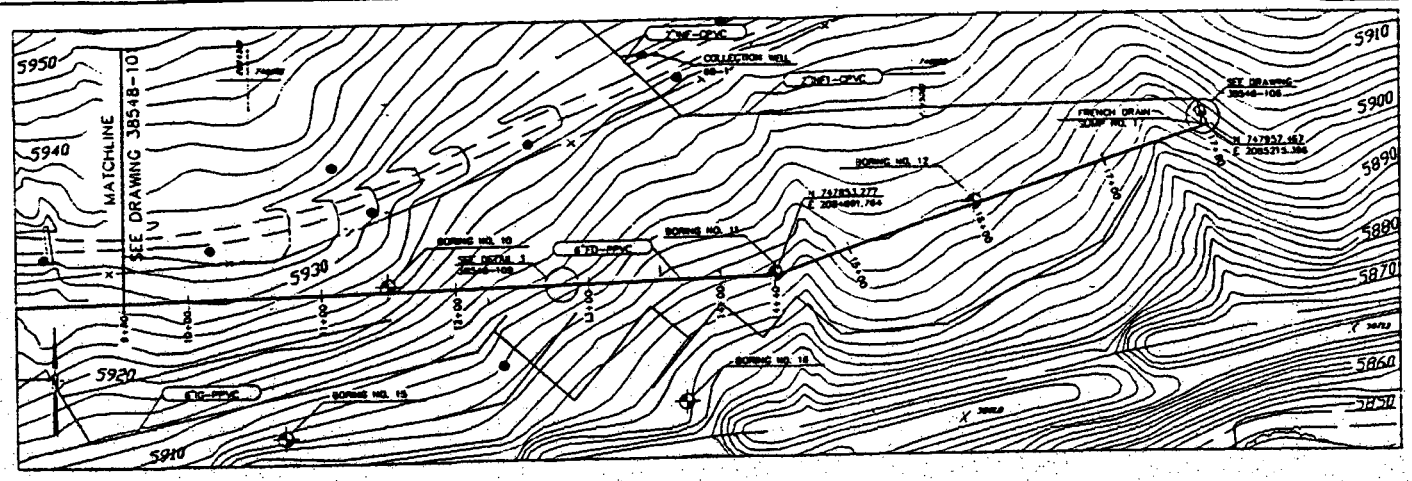
601 Hillside Removal Action
French Drain Plan/Profile
Station 1+00 to Station 9+50

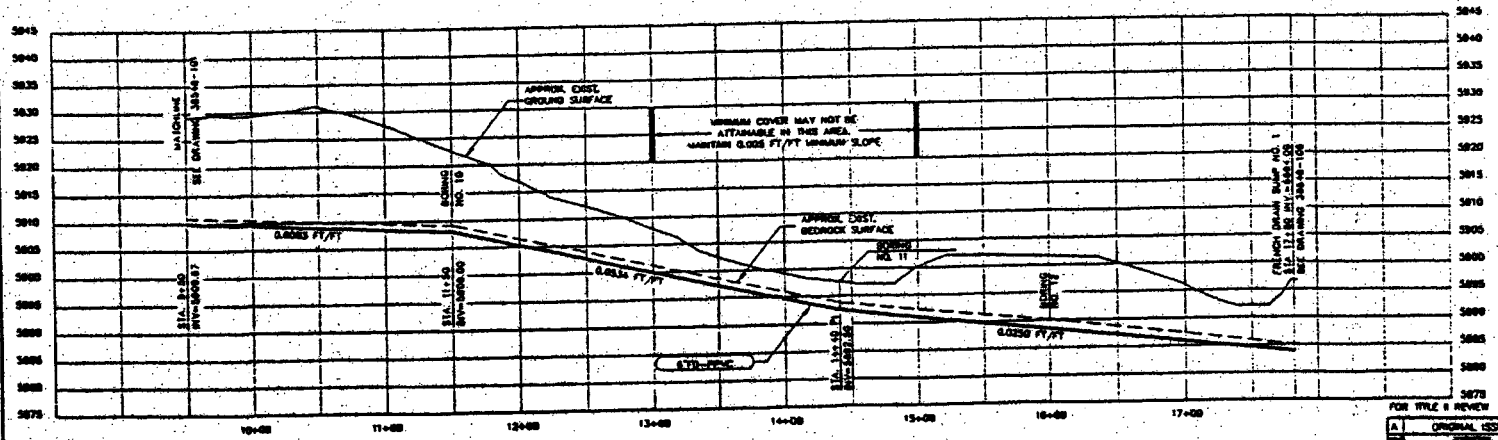
D 38548-101 | 9 of 35

COMPUTER GENERATED DRAWING NO MANUAL CHANGES ALLOWED

615282

603613-00001739-054





FOR TITLE II REVIEW NOT FOR CONSTRUCTION

ENGINEERING-SCIENCE
Denver, Colorado

ORIGINAL ISSUE

U.S. DEPARTMENT OF ENERGY
ROCKY FLATS FIELD OFFICE, GOLDEN, COLORADO

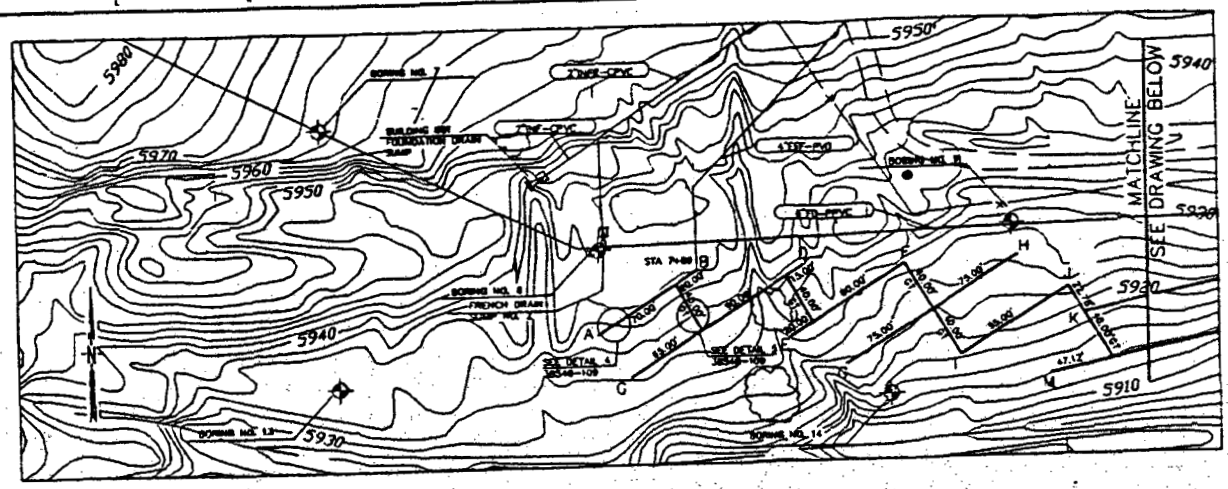
881 Hillside Removal Action
French Drain Plan/Profile
Sta. 9+50 to 17+60

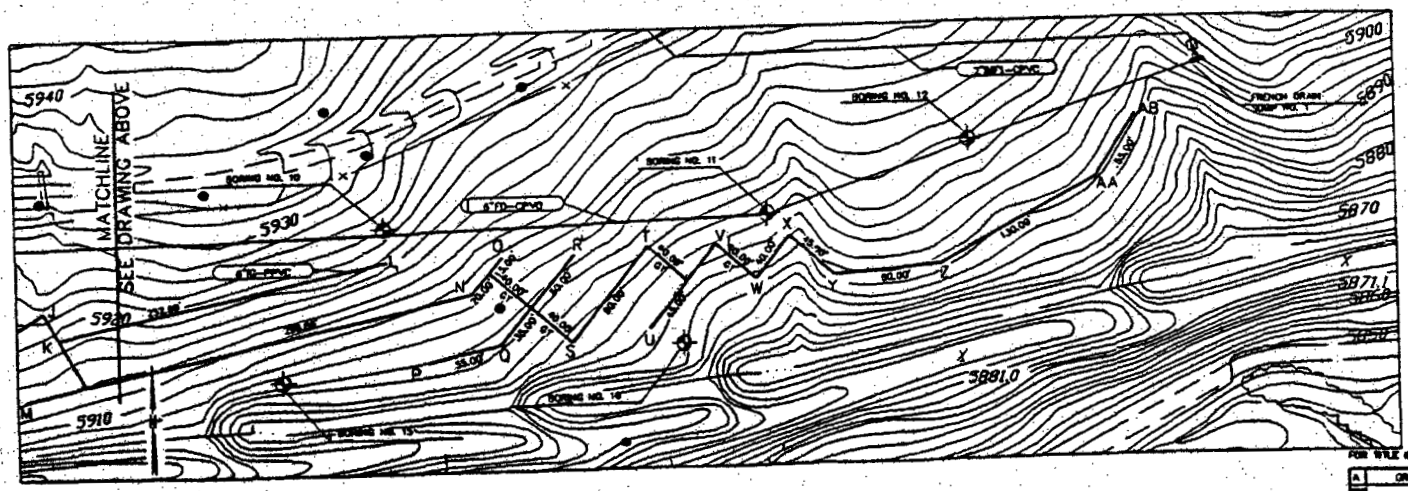
D 38548-102 | 10 of 35

COMPUTER GENERATED DRAWING NO MANUAL CHANGES ALLOWED

615283

603613-00001740-054





POINT NO.	COORDINATES NORTHING	EASTING	INVERT
A	747,785.161	2,083,987.714	5929.00
B	747,811.314	2,084,084.320	5929.00
C	747,733.449	2,084,012.082	5924.00
D	747,813.289	2,084,144.923	5924.00
E	747,788.987	2,084,135.523	5921.00
F	747,812.471	2,084,225.240	5921.00
G	747,738.556	2,084,177.344	5916.00
H	747,848.812	2,084,388.179	5916.00
I	747,743.897	2,084,282.443	5912.00
J	747,792.826	2,084,343.874	5912.00
K	747,773.298	2,084,395.608	5912.00
L	747,825.674	2,084,602.864	5912.00
M	747,779.213	2,084,338.129	5903.00
N	747,808.735	2,084,686.604	5903.00
O	747,827.367	2,084,689.314	5903.00
P	747,781.932	2,084,633.508	5898.00
Q	747,783.387	2,084,687.307	5898.00
R	747,828.044	2,084,742.469	5898.00
S	747,784.045	2,084,740.453	5891.00
T	747,832.528	2,084,794.804	5891.00
U	747,777.138	2,084,800.088	5888.00
V	747,833.394	2,084,891.987	5888.00
W	747,837.250	2,084,892.433	5883.00
X	747,837.688	2,084,906.398	5883.00
Y	747,886.488	2,084,942.529	5883.00
Z	747,814.828	2,085,022.377	5883.00
AA	747,873.635	2,084,138.162	5883.00
AB	747,828.085	2,085,168.081	5883.00

FOR TITLE & REVIEW NOT FOR CONSTRUCTION

A	ORIGINAL ISSUE		

ENGINEERING-SCIENCE
Denver, Colorado

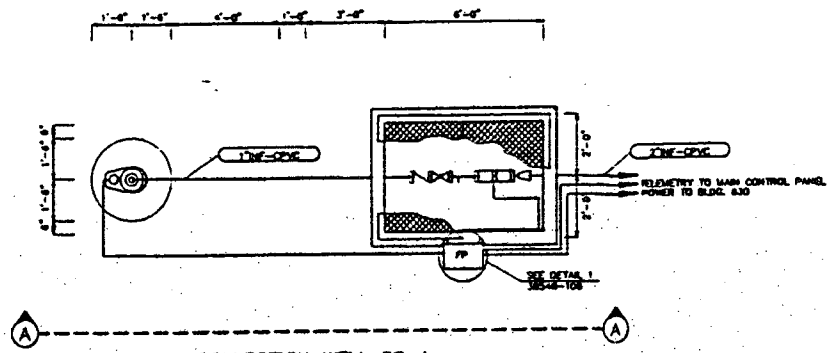
681 Hillside Remedial Action
Infiltration Gallery Plan/Profile

D 38548-105 | 13 of 35

COMPUTER GENERATED DRAWING NO MANUAL CHANGES ALLOWED

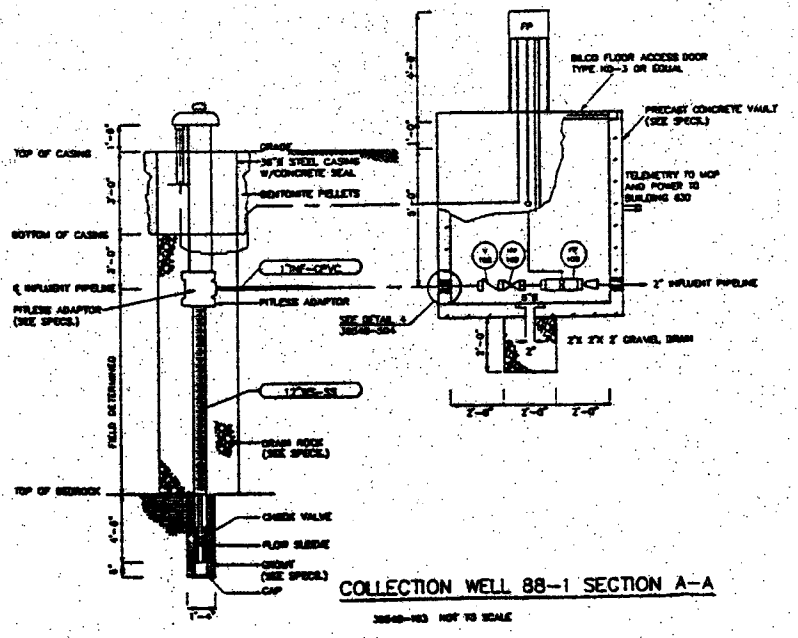
615284

603613-00001741-054



COLLECTION WELL 88-1
AND METER VAULT PLAN VIEW

38548-103 NOT TO SCALE



COLLECTION WELL 88-1 SECTION A-A

38548-103 NOT TO SCALE

FOR TITLE II REVIEW NOT FOR CONSTRUCTION

A ORIGINAL ISSUE

ENGINEERING-SCIENCE
Denver, Colorado

ES

SBT

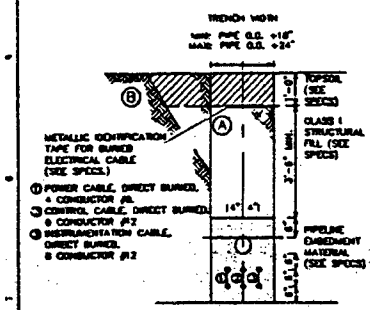
881 Hillside Remedial Action
Collection Well 88-1
Details

D 38548-108 16 OF 35

COMPUTER GENERATED DRAWING NO MANUAL CHANGES ALLOWED

615285

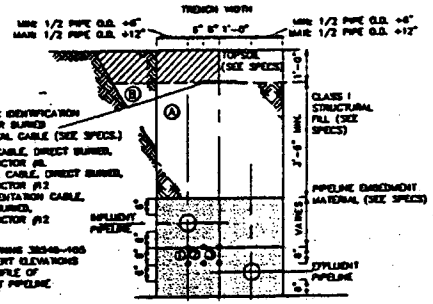
603613-00001742-054



1. ALTERNATE TRENCH SECTIONS (A and B) ARE FOR USE ONLY WHERE STABLE, COMPACT SOIL CONDITIONS EXIST:
   A. Vertical Trench Sidewall Sections (A)
   For depths exceeding 5 feet, shoring or solid sheeting is required. Design calculations by a duly registered Civil Engineer in the State of Colorado and approved by Buyer of support methods are required before construction.
   B. Combination of Vertical and Sloping Sidewalls Section (B)
   For depths exceeding 5 feet, shoring or solid sheeting are required. Design calculations by a duly registered Civil Engineer in the State of Colorado and approved by Buyer of support methods are required before construction.
2. WHERE WET, UNSTABLE, OR RUNNING SOIL IS ENCOUNTERED, SOLID SHEETING IS REQUIRED FOR ALL VERTICAL SIDEWALLS.

DETAIL 1
TYPICAL SECTION

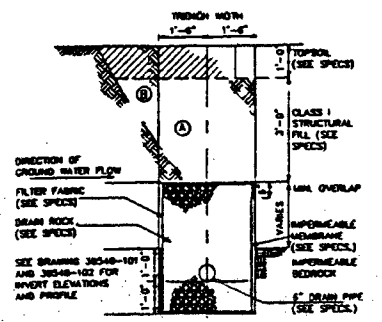
38548-103, 104 NOT TO SCALE



1. ALTERNATE TRENCH SECTIONS (A and B) ARE FOR USE ONLY WHERE STABLE, COMPACT SOIL CONDITIONS EXIST:
   A. Vertical Trench Sidewall Sections (A)
   For depths exceeding 5 feet, shoring or solid sheeting is required. Design calculations by a duly registered Civil Engineer in the State of Colorado and approved by Buyer of support methods are required before construction.
   B. Combination of Vertical and Sloping Sidewalls Section (B)
   For depths exceeding 5 feet, shoring or solid sheeting are required. Design calculations by a duly registered Civil Engineer in the State of Colorado and approved by Buyer of support methods are required before construction.
2. WHERE WET, UNSTABLE, OR RUNNING SOIL IS ENCOUNTERED, SOLID SHEETING IS REQUIRED FOR ALL VERTICAL SIDEWALLS.
3. CONTRACTOR MAY LOWER INFLUENT PIPELINE TO MATCH EFFLUENT PIPELINE ELEVATION. THIS OPTION WILL NOT CONSTITUTE A CHANGE IN CONTRACT PRICE.

DETAIL 2
TYPICAL COMBINATION INFLUENT AND EFFLUENT TRENCH

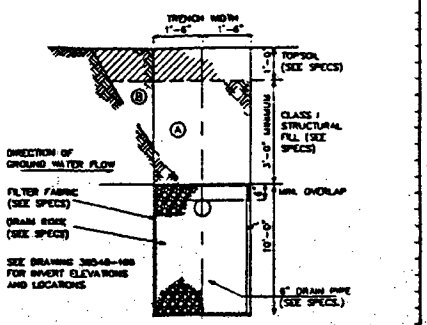
38548-103, 104 NOT TO SCALE



1. ALTERNATE TRENCH SECTIONS (A and B) ARE FOR USE ONLY WHERE STABLE, COMPACT SOIL CONDITIONS EXIST:
   A. Vertical Trench Sidewall Sections (A)
   For depths exceeding 5 feet, shoring or solid sheeting is required. Design calculations by a duly registered Civil Engineer in the State of Colorado and approved by Buyer of support methods are required before construction.
   B. Combination of Vertical and Sloping Sidewalls Section (B)
   For depths exceeding 5 feet, shoring or solid sheeting are required. Design calculations by a duly registered Civil Engineer in the State of Colorado and approved by Buyer of support methods are required before construction.
2. WHERE WET, UNSTABLE, OR RUNNING SOIL IS ENCOUNTERED, SOLID SHEETING IS REQUIRED FOR ALL VERTICAL SIDEWALLS.
3. DEPTH TO IMPERMEABLE BEDROCK SHALL BE ESTABLISHED IN THE FIELD BY AN EXPERIENCED GEOLOGIST OR GEOLOGICAL ENGINEER (BUYER'S REPRESENTATIVE).

DETAIL 3
TYPICAL FRENCH DRAIN TRENCH SECTION

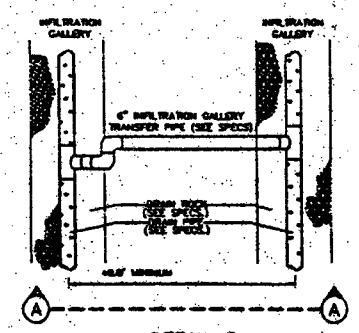
38548-101, 102 NOT TO SCALE



1. ALTERNATE TRENCH SECTIONS (A and B) ARE FOR USE ONLY WHERE STABLE, COMPACT SOIL CONDITIONS EXIST:
   A. Vertical Trench Sidewall Sections
   For depths exceeding 5 feet, shoring or solid sheeting is required. Design calculations by a duly registered Civil Engineer in the State of Colorado and approved by the Owner of support methods are required before construction.
   B. Combination of Vertical and Sloping Sidewalls Section
   For depths exceeding 5 feet, shoring or solid sheeting are required. Design calculations by a duly registered Civil Engineer in the State of Colorado and approved by the Owner of support methods are required before construction.
2. WHERE WET, UNSTABLE, OR RUNNING SOIL IS ENCOUNTERED, SOLID SHEETING IS REQUIRED FOR ALL VERTICAL SIDEWALLS.
3. IF BEDROCK IS ENCOUNTERED BEFORE REQUIRED DEPTH IS REACHED, THE DEPTH OF DRAIN ROCK MAY BE REDUCED WHERE APPROVED BY BUYER.

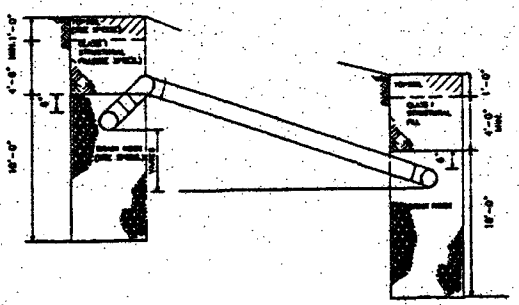
DETAIL 4
TYPICAL INFILTRATION GALLERY TRENCH SECTION

38548-105 NOT TO SCALE



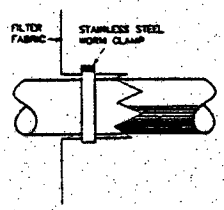
DETAIL 5
PLAN VIEW INFILTRATION GALLERY TRANSFER PIPE CONNECTION DETAIL

38548-105 NOT TO SCALE



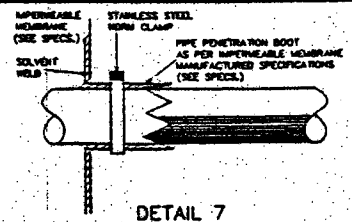
SECTION A-A
DETAIL 5
PLAN VIEW INFILTRATION GALLERY TRANSFER PIPE CONNECTION DETAIL

38548-105 NOT TO SCALE



DETAIL 6
PIPE PENETRATION FILTER FABRIC

38548-105, 107, 108, 109, 110 NOT TO SCALE



DETAIL 7
PIPE PENETRATION IMPERMEABLE MEMBRANE

38548-104 NOT TO SCALE

FOR TITLE & REVIEW NOT FOR CONSTRUCTION

A	ORIGINAL ISSUE		

ENGINEERING-SCIENCE
Denver, Colorado

881 Hillside Remedial Action
Civil Details

D 38548-109 | 17-35

COMPUTER GENERATED DRAWING NO MANUAL CHANGES ALLOWED

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