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TA-21

RCRA Facility Investigation Work Plan, Volume II, DP Tank Farm

Environmental Restoration Project
A Department of Energy Environmental Cleanup Program

Los Alamos
NATIONAL LABORATORY
Los Alamos, NM 87545

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ACRONYMS AND ABBREVIATIONS

AEC	Atomic Energy Commission
bgs	Below ground surface
BTEX	benzene, toluene, ethylbenzene, xylene
CFR	Code of Federal Regulations
COPC	Chemical of potential concern
CSM	Conceptual site model
DOE	Department of Energy
DQO	Data quality objective
DRO	Diesel range organics
EDL	Estimated detection limit
EP	Extraction procedure
EPA	Environmental Protection Agency
ER	Environmental restoration
ESH	Environment, Safety, and Health (Laboratory Division)
FIMAD	Facility for Information Management, Analysis, and Display
FTL	Field team leader
GMFZ	Guaje Mountain Fault Zone
GPR	Ground-penetrating radar
HSWA	Hazardous and Solid Waste Amendments
IWP	Installation work plan
LAAO	Los Alamos Area Office
LANL	Los Alamos National Laboratory
LEL	Lower explosive limit
LCS	Laboratory control sample
MCAL	Mobile Chemical Analytical Laboratory
MDA	Material disposal area
MRAL	Mobile Radiological Analysis Laboratory
MS	Matrix spike
NFA	No further action
NMED	New Mexico Environment Department
OU	Operable unit
OVM	Organic vapor meter

PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyl
PID	Photoionization detector
ppm	parts per million
PRS	Potential release site
QA	Quality assurance
QAPP	Quality assurance project plan
QC	Quality control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA facility investigation
SAL	Screening action level
SSHASP	Site-specific health and safety plan
SMO	Sample Management Office
SOP	Standard operating procedure
SOW	Statement of work
SVOC	Semivolatile organic compound
SWMU	Solid waste management unit
TA	Technical area
TAL	Target analyte list
TPH	Total petroleum hydrocarbons
UST	Underground storage tank
VCA	Voluntary corrective action
VOC	Volatile organic compound

1.0 INTRODUCTION

The purpose of this Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) work plan is to provide background information and describe sampling and analysis activities proposed to be conducted at Potential Release Site (PRS) 21-029, DP Tank Farm, located at Technical Area (TA) 21 at the Los Alamos National Laboratory (Laboratory). PRS 21-029 is a solid waste management unit (SWMU) identified in Section I.3, Table A of the Module VIII Hazardous and Solid Waste Amendments (HSWA) as modified May 19, 1994, of the Laboratory's Hazardous Waste Facility Permit (EPA 1990, 1585).

The Laboratory is a multidisciplinary research facility owned by the Department of Energy (DOE) and managed by the University of California. The Laboratory is located in north-central New Mexico approximately 60 miles northeast of Albuquerque and 20 miles northwest of Santa Fe (Figure 1-1). The Laboratory site covers 43 square miles of the Pajarito Plateau, which consists a series of finger-like mesas separated by deep canyons containing ephemeral and intermittent streams that run from west to east. Mesa tops range in elevation from approximately 6200 to 7800 ft. The eastern portion of the plateau stands 300 to 900 ft above the Rio Grande.

TA-21 is located near the town of Los Alamos on DP Mesa (Figure 1-2), and DP Tank Farm is located at the western edge of TA-21 immediately adjacent to the town site (Figure 1-3). The site occupies about 3.5 acres and is bounded by the Knights of Columbus Hall to the west and a Los Alamos County Fire Station and training facility to the east. The site is surrounded by a chainlink fence that is adjacent to DP Road to the south and follows the rim of DP Canyon on the north of the site. The head of DP Canyon is located directly north of the west end of DP Tank Farm. The canyon walls are gently sloped, and the ephemeral stream bed is about 30–40 ft below DP Tank Farm. The predominant slope at DP Tank Farm is from south to north, although the mesas also slope gently from west to east.

PRS 21-029, DP Tank Farm, is the former location of 2 fill stations and 15 tanks that contained petroleum hydrocarbon products. The tank capacities reportedly ranged between 2100 gallons to about 51,000 gallons. The site was operational from January 1946 to February 1985. It served originally as the primary fueling station supporting Laboratory operations. Fuels were delivered by tanker trucks to the tanks on the south side of the site. The trucks would park on DP Road, attach to fill ports positioned above the tanks, and fill the tanks by gravity flow. The tanks stored fuels that were gravity-fed through valve boxes down the hill to the fill stations on the north side of the site. Delivery trucks would drive through the east and west gates onto the access road to the fill stations, where they would fill and distribute fuel throughout the Laboratory.

Structures at DP Tank Farm site consisted of fuel tanks, fill ports, valve boxes, the East and West Fill Stations, access roads, a large berm on the north side of the site extending from just east of the West Fill Station to the east end of the site, and pipes that drained into outfalls on the north-facing slope of DP Canyon. The site was decommissioned in 1988, resulting in removal of all major structures at the site (LANL 1991, 7529). Copies of original field logs of the decommissioning (McInroy 1988, 1641) indicate that the tanks and piping were in good condition with no structural failures. However, where a leak had occurred at a gasket in the piping near one tank, 4 yd^3 of soil were removed. About 75 yd^3 of soil were also removed from the areas around the two fill stations where the soil was stained with fuel residues. The berm was removed and used as fill material on site. Remnants of the drain pipes and one fill port remain at the site.

An RFI work plan for investigations at PRS 21-029 was prepared and submitted in May 1991 (LANL 1991, 7529). The Phase I RFI was conducted in 1994 in accordance with the approved work plan, which directed the investigations to focus on the former location of the tanks and the East and West Fill

Stations. Results of the investigation strongly suggested that petroleum-related products were the only chemicals of potential concern (COPCs). However, petroleum-related products were detected at concentrations exceeding 100 ppm in soil samples collected at the site. These levels of petroleum-related products constituted a *suspected release*, as defined in the State of New Mexico Environment Improvement Board underground storage tank (UST) regulations. The suspected release was reported to the New Mexico Environment Department (NMED) UST Bureau in April 1995. An investigation was performed in May 1995, in accordance with NMED UST regulations, to define the extent of petroleum contamination at the East and West Fill Stations (LANL 1995, 59364).

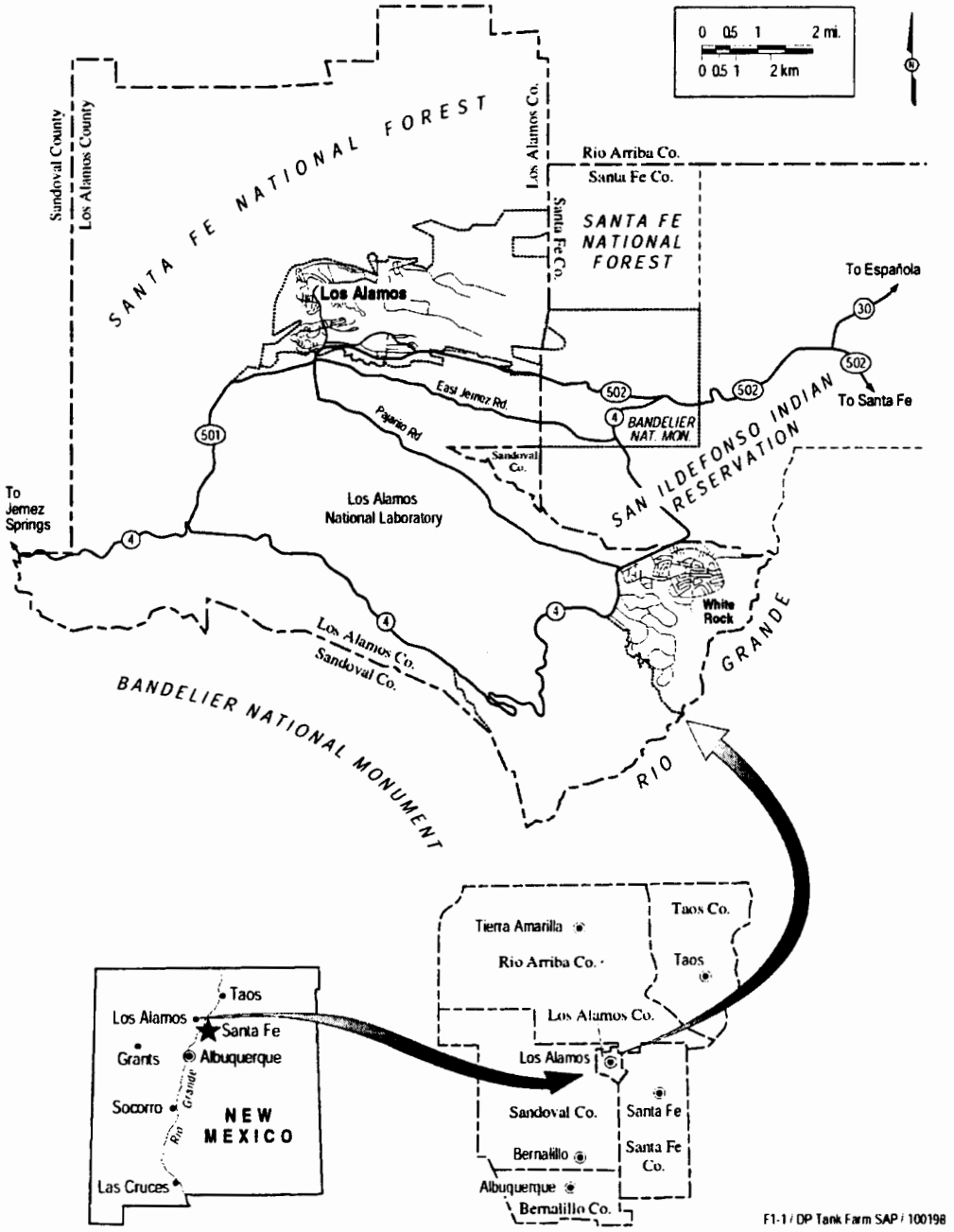


Figure 1-1. Location map of Los Alamos National Laboratory.

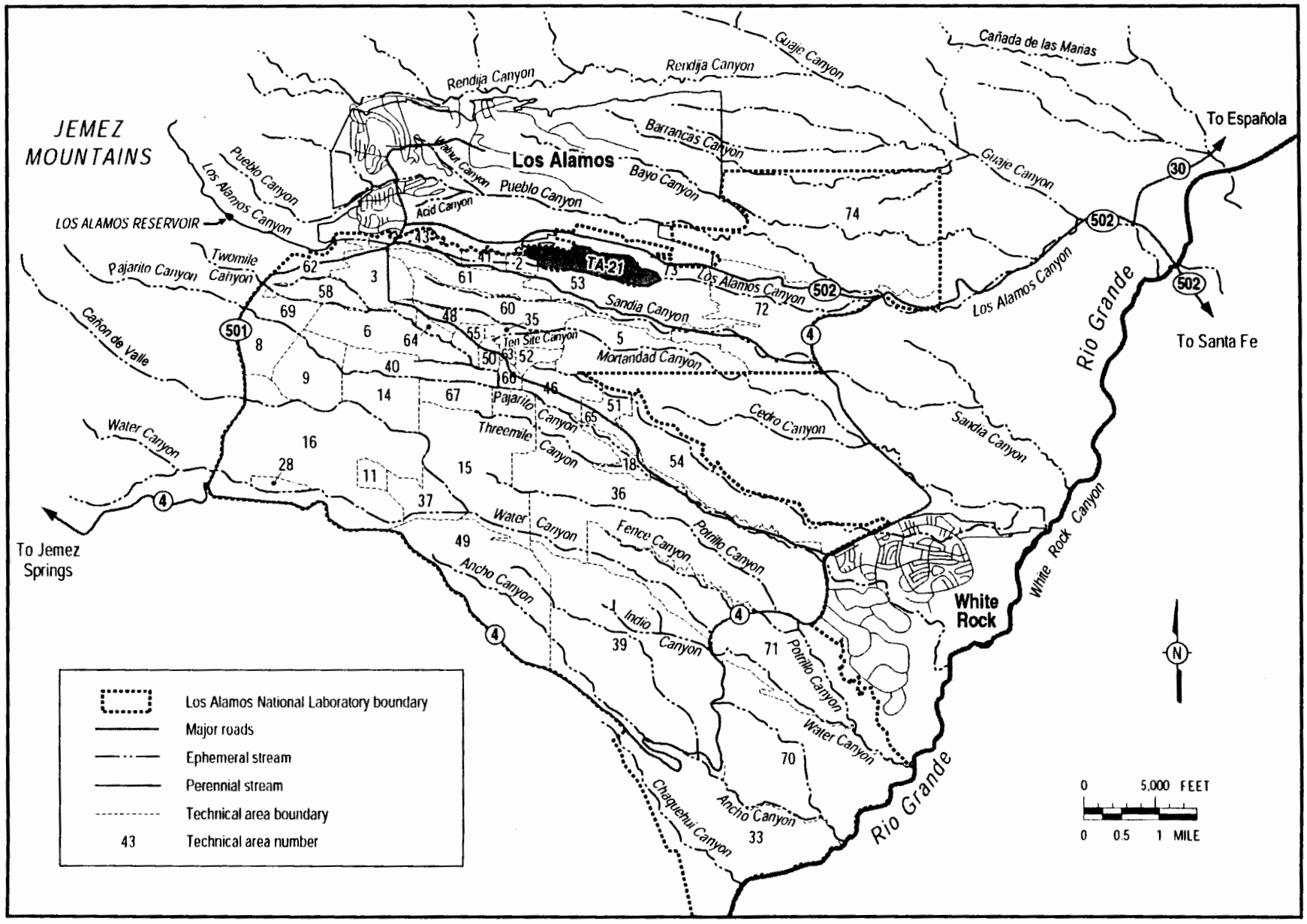


Figure 1-2. Technical Areas at Los Alamos National Laboratory.

F1-2 / DP Tank Farm SAP / 100198

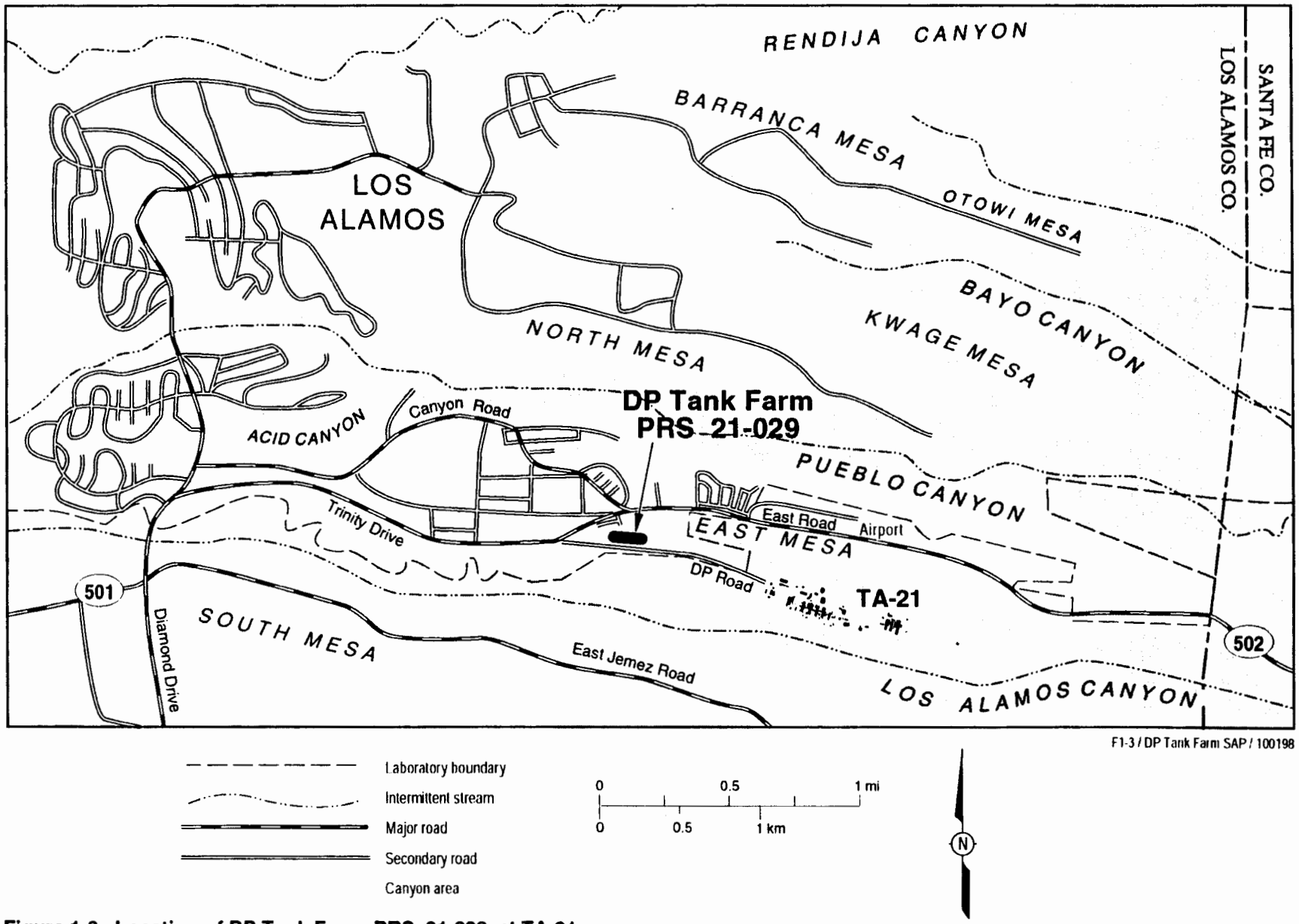


Figure 1-3. Location of DP Tank Farm, PRS 21-029, at TA-21.

The results of the 1994 RFI and 1995 UST investigations were reported in RFI Report for Potential Release Site 21-029 (LANL 1996, 52270). The RFI report recommended no further action (NFA) at the site under NFA Criterion 3 (currently Criterion 4 in the LANL Environmental Restoration (ER) Project installation work plan) (LANL 1996, 55574, p. 3-11) as follows: "the site was characterized and/or remediated under a different regulatory authority (in this case the NMED UST regulations) which adequately addresses corrective action."

Site remediation at DP Tank Farm was not anticipated to be required under the NMED UST regulations because the petroleum-related contamination was not expected to pose a threat to groundwater or surface water. However, it was anticipated that the DP Tank Farm property would be transferred to Los Alamos County for commercial use in the foreseeable future. In the interest of best management practices, the Laboratory planned to voluntarily remediate the site in preparation for the potential future land transfer. A voluntary corrective action (VCA) plan (LANL 1996, 55344) was prepared for remediation of the former East Fill Station; the work was performed in May 1996.

During the 1994 investigation, a localized hydrocarbon sheen area (also commonly known as the *seep*, see discussion below) was discovered in DP Canyon directly north of DP Tank Farm. Efforts in 1995 to tie the sheen area to contamination at DP Tank Farm proved inconclusive (LANL 1996, 52270). Several other potential sources of the sheen area exist in the vicinity, including PRSs 00-027 and 00-030(a), former USTs and septic system near the Knights of Columbus Hall, and 00-031(a), former location of gasoline pumps and tanks near the Hilltop House Hotel. The NMED UST Bureau determined that the potential for a threat to surface water must be considered by the NMED Surface Water Bureau before the UST Bureau would consider site closure. Because of the remediation activities at the location of the former East Fill Station, which had changed the conditions at the site, a monitoring program was established that required two years of quarterly monitoring involving visual inspection of the sheen area. The inspection over the course of the last two years has shown that the sheen area is highly variable depending on seasonal fluctuations in weather patterns.

The area of DP Canyon in the vicinity of the DP Tank Farm commonly designated the *seep* area is a reach where darkening stains on the rocks of the streambed can be seen, the odors of organic constituents of fuel oil are apparent, a hydrocarbon sheen can appear on the surface of stagnant pools in the canyon stream if the rock or sediments are pressed by foot, and an oily substance with an aromatic odor can be found in sediments collected in small depressions of the stream bed and in pieces of broken tuff. The extent of this area varies from a few yards to approximately 100 ft over time because of parameters, possibly weather- and/or season-related, that have not been identified as yet. Similarly, the occurrence and intensity of odors, hydrocarbon sheens on pools of water, degree of staining, and the presence of an oily substance in sediments also vary widely from not observable to obvious. As noted in the Laboratory's response to the denial of the RFI report (Jansen and Taylor 1997, 56512, pp. 3 and 4), the use of the term *seep* to describe this area is inappropriate because the term indicates actively flowing or oozing petroleum, which is not the observed condition; the preferred description is the localized hydrocarbon sheen area. Hereafter in this work plan, the terms *localized hydrocarbon sheen area* or *sheen area* will be used to refer to this area. The source or sources of materials causing this sheen area are not known, but several are possible, including street runoff and historical and present-day industrial activity in nearby areas, as well as the DP Tank Farm site.

This report addresses sampling and analysis needs to fill data gaps at the localized hydrocarbon sheen area that are aimed at determining the extent and the source of the sheen area. The intent is to determine if the sheen area is associated with petroleum hydrocarbon contamination at DP Tank Farm or some other local source of petroleum hydrocarbon contamination. Earlier efforts at associating the sheen area

with DP Tank Farm focused investigation on the mesa; however, the VCA performed in 1996 indicated that subsurface fractures are prevalent and that petroleum hydrocarbons are present in the fractures. On July 7, 1998, discussions were held with NMED, including the Hazardous and Radioactive Materials Bureau and the UST Bureau (Rochelle 1998, 58991), at which it was agreed that the most reasonable path forward at this time is to investigate the sheen area directly, rather than pursuing petroleum hydrocarbon contamination through fractures on the mesa, and that contingencies should be based on the outcome of this proposed sheen area investigation. This work plan also addresses sampling and analysis needs at DP Tank Farm in areas that have not previously been assessed, including a more extensive investigation around the former locations of the tanks, the valve boxes, the fill ports, drains to DP Canyon, and the berm area.

1.1 Objectives and Scope

Available and relevant information related to DP Tank Farm was reviewed to support development of this work plan. Chromatograms of organic analyses available from previous investigations were reviewed; fractures as a mechanism for migration of petroleum-related products were discussed; an investigation of the localized hydrocarbon sheen area in DP Canyon aimed at determining its extent and potential source was proposed; and contingencies depending on the outcome of the sheen area investigation were investigated (Rochelle 1998, 58991). The review highlighted several features of the DP Tank Farm that have not been previously investigated, such as the drains into DP Canyon; the former locations of the valve boxes that controlled the flow of fuels and other materials to the fill stations; fill ports, the remnants of one of which is still present; and the former location of the berm that was constructed to the north and east of DP Tank Farm. In addition, review of the chromatograms revealed the potential for small amounts of petroleum-related contamination in the subsurface around two of the tanks. Data available from the 1988 decommissioning were inconclusive with respect to the potential contamination, suggesting that nature and extent of contamination in these areas has not been completely characterized. Finally, recently available background data for geologic media at the Laboratory were used in this review as the basis for background comparisons, the results of which suggest some potential for low levels of lead contamination at the site. The scope and objectives of this work plan accommodate investigation of these newly found issues.

This work plan provides details of the sampling and analysis activities planned to address data gaps related to the localized hydrocarbon sheen area in DP Canyon, information on the newly identified issues at DP Tank Farm, and discussions of fractures at the site and the information review performed. The following more specific objectives have been identified in this work plan:

- Identify the nature and extent of surface and subsurface petroleum hydrocarbon contamination and surface inorganic chemical contamination associated with the localized hydrocarbon sheen area in DP Canyon.
- Identify the source or sources of petroleum hydrocarbons associated with the localized hydrocarbon sheen area in DP Canyon.
- Identify the migration pathway or pathways by which petroleum-related products have moved from the source(s) to the area of the sheen in DP Canyon and determine if these pathways are still active.
- Refine the determination of nature and extent for inorganic chemical and petroleum hydrocarbon contamination within the DP Tank Farm PRS.

Some of the sampling and analysis activities that support these objectives will be performed in sequence. For example, investigation of nature and extent of the localized hydrocarbon sheen area will begin with a

comprehensive examination of the sheen area and surrounding locales to identify particular locations where sampling may be most informative. This will be followed by sampling activities within the channel of DP Canyon and on the banks and hillsides (canyon walls) adjacent to the channel. On the mesa area of DP Tank Farm, boreholes will be drilled around the former locations of the tanks; the expectation is that little or no contamination will be observed. The overall intent of these investigations is to improve understanding of the nature and extent of contamination at DP Tank Farm, to refine the conceptual model based on the information obtained, and to consider future options based on data gaps, if any, that are evident following data assessment. Contingency activities that could be envisioned include

- NFA, if the conceptual model appears to be well understood, no human or ecological risk is apparent, and uncertainties are acceptable or cannot be further reduced effectively;
- performing human and/or ecological risk assessment to evaluate the potential for unacceptable risks to human health or the environment;
- planning for longer-term monitoring of the localized hydrocarbon sheen area to quantify temporal trends in petroleum hydrocarbon contamination in DP Canyon (note that these activities could also support risk assessment activities); and
- further actions to remove any source(s), restrict any contaminant migration, restrict redistribution of any petroleum-related products in the environment, or interrupt human and/or ecological exposure pathways.

These potential options will be evaluated pending further investigation of the localized hydrocarbon sheen area and DP Tank Farm according to the sampling and analysis activities specified in this work plan. The revised conceptual model will be used to determine future actions in much the same way as data gaps identified in the current conceptual model were used to identify sampling and analysis needs at this time. Decisions will be made based on the revised conceptual model, the available data, and in conjunction with regulatory requirements (including HSWA, UST and surface water regulations) and other programmatic requirements (such as the pending transfer of land from DOE to Los Alamos County).

1.2 Approach and Implementation

The sampling and analysis activities detailed in this work plan are organized into seven activities that support the primary objectives described in Section 1.1. As outlined in Section 1.1, the principle objective of these activities is to determine the extent, possible origin, and migration mechanisms related to the petroleum hydrocarbon contamination observed in DP Canyon. An additional objective includes determination of the nature and extent of petroleum hydrocarbon and inorganic chemical contamination on the mesa top. Generally, samples will be analyzed for inorganic chemicals, benzene, toluene, ethylbenzene, and xylenes (BTEX), semivolatile organic compounds (SVOCs), and both diesel range and motor oil range hydrocarbons; volatile organic compound (VOC) analyses will not be performed because all prior investigations found no VOCs that were not petroleum related.

Activity 1 is a geophysical survey on the mesa top to locate any remaining pipes and filling ports. If pipes are found, visual inspection and photoionization detector (PID) measurements will be taken to guide soil sample collection for laboratory analysis for inorganic chemicals, BTEX, SVOCs, and diesel range and motor oil range hydrocarbons.

Activity 2 includes an initial detailed reconnaissance of DP Canyon (before sampling activities) followed by monthly to biweekly inspections of the canyon. The initial reconnaissance will be used to guide sample

collection in the remaining Activities. The periodic inspection will be used to develop a standardized, consistent set of observational data on the extent of the localized hydrocarbon sheen area and the variability associated with differing hydrologic regimes.

Activity 3 is collection and analysis of sediment samples from the channel within, upstream, and downstream of the localized hydrocarbon sheen area. These samples will be analyzed for inorganic chemicals, BTEX, SVOCs, and diesel range and motor oil range hydrocarbons. Sampling will be performed when the canyon is dry, both to facilitate sample collection and because observations to date suggest that petroleum hydrocarbons are most evident in the channel during dry periods. Specific locations and numbers of sampling points will be guided by observations made during the field survey conducted under Activity 2.

Under Activity 4, auger holes will be drilled in the channel and adjacent banks within the localized hydrocarbon sheen area as well as up and down channel of the sheen area. The auger holes will be drilled as deep as possible given the limitations imposed by the topography on the type of drilling equipment that can be used. Each 1-ft interval of tuff core will be crushed and analyzed with a PID for organic vapors. Samples with positive readings and the sample at the bottom of the auger hole will be submitted for laboratory analysis of inorganic chemicals, BTEX, SVOCs, and diesel range and motor oil range hydrocarbons. If feasible, auger holes will be drilled one interval beyond a positive PID reading. Approximately 12 to 15 locations will be sampled; the exact number and location will be determined during the site survey.

Activity 5 is vapor-phase sampling, using a PID, of auger holes in the canyon walls to the north, south, and west of the localized hydrocarbon sheen area. Auger holes will be drilled to a depth of approximately 8 to 10 ft. The vapor-phase samples will provide qualitative, integrated information on subsurface petroleum hydrocarbon contaminants over a relatively large area; this information will help to identify the direction of origin of the hydrocarbon contaminants in DP Canyon. If organic vapors are measurable in the field in the auger holes to the channel walls, three additional auger holes in each direction (north, south, and west) will be drilled and sampled out from the sheen area. The exact number and locations will be determined based on the results of the initial PID readings.

Under Activity 6, surface and near-surface soil samples will be collected at drain pipes, fill port areas, and in other potentially contaminated areas of DP Tank Farm. Samples will be collected at 1-ft intervals from auger holes drilled to approximately 5 ft. Each interval of tuff core will be crushed and then analyzed with a PID for organic vapors. Tuff samples with positive readings and the sample at the bottom of each auger hole will be submitted for laboratory analysis of inorganic chemicals, BTEX, SVOCs, and diesel range and motor oil range hydrocarbons. Surface soil samples will be analyzed for the same analytical suite. Exact sample locations will be determined during the reconnaissance activities described in Activity 2.

Under Activity 7, subsurface tuff samples will be collected at 1-ft intervals from auger holes advanced to approximately 5 ft below the soil-tuff interface at the former locations of all tanks except numbers TA-21-ATF-6, -10, and -13. At tank numbers TA-21-ATF-6 and -10, boreholes will be drilled to 15 ft with samples taken at 2-ft intervals. Each interval of tuff core will be crushed and then analyzed with a PID for organic vapors. Tuff samples with positive readings and the sample at the middle (for the 15-ft borehole) and bottom (for the 5-ft auger hole and 15-ft borehole) of the holes will be submitted for laboratory analysis of inorganic chemicals, BTEX, SVOCs, and diesel range and motor oil range hydrocarbons. Soil samples will be collected at each auger hole and borehole location and analyzed for inorganic chemicals, BTEX, SVOCs, and diesel range and motor oil range hydrocarbons.

Site survey and reconnaissance activities (Activities 1 and 2) will provide observational support for determining the extent of the contamination in the canyon as well as guiding sampling locations for generating more quantitative information. Activity 3 is designed to address the extent of water-borne contamination associated with the localized hydrocarbon sheen area. Comparison of chromatograms of sediment samples collected under this activity may aid in identifying the source of the petroleum hydrocarbon contamination. The primary objective of Activity 4 is to determine the extent of subsurface contamination associated with the sheen area in DP Canyon. Likely sources of the contamination may also be identified based on chromatograms of samples taken under Activity 4. The vapor-phase sampling (Activity 5) is designed to narrow the number of potential sources of the petroleum hydrocarbon contamination in DP Canyon through development of organic vapor concentration gradients. These gradients will also provide information on the extent of the petroleum hydrocarbon contamination. The surface and subsurface sampling and analysis under Activity 6 is aimed at determining the magnitude and origin of releases of inorganic chemicals and petroleum-related products on the mesa-top. Finally, the objective of Activity 7 is to evaluate the nature and extent of petroleum hydrocarbon contamination resulting from releases or leaks at, or from, the tanks.

1.3 Background Issues

1.3.1 Regulatory Requirements

The investigation, including sampling and analysis, of SWMUs is intended to address the requirements of the Module VIII HSWA of the Laboratory's Hazardous Waste Facility Permit, issued May 23, 1990 (EPA 1990, 1585) and modified May 19, 1994.

1.3.2 Other Issues

In 1994 a Phase I RFI was performed at DP Tank Farm to determine the nature of contamination, if any, at the site. At that time, evaluation of data collected during the Phase I RFI (LANL 1996, 52270) found that COPCs present in the soils were associated with petroleum products only. However, there was evidence from the concentrations of total petroleum hydrocarbons (TPH) of a suspected release, as defined in the New Mexico UST regulations (NMED 1996, 58202). The suspected release was reported in April 1995, with the submission of a 45-day report, as required being submitted July 11, 1995 (LANL 1996, 52270, Attachment A). Because the contamination was identified as petroleum-related hydrocarbons only and DP Tank Farm was the site of many USTs, the site was considered subject to UST regulations.

An on-site investigation was performed in 1995 in accordance with UST regulatory requirements. A technical memorandum (LANL 1995, 59364) was prepared that provided the sampling and analysis plan, which was approved by Environmental Protection Agency (EPA) Region VI before the investigation. The investigation involved determining extent of contamination at the locations of the former East and West Fill Stations and investigating the localized hydrocarbon sheen area that had been discovered in DP Canyon in the 1994 RFI. The results of the two investigations, the 1994 Phase I RFI and the 1995 UST investigation, were reported in January 1996 in the RFI report (LANL 1996, 52270). The UST Bureau recognized that the site did not pose a threat to groundwater but were concerned about potential adverse surface water effects in connection with the sheen area and indicated that closure of the site under UST could only occur after concurrence from the NMED Surface Water Bureau (McInroy and Koch 1996, 55172, Item 3c). Consequently, further monitoring of the sheen area has been ongoing.

Remediation at DP Tank Farm was not expected to be required under the UST regulations; however, because the site is targeted to be transferred to Los Alamos County for commercial development, the Laboratory planned for a voluntary cleanup to facilitate the transfer. The Laboratory conducted a VCA in

May 1996, removing approximately 1720 yd^3 of contaminated soil from the area of the former East Fill Station and backfilling with clean soil brought in by the contractor from off site. The cleanup targets were the limits of New Mexico special waste, which were 1000 ppm TPH, 500 ppm BTEX, and 10 ppm benzene (lowered by DOE/Los Alamos Area Office to 1 ppm). These targets were generally achieved in the VCA.

In summary, the site is subject to RCRA and HSWA regulations because it has been identified as a SWMU by the Laboratory, DOE, and EPA. The site is also potentially subject to UST regulations because it is the former location of USTs, and the only COPCs identified to date at the site are petroleum-related products. Finally, if the localized hydrocarbon sheen area is found to violate surface water regulations and DP Tank Farm is determined to be the source of the contamination, then further activities at the site might be necessary.

Beyond the regulatory requirements, the other main consideration for this site is the potential federal requirement for transfer of the land (Public Law 105-119). The potential intended use for the land is industrial, which is consistent with ongoing commercial activities along DP Road. It is unlikely, however, that DP Canyon can be used for industrial development because of the topography and its role as the main drainage for the eastern part of Los Alamos. If risk assessments are needed in the future at this site, then the land-use issues must be resolved so that appropriate receptor scenarios can be developed.

1.4 Data Quality Objectives Process

The objectives and requirements of this work plan were developed under an iterative planning process that will ensure that appropriate data are collected to address the data gaps identified in Section 1.1. The objectives were reached through the process of

- gathering information,
- evaluating current knowledge of nature and extent of contamination and migration pathways for the contamination,
- identifying data gaps based on current knowledge that should be filled in this next phase of investigation, and
- specifying sampling and analysis requirements to collect the data needed to improve understanding of or refining of the conceptual model.

Figure 1-4 provides a flow diagram of the process in which site information was gathered, the conceptual model was reviewed and revised, as appropriate, and data gaps were identified. Once all available data were evaluated, the sampling and analysis plan was designed to ensure data collection suitable for addressing the data gaps.

The initial step in gathering site information was a review of reports from previous investigations and of available historical documentation of activities at DP Tank Farm. The major documents relied upon in this step were the 1996 RFI report (LANL 1996, 52270) and the 1996 VCA report (LANL 1996, 55344). All data collected during the 1994 Phase I RFI; the investigation conducted in May, 1995, under the NMED UST regulations; and the VCA conducted in May 1996 at the former location of the East Fill Station were revalidated and verified against original field logs, as available. These data, including chromatograms from fixed laboratory analyses of samples for petroleum hydrocarbons, were re-examined and used in development of a conceptual model of the nature, extent, transport, and fate of contaminants at the site. Based on this conceptual model, an initial list of data gaps was identified.

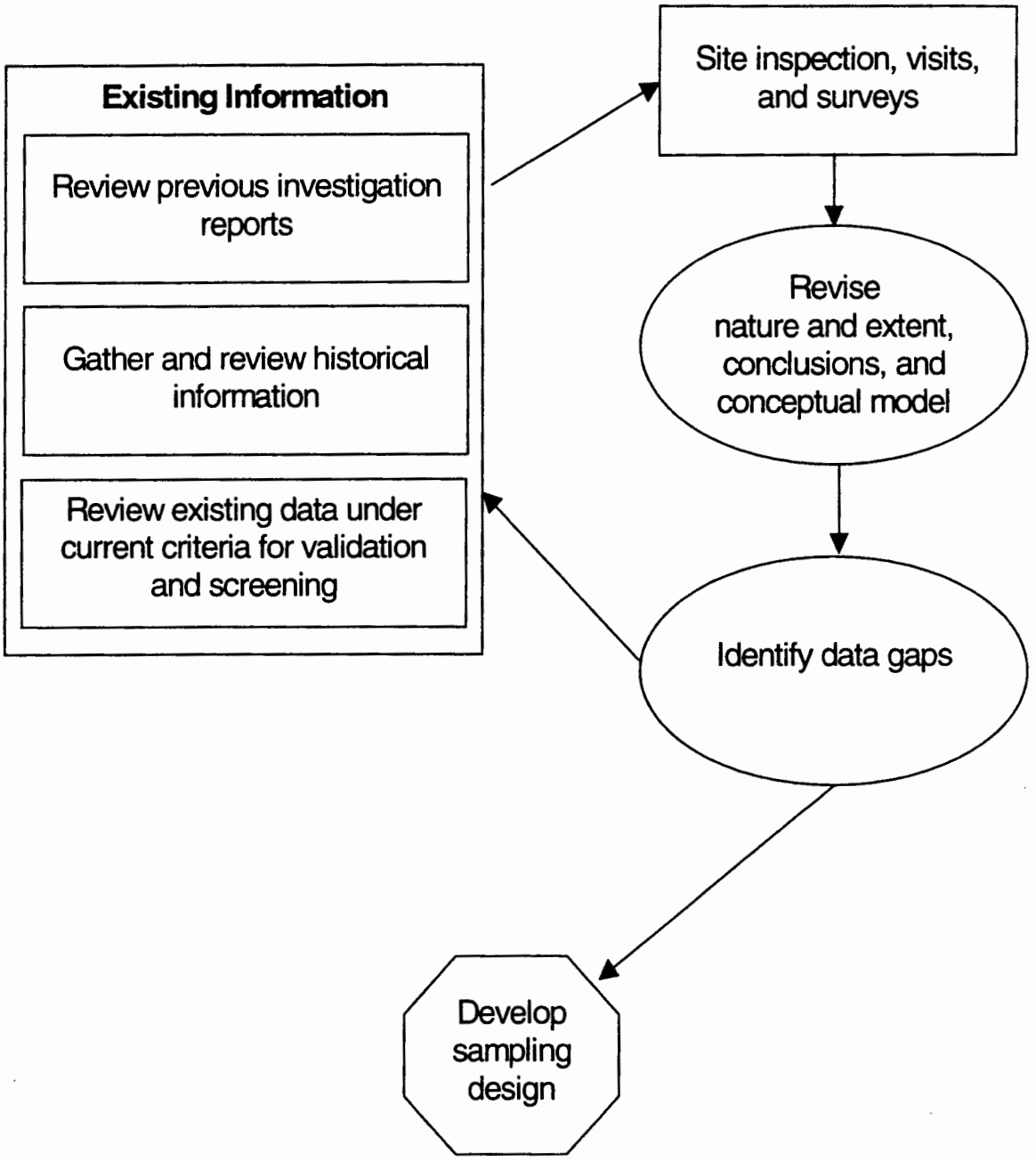


Figure 1-4. Flow diagram of data quality objectives process.

Historical information on DP Tank Farm and other activities in the watershed were further explored to close as many of the initially identified data gaps as possible. Copies of original maps and aerial photographs prepared and obtained during the period of operation were found and incorporated into a revised base map of the area and a chronology of development and activities near the site. Site walkovers at the DP Tank Farm area, in conjunction with a detailed review of historical engineering drawings and aerial and ground-level photographs of the area, resulted in modifications to the base map and an increased understanding of the history and current conditions at the site. A set of engineering drawings (Zia Company 1948, 24947) of the tank farm from 1948 were used to digitize the structural features of the tank farm into Geographic Information System (GIS) coverages in the Facility for Information Management, Analysis, and Display (FIMAD) GIS database. New base maps of the tank farm area were produced and were then compared against aerial photographs from 1946, 1958, 1974, 1986, and 1991 for accuracy. This led to further site surveys, under varying hydrologic regimes, and a revision of the site conceptual model. This further exploration of the available data generated new data gaps and resolved others.

Information collected in previous investigations was re-examined in light of the current procedures for validation, the new screening and background levels, data review, and site assessment; the information re-examined included

- reports and memorandums of activities conducted in the early 1980s to inspect the tanks for integrity and leaks and for the collection and analysis of tank contents and soil samples;
- copies of original field logs and photographs of tank and soil removal activities, which included draining the contents of the tanks and piping, shipment of the contents to TA-54 for final disposition, removal of contaminated surficial soils to TA-54 for final disposition, and backfilling during the decommissioning of the site and removal of the tanks in 1988;
- data on organic chemicals in surface water, sediments, soils, spring water, alluvial groundwater, and the regional aquifer collected in the Laboratory's surveillance program and the canyons investigations in DP Canyon and chromatograms of the organic analyses;
- data from the analyses of soil samples collected in the RFI at nearby PRS 00-027 DP Road storage area and chromatograms of the organic analyses;
- recently acquired information on fractures in bedrock at TA-21; and
- data and information from other potentially relevant PRSs.

The information gathered in this effort led to refinements in the site conceptual model and modification of the list of data gaps. Finally, once all available data was exhausted, the sampling and analysis design was developed to fill the remaining data gaps. Further decisions at the site depend on the information that will be gathered, as specified in this work plan, and will be addressed once the information to be collected has been assimilated and evaluated.

2.0 POTENTIAL RELEASE SITE 21-029, DP TANK FARM

2.1 Characterization and Setting

This section focuses on the environmental setting and historical operations of PRS 21-029, DP Tank Farm. Because of the inclusion of the localized hydrocarbon sheen area in DP Canyon, the descriptions cover a broad area encompassing the mesa top area of DP Tank Farm and the potentially impacted section of DP Canyon directly to the north of the site.

The DP Tank Farm site is located near the western end of DP Mesa (Figure 1-3) at an elevation ranging between 7202 ft and 7240 ft above mean sea level, approximately 1200 ft above the water surface of the regional aquifer. The topography slopes gently downward to the northeast. The site is currently bounded by the Knights of Columbus Hall on the west and a Los Alamos County fire station and training facility on the east. The site is bounded on the north by a chainlink fence parallel to DP Canyon and on the south by a chainlink fence adjacent to DP Road (Figure 2.1-1). The DP Tank Farm was operational from January 1946 to February 1985. Figure 2.1-2 depicts the tanks, structures, and roads at the DP Tank Farm during the operational period. It was believed that all tanks, structures, and roads at the site were decommissioned and removed in 1988 (LANL 1991, 7529; LANL 1996, 55347).

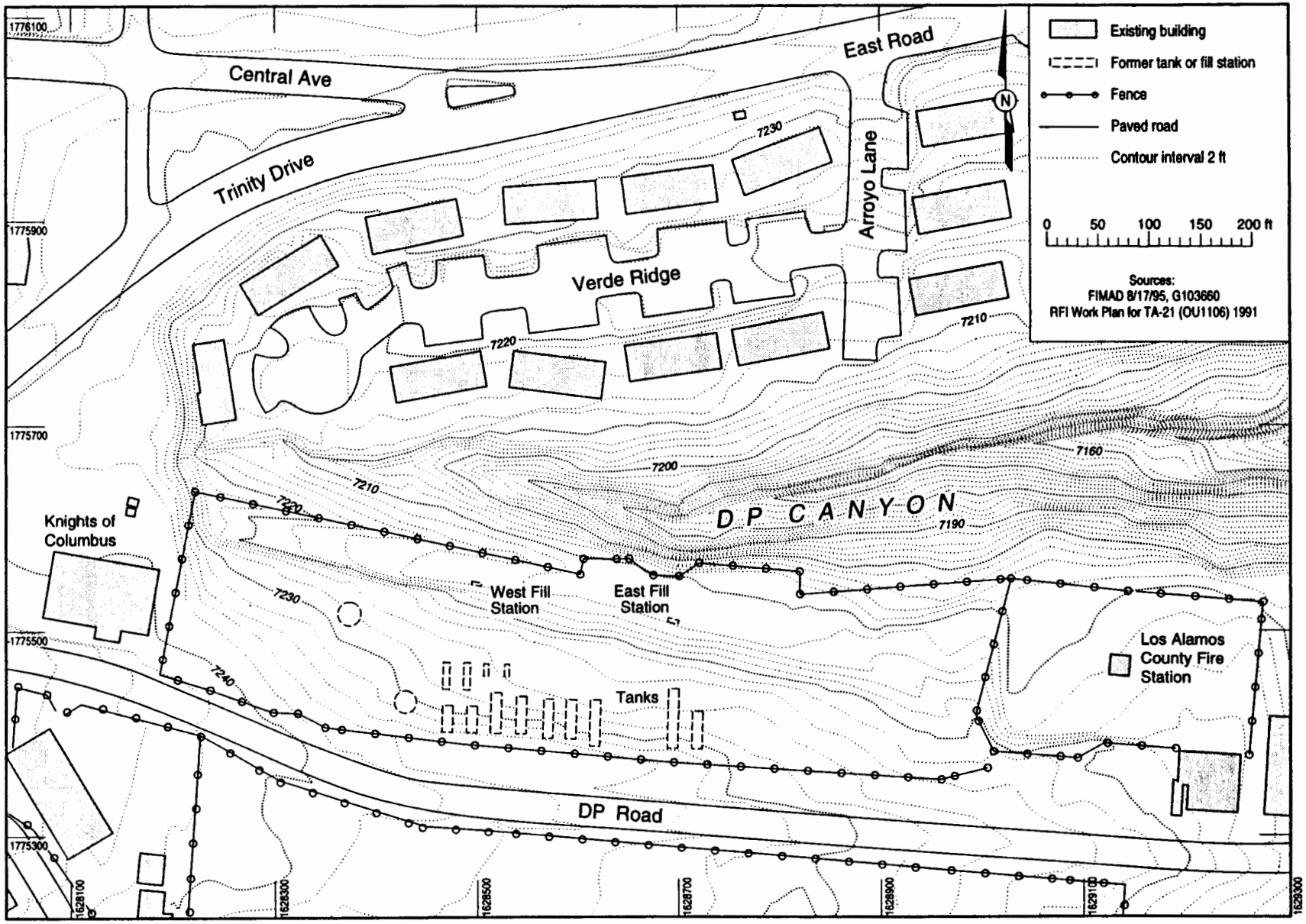
2.1.1 Site Description

The following information was taken largely from the Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) Report for Potential Release Site 21-029 (LANL 1996, 52270, Section 2.0, pp. 5–7). Appropriate details regarding geology, soils, fractures, hydrology, wildlife, receptor scenarios, nearby PRSs, and other potential sources of contamination have been added to update the original discussion in the RFI report.

Climate

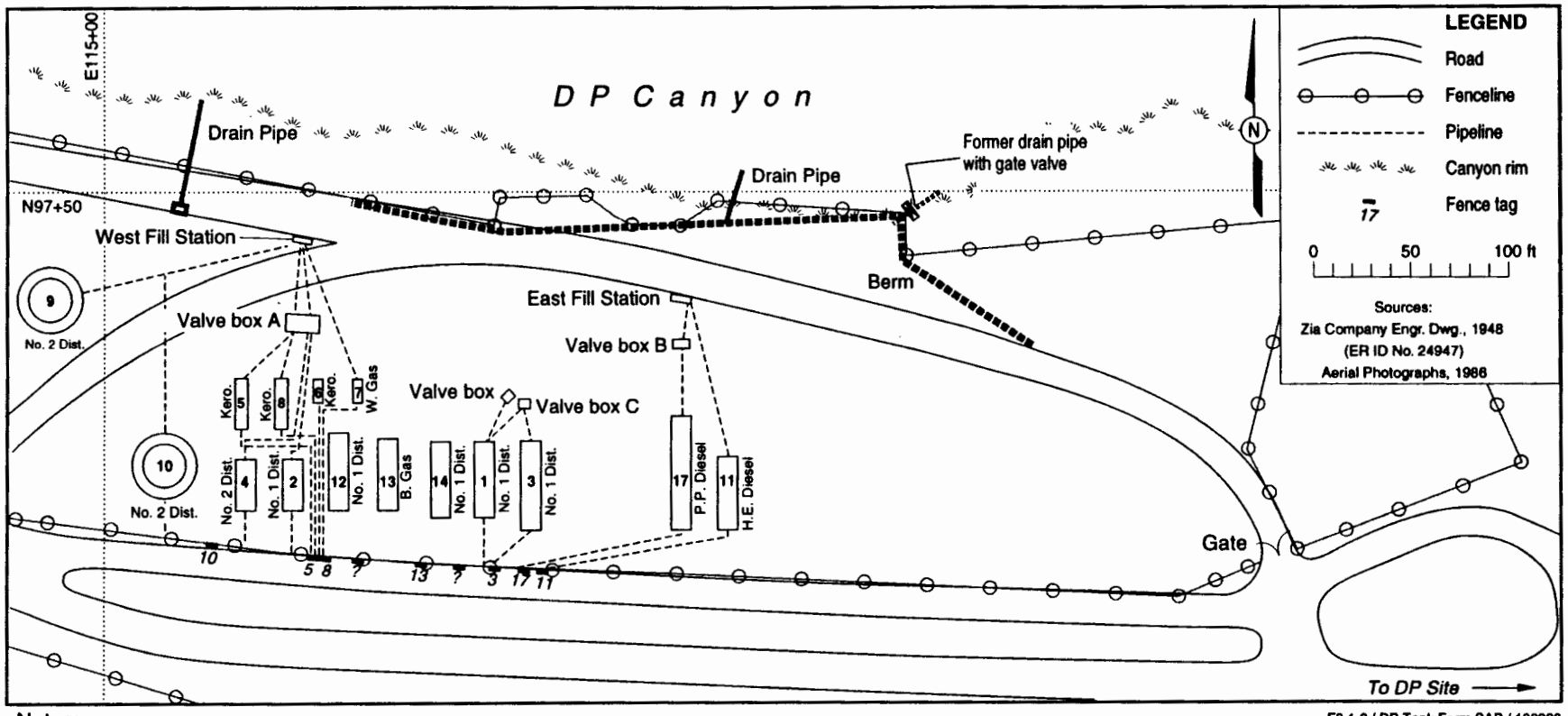
The DP Tank Farm site is located in Los Alamos County. The Los Alamos area of north-central New Mexico has a semiarid, temperate mountain climate. Annual precipitation in the area averages about 18 in. Forty percent of this precipitation occurs as brief, intense thunderstorms during July and August, which often result in significant runoff events. Snowfall averages about 51 in. annually and usually produces brief periods of snowmelt runoff in the spring. In summer months, maximum daily temperatures in the area are usually below 90° F, dropping into the 50s at night. Winter temperatures typically range between 30° F and 50° F during the day and between 15° F and 25° F at night, occasionally dropping to 0° F or below (Bowen 1990, 6899). The climate of Los Alamos County is described in more detail in the LANL Installation Work Plan for Environmental Restoration (LANL 1996, 55574).

Of particular relevance to the proposed sampling and analysis activities is the annual pattern of precipitation and temperature. The most advantageous conditions under which petroleum hydrocarbon contamination might be detected is at the end of a particularly hot and dry period. This most often occurs during late spring, before the thunderstorm season that usually begins in mid- to late June and continues through August. The pre-July time frame might provide the best conditions for detection of petroleum hydrocarbon contamination; however, it is also important to understand temporal patterns related to the localized hydrocarbon sheen area in DP Canyon. The range of precipitation and temperature conditions observed in Los Alamos will be considered in determining the frequency of inspections of the sheen area, as described in Section 1.2, Activity 2.



F2.1-1 / DP Tank Farm SAP / 090398

Figure 2.1-1. Location of DP Tank Farm, PRS 21-029, former tanks, boundaries, topography, and adjacent features.



F2.1-2 / DP Tank Farm SAP / 100298

Notes:

Notation as to tank contents are from the original Zia Company engineering drawings. During the period of operation, available evidence suggests that actual contents of the tanks varied, as discussed in the text of this work plan. Review of historical aerial photos suggests that the earthen berm was constructed sometime between 1974 and 1986. Of the three drain pipes shown, only that closest to the West Fill Station is indicated on the original engineering drawing. The drain pipe near the East Fill Station was added based on field inspections.

Evidence for the existence of the "Former drain pipe with gate valve," shown in the northeast corner of the berm is from a hand drawing by McInroy (1988, 1641).

Figure 2.1-2. Locations of former structures and roads at DP Tank Farm, PRS 21-029.

Geology

The DP Tank Farm site lies on DP Mesa immediately west of Technical Area (TA) 21. DP Canyon begins just west of the site, passing along its northern boundary.

The geologic unit underlying PRS 21-029 is the Tshirege Member, Unit 3 ignimbrite of the Bandelier Tuff, designated Qbt3 by Goff (1995, 49682) and Broxton et al. (1995, 50121), following the nomenclature of Vaniman and Wohletz (1990, 9995; 1991, 40085). Unit 3 is subdivided into an upper welded unit and a lower nonwelded unit in the central and western portions of the geologic map of TA-21 (Goff 1995, 49682) in the vicinity of the site. The upper Unit 3 ignimbrite (Qbt3) consists of nonwelded to partially welded tuff and is a prominent cliff-forming unit. The tuff's color is light gray on unweathered surfaces and tan or pale orange on weathered surfaces. Beneath the site, Unit 3 is approximately 50 ft thick and is overlain by a variable thickness of disturbed soil and artificial fill (Unit Qf on the geologic map of TA-21 [Goff 1995, 49682]).

Unit 3 contains 10 to 20% pumice lapilli in an ashy matrix consisting of shards, pumice fragments, and phenocrysts. Phenocrysts, which make up about 35 to 40% of the total solids, are mostly sanidine and quartz. Pumice lapilli are typically 1 to 4 cm long, gray to brown in color, and are only slightly compacted. The overall porosity of the matrix is high (Broxton et al. 1995, 50121).

Abundant fractures extend through the upper units of the Bandelier Tuff, including the Tshirege Unit 3 ignimbrite. The origin of the fractures has not been fully determined, but the most probable cause is brittle failure of the tuff caused by cooling contraction soon after initial emplacement (Vaniman and Wohletz 1990, 09995; Wohletz 1995, 54404). It is probable that past tectonic activity on the Pajarito fault system and the Guaje Mountain Fault Zone (GMFZ) has also caused fracture development, reorientation, and extension (Wohletz 1995, 54404).

The GMFZ extends in a north-south direction through PRS 21-029. At this location, the fault zone is about 300 ft wide but produces no obvious offset or other surface expression in the Bandelier Tuff. Its presence is expressed in the form of a significant increase in fracture density (Wohletz 1996, 58846). The location of the former West Fill Station coincides with the eastern edge of the GMFZ. Fractures in the eastern portion of the site (east of the former West Fill Station) are largely unaffected by the fault zone (Wohletz 1995, 58845).

Average fracture spacing for the DP Tank Farm is about 5 ft but decreases to about 2 ft within the GMFZ. Most of the fractures have strikes between NW and NE, but some have nearly E-W strikes. The fractures range between nearly vertical and nearly horizontal, and the average dip is about 50° to the north. The average fracture aperture is about 0.5 cm, and apertures are not significantly different within the GMFZ, although locally at the former West Fill Station apertures average about 0.75 cm. Additional details of fracture characterization activities at TA-21 are included in Section 2.2.1.1 of this work plan.

Fracture-filling materials are common in the fractures of Unit 3 (Wohletz 1995, 54404). The nature of the fracture-filling materials has not been characterized at DP Tank Farm or at TA-21 in general, although calcite, clays, and detritus are mentioned as materials commonly found in fractures of Unit 2 (Qbt2) which underlies Unit 3. Evidence from other locations at Los Alamos National Laboratory (Laboratory) suggests that the most common fracture-filling material in near-surface fractures is smectite clay (Vaniman and Chipera 1995, 58032; Davenport et al. 1995, 58847). Smectite is a swelling clay that may reduce the near-surface permeability of fracture systems in the tuff. The fracture-filling materials tend to decrease in abundance with depth, so that fractures in the underlying Unit 2 (Qbt2) are largely devoid of fracture-fill materials (Wohletz 1996, 58846).

Any fractures in the tuff below the location of the former West Fill Station would be expected to show a predominant NW to NE strike, northward dip, and a 2- to 5-ft spacing, based on the patterns observed near the GMFZ. If infiltration of fuel oils occurred in this region during the period of operation, the fuel oil would likely have migrated mostly to the north, intersecting the drainage on the north side of the site.

Soils

The entire area of PRS 21-029 has been disturbed by a number of activities including construction, which began in 1946 with the start of operations and continued intermittently through 1985 until operations ceased; removal of the tanks, piping, and roads and backfilling of excavation in 1988; and the removal of 1720 yd^3 of contaminated soil from the location of the former East Fill Station and backfilling in the 1996 voluntary corrective action (VCA). As a result, natural soil profiles are, in general, not well preserved. In some cases, soil has been removed or buried by fill during construction, removal, and backfilling.

The limited amount of undisturbed soil that exists on the site is composed of moderately developed soils developed on Bandelier Tuff and alluvium. Soils belong to either the Hackroy or Nyjack soil series (Nyhan et al. 1978, 5702). The Hackroy series consists of very sandy loam to clay. The Nyjack series consists of moderately deep, well-drained soils that have an A-Bt-C-R profile. Texture ranges from gravelly sandy loam to clay loam. At the DP Tank Farm, the R horizon is fractured Bandelier Tuff that shows signs of incipient weathering and usually has a clay-rich soil matrix along bedrock fractures. Hill slopes are covered in poorly to moderately developed soils formed in colluvium of variable thickness and overlying Bandelier Tuff.

Of particular relevance for this investigation is the distinction between soil and tuff samples when comparing site data for inorganic constituents with background concentrations. This distinction is complicated by historical operations at the site that have influenced the distribution and redistribution of soil and tuff at the site, resulting in mixed profiles. To perform the background comparisons successfully, an accurate record of the sample materials (soil, tuff, or a mixture) will be required.

Hydrology

A watershed map of DP Canyon (Figure 2.1-3) shows that the major sources of runoff to the head of the canyon at the present time include large developed areas of the Los Alamos townsite. As also indicated in the figure, historically the watershed area contained other PRSs including the Zia Motorpool (PRS 00-031[b]), where the Los Alamos National Bank building and parking lot now stand; the underground fuel tanks for the former government filling station (PRS 00-031 [a]) near the intersection of Trinity Drive and Central Avenue at the present location of Hilltop House Hotel; and the DP Road Storage Area (PRS 00-027) and the associated septic system (PRS 00-030[a]) where the Knights of Columbus Hall and parking lot now stand.

Also historical aerial photographs (Appendix F-1.0) show the area of the present-day Mari Mac Shopping Center as an unpaved parking area and the area of the present-day Pine Glen Apartments also undeveloped but, possibly, used for heavy equipment storage (Francis 1993, 58986). The aerial photograph for 1946 suggests that, at that time, the head of DP Canyon extended westward about 200 ft of its present location at a point nearer the intersection of DP Road and Trinity Drive. Anecdotal reports (Francis 1993, 58986; Cramer 1998, 58990) indicate that contractors and residents would dump construction debris into the head of the canyon, and the Zia Company would periodically level the area with soil fill. The Knights of Columbus Hall and parking lot presently sit on this construction debris and fill.

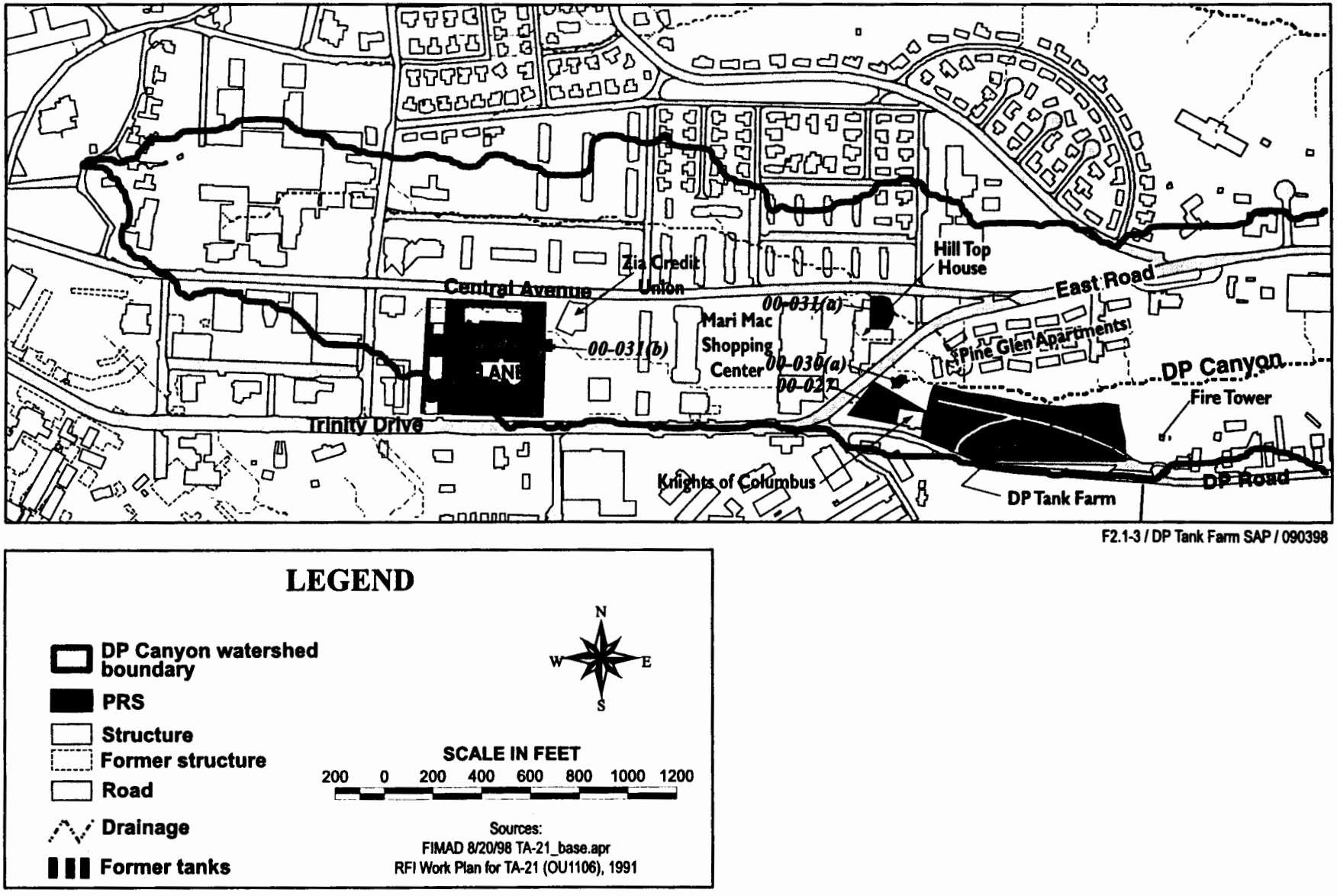


Figure 2.1-3. Map of the upper DP Canyon watershed.

At the site, surface water runoff from DP Tank Farm drains northward into the DP Canyon channel. The stream in this channel is ephemeral, flowing suddenly and heavily following summer downpours and periods of spring snowmelt. Runoff comes from the entire watershed (Figure 2.1-3) and enters the head of DP Canyon near the Knights of Columbus Hall just upstream of the DP Tank Farm site through two 4-ft-diameter culverts. Typically, the channel does not flow for more than a few days and only when supplied by rainfall runoff. It remains dry until the next runoff event except for water collected in deeper pools that often becomes stagnant between runoff events. The north and south banks of DP Canyon are relatively steep in the vicinity of the former DP Tank Farm. Both banks are predominantly exposed tuff covered with leaves, pine needles, branches, and other debris from the numerous trees growing in the canyon. The extensive paved areas of the Pine Glen Apartments drain into DP Canyon from the north, and the area that currently includes the Hilltop House Hotel and the Knights of Columbus properties drains into DP Canyon from the west. Although alluvium and alluvial groundwater exist downstream in DP Canyon, the area of the localized hydrocarbon sheen is close to the head of DP Canyon and consists of bedrock (tuff) with no alluvium. Hence, alluvial groundwater is not present. The larger fractures in the area are filled with sediments or finer-grained materials. The moisture content of these materials varies considerably depending on the time since the last precipitation event.

The Bandelier Tuff is known to be a water-bearing formation only in shallow and localized areas. Based on the absence of saturated zones in the borehole for well LADP-4 (approximately 0.75 miles east of DP Tank Farm) and the 1995 Material Disposal Area (MDA) V deep borehole (0.5 miles east of DP Tank Farm), it is unlikely that a localized water-bearing zone is present in the Bandelier Tuff between the surface at DP Tank Farm and the regional aquifer. No groundwater was encountered in the 95-ft borehole drilled at DP Tank Farm during the 1994 field season (LANL 1996, 52270).

The regional aquifer beneath PRS 21-029 is at an elevation of approximately 5900 ft (determined in Test Well 2, Pueblo Canyon, and in Otowi 4, Los Alamos Canyon), chiefly within sediments of the Puyé and Tesuque Formations (Purtymun 1995, 45344; Broxton 1995, 50119). Thus, for mesa-top sites, such as PRS 21-029, that are at or near TA-21, more than 1200 ft of tuff and volcaniclastic sediments separate the surface from the regional aquifer. Because of the thickness of the units between the surface and the regional aquifer, coupled with the general absence of water (the absence of saturated conditions in the units, hence extremely low hydraulic conductivity) contaminants from the site are unlikely to have reached the regional aquifer.

A perennial spring (DP Spring), located on the north side of lower DP Canyon 0.62 mile east-southeast of well LADP-4, discharges at a rate of 1–4 gal. per minute (Broxton 1995, 50119; Purtymun 1995, 45344). Possibly the source of water at DP Spring is alluvial groundwater in lower DP Canyon (well downstream of the DP Tank Farm) or, alternatively, an intermediate perched zone within the Bandelier Tuff (between Units 1g and 1v) beneath DP Mesa (Broxton 1995, 50119). However, no intermediate perched zone within the Bandelier Tuff was encountered in the borehole for well LADP-4 to support the latter hypothesis. Study of DP Spring is ongoing in the Environmental Restoration (ER) Project's canyons investigations (Section 2.2.1.2 of this work plan).

Wildlife Habitats

The mesa top at DP Tank Farm is within the town site. The surrounding area has heavy commercial development and urban disturbance. Although vegetation on the mesa top was originally disturbed by DP Tank Farm construction and activities, the area has been heavily revegetated since the 1988 facility decommissioning and the 1996 VCA at the East Fill Station. The mesa top is currently open grassland with scattered forbs and shrubs. Vegetative cover is approximately 90%. The canyon area immediately

adjacent to DP Tank farm is ponderosa pine/Gambel oak, with an understory of scattered grasses, forbs, and shrubs. Vegetative cover in this part of DP Canyon is approximately 70–90%. Plants present on the mesa top and in the canyon showed no visual indications of stress.

DP Canyon at this location is very shallow and narrow, and wildlife usage of this area is limited to species tolerant of human encroachment. Mammal tracks (raccoon, deer) were noted in the streambed, and scattered fossorial mammal burrows are present on the mesa top. Ephemeral aquatic communities are present in the streambed, but the quality of aquatic habitats is potentially being degraded because of runoff from the townsite. The affected habitat in this area is assessed in the ecological surveys of TAs-1, -32, and -21 (Bennett 1992, 58236; Biggs 1993, 49730). As these surveys show, there are no threatened or endangered species in the immediate vicinity of DP Tank Farm. DP Canyon joins Upper Los Alamos Canyon approximately 1.9 miles east of DP Tank Farm. Upper Los Alamos Canyon is identified as roosting and foraging habitat for Peregrine falcon and Mexican spotted owl, both federally listed threatened and endangered species. Habitat for these two species is not present at DP Tank Farm or within DP Canyon immediately downstream of the tank farm. The Ecological Scoping Checklist for the site is provided in Appendix E-5.0 of this work plan.

Anticipated Disposition of the Site

The DP Tank Farm site property, which is currently inactive and owned by Department of Energy (DOE), is expected to be transferred to Los Alamos County for commercial use pending resolution of regulatory and remediation issues. TA-21, of which DP Tank Farm is a part, is subject to Public Law 105-119, which indicates that DP Mesa is being considered for transfer to Los Alamos County or San Ildefonso Pueblo. It is anticipated that Los Alamos County will zone the site for industrial use, considering the light industry that already exists on DP Road. San Ildefonso Pueblo has not indicated the potential use of land transferred to them.

2.1.2 Operational History

Potential Release Site 21-029, DP Tank Farm Site

The DP Tank Farm site is the former location of two fill stations and 15 storage tanks that contained petroleum hydrocarbon products including leaded and unleaded gasoline, diesel, kerosene, and No. 2 fuel oil. The tank capacities reportedly ranged between about 2100 gallons and about 51,000 gallons. DP Tank Farm was operational from January 1946 to February 1985. The tanks were filled by gravity from tanker trucks parked on DP Road (and the remains of one fill port can still be found there as described in Section 2.2.1.1), and smaller vehicles would drive through the east and west gates onto the access road to the fill stations (Figure 2.1-2) (Francis 1993, 58987). The rate of fuel pumpage at the tank farm is not known in detail, but Francis (1993, 58987) recalls that peak fuel distribution occurred in 1946 or 1947 when approximately 7.5 million gallons were distributed. Structures at DP Tank Farm site consisted of tanks, fill ports, valve boxes, the East and West Fill Stations, access roads, a large berm on the north side of the site extending from the West Fill Station to the east end of the site, and large culverts that drained into outfalls on the north-facing slope of DP Canyon.

The aerial photographs of the area in Appendix F-1.0 show that an earthen berm was built sometime between 1974, when the berm is not seen in the aerial photograph, and 1986, when the berm is plainly visible along the north side of the access road from just east of the West Fill Station eastward past the East Fill Station and curving around the eastern downhill end of the area. The purpose of the berm was to contain any large fuel release, particularly from the tanks that were lying horizontally and had no

containment berms. The two vertical tanks (TA-21-ATF-9 and TA-21-ATF-10) had berms surrounding their bases, as clearly seen on the aerial photographs taken in 1958, 1965, 1974, and 1986 (Appendix F-1.0). The berm was reported in 1983 to be 397 ft long and 4 ft high and capable of containing 377,000 gallons (Paxton 1983, 698). The aerial photographs do not suggest any major spills during the period of operation, and no such reports have been found in the archives. At the time of decommissioning in 1988, the berm soils were considered to be clean and were used as backfill probably in the area of the East and West Fill Stations and the access road.

A storm drain ran from near the West Fill Station northward into DP Canyon; the remains of the drain (a 24-in.-diameter corrugated pipe) can be found today on the south bank of DP Canyon near the former location of the West Fill Station. Runoff entering this storm drain would be expected to have come from the south in the area of some of the tanks, from the southwest on the access road to the southwest of the West Fill Station, from the west on the road connecting the DP Tank Farm with the DP Road Storage Area to the west (now PRS 00-027 and the Knights of Columbus Hall and parking lot), and possibly, some from the east along the access road (Figure 2.1-2).

A second storm drain daylighted at DP Canyon north of the East Fill Station; the location of the inlet to this drain is unknown. The drain is not shown on the original site drawing (Zia Company 1948, 24947), but a photograph taken during the 1996 VCA at the former location of the East Fill Station shows a portion of a drain pipe being excavated (LANL 1996, 55347). The remains of this drain (an 18-in.-diameter corrugated pipe) can be found today on the south bank of DP Canyon near the former location of the East Fill Station (Section 2.2.1.1).

A 14-in. pipe with gate valve through the berm was also located at the northeast corner of the site (Figure 2.1-2). At the decommissioning in 1988, this pipe and gate valve were removed along with the berm. The field logs of the decommissioning (McInroy 1988, 1641) mention that there was no visual evidence that fuels had ever been released through the gate valve (or even that the gate valve had ever been opened).

As discussed further in Section 2.2.1.1 below, the tanks were inspected for evidence of corrosion and contents, apparently, in August 1980 (Bend 1980, 3688). The objective of the inspection was to gather information to "facilitate disposal of the tank farm by determining the condition of the tanks and the diesel fuel that had been in storage for several years." The tanks were found to be intact; in most cases, the original coatings were intact, and the worst condition noted was a slight rust film (Bend 1980, 3688).

In 1985, further consideration was given to the decommissioning of the tank farm and particularly the implications of the RCRA Subtitle C requirements to the disposal of fuels, tanks, and any contaminated soils. There was suspicion at the time that the tanks would contain sludges that, because some of the tanks had contained leaded gasoline, would be RCRA characteristic hazardous wastes (Ahlquist 1985, 1635). Ahlquist (1985, 1635) also believed that "there is a high probability that the tanks have leaked and that the soil in the vicinity of the leak contains lead in hazardous quantities (by RCRA definition)." The Environmental Surveillance Group (HSE-8 at the time) had soil samples analyzed by the extraction procedure (EP) toxicity test for lead and arsenic and determined that "surface soil is not a hazardous waste..." (Gunderson 1985, 37311), that is, if the soil were excavated, it would not be a RCRA characteristic waste for lead or arsenic [Title 40 Code of Federal Regulations (CFR) Part 261.24, Identification and Listing of Hazardous Wastes]. They also recommended procedures for handling the diesel tanks (10 of the 15), the gasoline tanks (3 of the 15), and any soils found to be contaminated by leaks, in accordance with RCRA at the time the tanks are *exhumed*. The two remaining tanks were believed to have contained kerosene at the time. However, in an earlier memorandum, Ahlquist (1985, 1636) notes that 3 of the 15 tanks had been used for gasoline and the remaining 12 for diesel or kerosene.

The exact contents of each tank at DP Tank Farm during the period of operation (1946–1985) cannot be determined, and it is possible that contents varied over the period. The potential contaminants at the site are expected to consist of petroleum-related hydrocarbons. However, given the nature of historical operations, it is possible that low levels of metals, particularly lead, might be present at the site. Large trucks were driven around the site, and leaded gasoline was almost certainly used extensively at the time of operation. In addition to the petroleum-related products stored in the tanks, one tank was known to have contained ethanol, possibly as a source of ethanol for gasohol (Francis 1993, 58986 and 58987) at the time the tank farm became inactive in 1985. Details on the use of ethanol over the period of operations could not be found, however. Francis (1993, 58986) also recalled *cleaning solvent* being distributed from the tank farm at times. His best recollection of the cleaning solvent is that it was Stoddard solvent, consisting of mineral spirits or petroleum distillates. There is also a possibility that oil-related products were used for dust suppression at the site. No documentation exists to verify this; however, it was not an uncommon practice during the time frame of operation of this tank farm. Nevertheless, there is no evidence that the tanks were ever used to store anything other than petroleum products (fuels and petroleum distillates) and 30-50% ethanol, which was possibly used to make gasohol.

At the time of the August 1980 inspection of the tanks noted above, samples were taken from the tanks sometime between August 5, 1980, the date that the inspection and sampling was directed, and October 7, 1980, the date of the memorandum reporting the results (Bend 1980, 3688). Bend states that "Samples of the fuel from each tank were drawn off and forwarded to E. W. Saybott and Company to be analyzed in comparison with Federal specifications for diesel fuel oil UV-F-800B. The results reported by the Saybott Laboratories indicate that, with the exception of one tank containing 10,000 gallons, the diesel fuel on hand meets all of the specifications for use as a motor fuel since the cetane ratings are within the allowed numbers of 43 to 48. The approximate 10,000 gallons in question have a cetane [rating] of 41.3 and, in the opinion of the lab, would not cause a significant problem if used as a motor fuel."

As discussed further in Section 2.2.1.2 below, four liquid samples were taken on January 17, 1985, from selected tanks; the samples were labeled A through D. The author notes (LANL 1985, 37841) that samples A through D were "fuel-range petroleum distillates with sample A containing 30–50% ethyl alcohol." A hand-drawn field sketch, apparently associated with this memorandum, shows the location of sample A to be proximate to tank TA-21-ATF-11.

From these reports (Bend 1980, 3688; LANL 1985, 37841) of the sampling and analyses of the tank contents, it may be concluded that

- in 1980, the tanks all contained fuels of various grades, mostly diesel;
- in 1980, one of the tanks, probably tank TA-21-ATF-11, contained a lower-grade fuel or ethanol, and it is most likely that the lower cetane rating of the fuel sample was due to ethanol (ethyl alcohol),
- by 1985, 10 (or 12) of the 15 tanks contained diesel, 3 contained gasoline, (Gunderson 1985, 37311), 1 (probably tank TA-21-ATF-11) contained a fuel-range petroleum distillate with 30–50% ethanol (LANL 1985, 37841) or "residual ethanol alcohol" (Paxton 1983, 698), and 1 tank contained kerosene [while the identification of contents is not certain, the records of activities during the decommissioning in 1988 discussed below indicate that the contents of the tanks, if any, were still fuel-range petroleum distillates at that time]; and
- as of 1980, no significant corrosion of any of the tanks could be observed (Bend 1980, 3688).

It was believed that all tanks and structures at the site were decommissioned and removed in May 1988. Recent walkovers of the site, however, found the remains of one fill port near DP Road, suggesting that piping in that area may not have been removed completely. According to the field notes of the decommissioning (McInroy 1988, 1641), the remaining contents of the tanks, pipes, and valve boxes were drained through the existing piping network into forty 55-gallon drums and ten 30-gallon drums. The contents were segregated to some degree by type of fuel and solids content (of sludges). The drums were sent to TA-54 for final disposition.

The field notes from the decommissioning (McInroy 1988, 1641) indicate that surficial contaminated soils at the location of the two former fill stations were removed; a total of 15 truckloads of 5 yd^3 each were removed and taken to TA-54 for final disposition.

Contrary to the concerns expressed by Ahlquist (1985, 1635) that the tanks could have leaked significantly, at site decommissioning it was found that only a gasket associated with one tank (TA-21-ATF-10) had leaked. The gasket is presumed to have been located where the gravity flow pipe met the tank (McInroy 1988, 1641). Approximately 4 yd^3 of contaminated soil were removed at the location of the leak at the time of tank removal. The tank contained diesel fuel; therefore, because diesel fuel would not have contained tetraethyl lead as an additive, the contaminated soil was not considered a [characteristic] hazardous waste (LANL 1991, 7529, p. 14-45). The remaining tanks and underground distribution piping were reported to have been in good condition at removal, consistent with their conditions as reported earlier by Bend (1980, 3688), and no other leaks had occurred (McInroy 1988, 1641).

As discussed in Section 1.0 and Section 2.2.1.2 of this work plan, the results of the screening assessment for the 1994 RFI data indicated that all of the chemicals of potential concern (COPCs) present in the DP Tank Farm soils were associated with petroleum products. There was no evidence that hazardous wastes had been on the site. However, petroleum products were detected at the site at levels exceeding 100 ppm. These levels of petroleum products constituted a *suspected release*, as defined in the State of New Mexico Environment Improvement Board Underground Storage Tank Regulations, Part I, Section 102, Definitions (EIB/USTR-1, §102, Paragraph XX), and was reportable in accordance with EIB/USTR-2, §204, Paragraph A (NMED 1996, 58202). The suspected release was reported to the New Mexico Environment Department (NMED) Underground Storage Tank (UST) Bureau in April 1995. COPCs at concentrations exceeding screening action levels (SALs) were found in soil samples only at the locations of the former fill stations (LANL 1996, 52270, Figure 5-3).

An investigation was performed in May 1995, in accordance with NMED UST regulations at EIB/USTR-12, §1205, to define the extent of petroleum contamination. The results of the RFI and UST investigations were reported in the RFI Report for Potential Release Site 21-029 (LANL 1996, 52270). The RFI report recommended no further action (NFA) at the site under NFA Criterion 3 (currently Criterion 4 in the installation work plan (IWP) (LANL 1996, 55574, p. 3-11); the site was characterized and/or remediated under a different authority (in this case the NMED UST regulations), which should adequately address corrective action.

Site remediation was not anticipated to be required under the NMED UST regulations because highly contaminated soils, as defined in EIB/USTR-12, §1201, Paragraph G, were not found to be present nor was the soil contamination located within 50 ft of groundwater. As a result, site closure and an agreement that no further action was necessary at this site were expected from NMED. The DP Tank Farm property, currently owned by the DOE, was at that time and still is expected to be transferred to Los Alamos County for commercial use in the foreseeable future or San Ildefonso Pueblo for uses yet to be decided.

Therefore, in the interests of best management practices, the Laboratory planned to voluntarily remediate the site to a soil cleanup level of 1000 ppm total petroleum hydrocarbons (TPH), 500 ppm of benzene, toluene, ethylbenzene, and xylenes (collectively known as BTEX) combined, and 10 ppm benzene. Petroleum-contaminated soils with these concentrations or greater are regulated as a New Mexico special waste; therefore, remediation of the site to these cleanup levels was intended to assist in the transfer of the land such that in any future excavations at the site, New Mexico special wastes would not be encountered. An additional objective in the remediation, added by DOE Los Alamos Area Office (LAAO) before the start of remediation, was to remove any benzene-contaminated soil to a cleanup level of 1 ppm so that a deed restriction could reasonably be assumed to be unnecessary if the site was developed for commercial use. A VCA plan (LANL 1996, 55344) for remediation at the site was prepared in April 1996.

Remediation at the location of the former East Fill Station at the site was conducted in May 1996 in accordance with the VCA plan (LANL 1996, 55344). Approximately 1720 yd^3 of petroleum-contaminated soil and tuff were removed, loaded on trucks, and transported off-site for land farming.

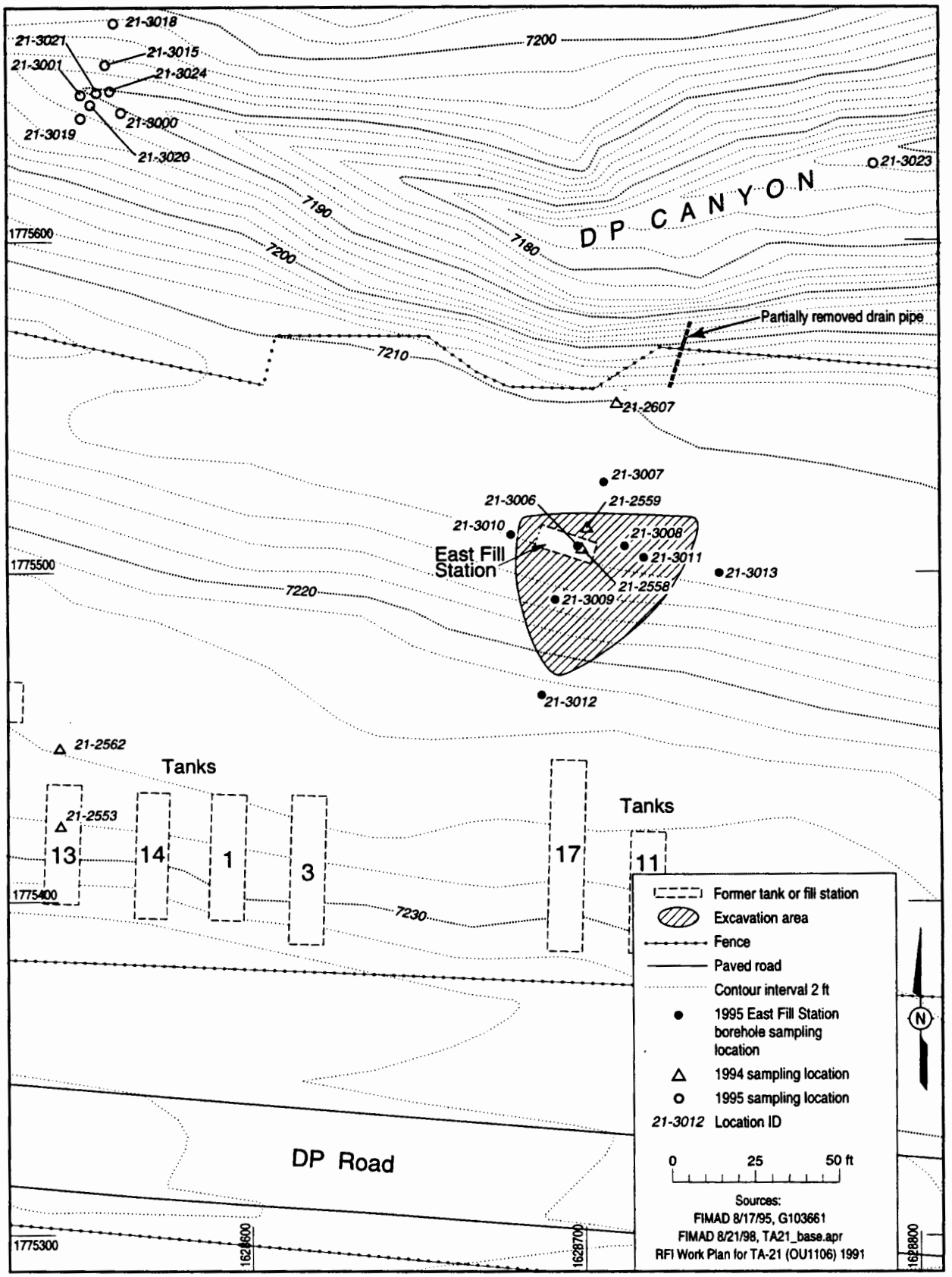
The following discussion of the VCA is taken from pages 7 through 8 of the VCA report prepared in August 1996 (LANL 1996, 55347).

In the 1994 RFI and 1995 UST investigations (LANL 1996, 52270), borehole samples collected in the area of the former West Fill Station did not contain TPH, BTEX, and benzene at concentrations greater than their respective cleanup levels, identified as the New Mexico special waste concentrations discussed above. In the 1995 UST investigations at the former East Fill Station location, TPH was detected at concentrations above 1000 ppm in samples collected from four boreholes at depths ranging between 4 and 35 ft below ground surface (bgs), BTEX was detected at concentrations above 500 ppm in samples from two boreholes at depths between approximately 9 and 20 ft bgs, and benzene was detected at concentrations above 1 ppm in samples from two boreholes at depths between 9 and 25 ft bgs. Therefore, remedial activities concentrated on the area of the former East Fill Station.

Remedial activities were conducted using a Caterpillar 235 trackhoe and a Caterpillar 966D front-end loader. Approximately 1720 yds^3 of petroleum-contaminated soil and tuff were excavated with the trackhoe and directly loaded onto trucks for transport to Envirotech, a land farm located in Farmington, New Mexico. Envirotech, who also supplied approximately 1560 yds^3 of uncontaminated backfill material, was to remediate the material and make it available for reuse as road base or fill material. The approximate extent of the excavation is shown in Figure 2.1-4.

The excavation was guided by the use of field screening with a Thermo Environmental Model 580B organic vapor meter (OVM), as well as BTEX and TPH analyses by the mobile chemical analytical laboratory (MCAL). Headspace analysis with the OVM was conducted on material collected from the side walls and bottom of the excavation at the same time samples were collected for analysis by the MCAL and a fixed laboratory. The results of the analyses of these samples are discussed in Section 2.2.1.2.

Contaminated soil with petroleum products at concentrations above cleanup levels, as discussed above, was removed from the site with the exception of stained material associated with fractures in the tuff. Stained tuff was observed adjacent to and along some fractures. Photographs of stained fractures in the excavation are provided in Appendix F-3.0 of this work plan.



F2.1-4 / DP Tank Farm SAP / 100598

Figure 2.1-4. Approximate extent of excavation at DP Tank Farm, PRS 21-029.

Although analytical results indicated that the cleanup level for TPH had not been met for these samples, no further removal was conducted because the small volume of contaminated material remaining was associated with staining that was observed adjacent to and along fractures only. The remaining contaminated tuff alongside the fractures constituted a small volume that would be difficult and damaging to remove because of the large volume of clean tuff that would have to be excavated to remove the stained tuff.

Uncontaminated backfill material and uncontaminated overburden provided by Envirotech were placed in the excavation to return the site to its original grade. The backfill was not structurally compacted. Peat moss was tilled into approximately the top 6 in. of the site to provide organic material to the backfill. The site was reseeded with a native grass seed mixture, and Curlex blankets were placed over the formerly excavated area for erosion control. A VCA report was prepared and submitted in August 1996 (LANL 1996, 55347) (NMED has not commented directly on this report).

On June 12, 1997, the NMED Hazardous and Radioactive Materials Bureau issued a letter, RE: Denial of RFI Report Dated January 1996 for Los Alamos National Laboratory LA-UR-95-3693 Technical Area 21 SWMU 21-029 (Dinwiddie 1997, 58547). The Laboratory responded to the items in the denial letter with a letter dated July 17, 1997 (Jansen and Taylor 1997, 56512). However, in a transmittal letter dated June 8, 1998, NMED issued a compliance order (Kelley 1998, 58548). The compliance order alleges under Findings of Fact, Items 20, 21, and 22, that the Laboratory failed to (1) address all necessary action to determine and verify the nature and extent of releases of hazardous waste or hazardous constituents from PRS 21-029; (2) fully evaluate potential contaminant migration pathways at and from the PRS; and (3) describe actual or potential receptors, including environmental systems that are susceptible to contaminant exposure from the facility. The Laboratory responded to the compliance order with an Answer by letter dated July 10, 1998 (LANL 1998, 58912).

Potential Release Sites and Other Potential Contaminant Sources Near the Head of DP Canyon

Other potential release sites (PRSs) and historical sites associated with former operations at the Laboratory and at the Los Alamos town site are located in the drainage area of DP Canyon and in the vicinity of the DP Tank Farm site (Figure 2.1-3). These surrounding sites also may have impacted DP Canyon and may have produced impacts to DP Canyon that are indistinguishable from impacts (specifically, the presence of the localized hydrocarbon sheen area discussed in Section 2.2.1.2) presently attributed to the DP Tank Farm. A brief description of surrounding sites is presented to provide the appropriate context of potential impacts to DP Canyon from the surrounding sites. The surrounding sites are presented in order from west to east, which is from upgradient of the canyon, progressing down the canyon.

PRS 00-031(a)

PRS 00-031(a), the site of a former service station, is described in the RFI work plan for operable unit (OU) 1071 (LANL 1992, 7667). The site is located at the northeast corner of the Hilltop House Hotel. The former Zia Company gasoline service station occupied the site from circa 1943 until 1967. The site was used as a gasoline service station and automobile repair shop (LANL 1990, 7511; Zia Company 1962, 23426 and 23427; Zia Company 1960, 0722; LANL 1992, 7667). The USTs consisted of at least two 10,000-gallon tanks that stored gasoline (LANL undated, 47474 and 47495). The tanks were buried beneath 5 ft of cover materials (Zia Company 1959, 0720)

In 1967, Bennie Moore leased the site from the US Government and continued to operate the service station as Moore's Motors, a Mobil gasoline service station and automobile repair shop. In 1968, the US Government transferred the site to private ownership. Philip and Bess Giber purchased the property on November 1, 1968, and soon thereafter, on November 26, 1968, transferred title to Aries Company of which Mr. Giber was president. The property was legally known as "Tract S, Eastern Area No. 2" (Francis 1997, 58707).

Bennie Moore leased the property from the Aries Company and continued to operate the service station and convenience store as Moore's Motors from November 1968 until 1974 when the property was sold to Waterchris a company owned by Robert Waterman. He continued to operate the service station and continued development of the property by constructing a hotel, the Hilltop House Hotel, along the west side of the property. The hotel and service station were renovated in 1988 and 1989 when the Hilltop House Hotel was extensively remodeled, and the service station was relocated to the north side of the property (Francis 1997, 58707).

Activities associated with the service station included refueling vehicles with leaded gasoline; changing engine oil, transmission fluids, gearbox fluids, and antifreeze coolant fluids; and providing engine repairs. Potential contamination could have resulted from leaks and spills associated with the service bays, the gasoline pumps and the associated piping, and underground tanks that were connected to the pumps. Given the predominant use of tetraethyl lead in gasoline during the period of operation, leaded gasoline was likely the primary source of any contaminants, but potential soil contamination could also be associated with the disposal of used oil, grease, and solvents that were used during normal operation of any service station. No documented releases are known to have occurred.

In 1988 and 1989 when the gasoline pumps were relocated to the north side of the hotel, three new fiberglass USTs were installed near the northwest corner of the Hilltop House Hotel building. With the relocation, the two USTs that had been installed by the US Government were removed from the area north of the entrance of the Hilltop House Hotel. No records or anecdotal reports have been found describing the condition of the tanks and the underlying soil at the time the tanks were removed. The site of the former USTs was leveled and paved with asphalt for the driveway and parking area for the hotel (Francis 1997, 58707).

As part of the RFI of PRS 00-031(a), the area of the former USTs was surveyed using geophysical techniques to determine if any USTs remained at the site (LANL 1992, 7667). On March 20, 1993, ground-penetrating radar (GPR) and electromagnetic measurements were obtained at the former location of the USTs. The results of the geophysical surveys did not indicate the presence of additional USTs (LANL 1993, 15022). Because no USTs were detected as a result of the geophysical surveys, no boreholes were drilled at the site to determine if potential contamination was present.

PRS 00-031(b), Zia Motor Pool

The Zia Motor Pool, PRS 00-031(b), was located further upgradient in the townsite (Figure 2.1-3). The area was redeveloped in 1995 with the Los Alamos National Bank building and the Mountain Community Bank building, all of which have extensive paved parking areas. RFI activities (LANL 1996, 54913) indicated that the only COPCs at this site were petroleum-related. Extensive remediation activities were performed before construction of the bank buildings and associated structures. This site is introduced at this time for reference only. It is sufficiently far upgradient from the current head of DP Canyon and the localized hydrocarbon sheen area that it is considered an unlikely source for the sheen. If the data

collected according to this work plan indicate otherwise, then further analysis of the available data for the Zia Motor Pool PRS will be performed.

PRS 00-027

PRS 00-027, the DP Road Storage Area, is described in Chapter 5.7 of the RFI work plan for OU 1071 (LANL 1992, 7667). This site was used as a fuel tank farm beginning in 1946. Aerial photographs (Appendix F-1.0) and engineering drawings from 1946 and 1947 indicate that at least eight aboveground fuel tanks and three fill stations were located in the DP Road Storage Area. In mid-1948, the fuel tanks and fill stations were relocated to the DP Tank Farm, PRS 21-029 (LANL 1990, 7511), and the fueling functions were transferred to DP Tank Farm.

After the fuel tanks were removed in mid-1948, the DP Road Storage Area was converted to a drum storage area where metal 55-gallon drums of lubricants were stored until they could be distributed to various job sites and craft shops at the Laboratory. The storage capacity of the DP Road Storage Area (PRS 00-027) was approximately 600 to 700 drums. The drum storage area consisted of six separate compartments, each approximately 38 ft wide (LANL 1990, 7511). The compartments were separated by 2-ft high earthen berms around the northern perimeter and a concrete retaining wall along the southern perimeter. The floor of each compartment was sloped to the north and covered by 2 in. of gravel.

The storage compartments were apparently removed in the early 1960s when the site was transferred to private ownership. Broken concrete debris was apparently used as fill material north of the storage area, at the edge of DP Canyon, where 9 ft of fill material was found covering the former access road to the DP Storage Area and the DP Tank Farm (LANL 1992, 7667) (Figure 2.1-2). The entire area of PRS 00-027 has been disturbed by construction and removal of the former tanks and storage compartment. As a result, natural soil profiles are, in general, not well preserved. In some cases, soil has been removed or buried by fill during construction of subsequent structures erected at the site. Soils, if present at the site are similar to those at the DP Tank Farm.

The drum storage area was decommissioned in the early 1960s, and the site was transferred to private ownership in 1962. The Santa Fe Diocese purchased the property and built the Knights of Columbus Hall building at the site in the early 1960s.

PRS 00-030(a)

PRS 00-030(a) consists of a septic tank and associated piping that served the former fuel dispatch office building that was initially associated with the DP Road Storage Area fuel tanks (PRS 00-027) and later with the DP Tank Farm (PRS 21-029). The septic system was installed circa 1943 or 1944 to handle sanitary wastes discharged by the former DP Road Storage Area fuel dispatch office. After mid-1948 the dispatch office served both the DP Road Storage Area and the DP Tank Farm until circa 1964, when the site was sold to private ownership. The septic system may have been unused sometime before 1964.

This septic system was used from circa 1943 until, presumably, about 1960 when the DP Road Storage Area was decommissioned. It was excavated in June 1996 according to the VCA completion plan for PRS 00-030(a) (LANL 1996, 54354). The tank was found to be intact. The description of all field activities, analytical results, and screening assessments performed as part of the VCA are described in the VCA Completion Report for PRS 00-030(a) (LANL 1996, 59576).

DOE Fire Station No. 2

DOE Fire Station No. 2 with a training tower is located adjacent to the DP Tank Farm to the east. The fire station was constructed before 1958 and was probably built in the mid-1950s. The fire station is located on land owned by the DOE. According to the Los Alamos County attorney (personal communications with Jo Cramer, July 1998), recent research on the property for the possible transfer to private ownership was unable to determine the exact date the fire station was constructed. However, the fire station is present on 1958 aerial photographs (Appendix F-1.0) and is still in use in 1998. The training tower is a concrete mock-up of a tall-building stairwell that is used for fire drill training purposes. Fires for training are set on the top of the tower and a biodegradable foam is used to extinguish the blaze. Minor vehicle maintenance activities are assumed to have taken place at the site as well.

Fire Station No. 2 was not transferred to Los Alamos County in 1998 because of the proximity of the DP Tank Farm, PRS 21-029, and the possibility of residual contamination. No PRSs are identified on this site, and no RFI or other investigation has been conducted.

Pine Glen Apartments

This property is located on the north side of DP Canyon directly across the canyon from the DP Tank Farm. Anecdotal reports (Francis 1997, 58549) suggest that the property was occupied by a contractor in the late 1940s or early 1950s. Although the name and type of contractor is not known, Francis (1997, 58549) recalls that the contractor parked a vehicle fleet on the site. The contractor probably moved to East Jemez Road in the early 1950s when the Atomic Energy Commission (AEC) required all contractors to relocate (Francis 1997, 58549). The property remained vacant until the Pine Glen Apartments were constructed in 1976. If a vehicle fleet was parked there as suggested by Francis (1997, 58549), potential contaminants such as spilled fuels, waste oil, and oil drippings from parked vehicles could have been deposited and could provide a source for petroleum hydrocarbon contamination in DP Canyon.

2.1.3 Waste Characterization

All evidence from various maps, memorandums, and records of sampling and analysis at PRS 21-029, DP Tank Farm, and the results of all investigations conducted to date indicate that no solid wastes, and thus no hazardous wastes, were ever stored at the site. Records indicate that the 15 tanks contained only petroleum products including leaded and unleaded gasoline, diesel, kerosene, and No. 2 fuel oil. One tank was known to have contained ethanol, possibly as a source of ethanol to make gasohol (Francis 1993, 58986 and 58987), at the time the tank farm became inactive in 1985. And as noted in earlier sections, Francis (1993, 58986 and 58987) also recalls Stoddard solvent (mineral spirits or petroleum distillate) being distributed at the tank farm at times.

Results of analyses of soil and tuff samples before and during the 1994 Phase I RFI, as discussed in Section 2.2.1.2 below, indicated that only petroleum-related products were present as contaminants at the site, and only seven of those—benzene, 1,2,4-trimethybenzene, 1,3,5-trimethylbenzene, butylbenzene, 4-isopropyltoluene, 2-methylnaphthalene, and propylbenzene—were considered to be COPCs. Soil samples collected beneath and/or around the tanks both before (in 1985) and after (in 1988) tank removal and analyzed for the characteristic of EP Toxicity showed levels of metals (lead and arsenic) in the EP toxicity leachate far below the criteria in Title 40 CFR Part 261.24, Identification and Listing of Hazardous Wastes, Table I.

2.2 Investigatory Approach

2.2.1 Existing Data

This section describes the relevant data (both nonsampling and sampling) and information obtained to characterize the DP Tank Farm site (PRS 21-029) and the area immediately surrounding the site, including other PRSs, and the chronology and pattern of development upgradient of the site in the drainage area of DP Canyon and downstream. Section 2.2.1.1, Nonsampling, discusses nonsampling data at DP Tank Farm and surrounding areas. Section 2.2.1.2, Sampling, discusses data collected at DP Tank Farm site and surrounding areas.

2.2.1.1 Nonsampling

Fractures at TA-21

An extensive field survey of fractures in the Bandelier Tuff at TA-21 was conducted in 1992. Wohletz (1995, 54404) measured strike, dip, and aperture for a total of 1662 fractures in Unit 2 of the Tshirege Member of the Bandelier Tuff (Qbt2) exposed on cliffs below TA-21 in Los Alamos Canyon. The fracture traverse was 7312 ft long, extending east from a starting point 1200 ft east of the access gate to TA-2. The western end of this traverse is roughly due south of the eastern end of the DP Tank Farm site. Fractures were plotted on photomosaic maps of the canyon wall and their horizontal position calculated relative to the starting point of the fracture traverse. Linear fracture densities for 10- and 100-ft intervals, cumulative fracture width (sum of all fracture apertures within a given interval) for 10- and 100-ft intervals, and the relative fracture dips from vertical were calculated from the field data.

The average background fracture spacing at TA-21 is about 5 ft. A 1500-ft-wide zone starting near MDA V and extending to the east has a fracture spacing of 1 to 2 ft. The spacing decreases abruptly near MDA V and then increases gradually, reaching the 5-ft background value about 1500 ft to the east. Wohletz suggested that this fracture zone represents a fabric of the Pajarito Fault Zone. Measured strikes show that the fractures make up two conjugate sets trending NW and NE. The NE-trending set (988 fractures) have a mean strike of N43E, and the NW-trending set (674 fractures) have a mean strike of N33W. Fracture dips range from nearly horizontal to vertical, although most are steeply dipping. The majority of fractures in both the NE- and NW-trending sets dip steeply toward the north, with mean dips of 73° and 74° from the horizontal, respectively.

Fracture apertures range from 0 cm to 15 cm. The NE and NW sets of fractures have mean apertures of 0.82 cm and 0.93 cm, respectively. These mean apertures increase to 1.1 cm and 1.5 cm within the fracture zone. The background cumulative fracture width is about 0.5 m of fracture opening per 100-ft interval. This increases to about 1.4 m per 100-ft interval within the fracture zone. Fracture apertures were observed to decrease both above and below Unit 2, although no data were recorded for those units. Fracture fillings were described as sparse to absent in Unit 2 but prominent in Unit 3 (Qbt3).

Fractures at DP Tank Farm

A 1995 study was intended to aid the understanding of possible fracture-controlled infiltration of petroleum products from the DP Tank Farm. This study used the same procedures as the TA-21 fracture study discussed above. A draft report (Wohletz 1995, 58845) documents the characterization of 157 fractures in a road cut running from the former West Fill Station west toward the Knights of Columbus Hall and 288 fractures on the north wall of Los Alamos Canyon, about 750 ft south of the road cut.

Fracture density data from this study confirm the presence of the N-S-trending GMFZ, from about 250 ft to 600 ft east of the intersection of Trinity Drive and DP Road. The former West Fill Station location is on the eastern margin of the fault zone. The general background fracture spacing at the DP Tank Farm averages about 5 ft, but the spacing decreases to an average of about 2 ft within the GMFZ. In the 100-ft section centered on the West Fill Station location, fracture spacing is about 1.7 ft.

The DP Tank Farm and Los Alamos Canyon fracture data sets show some differences with respect to fracture strike. The mean strike for fractures on the DP Tank Farm road cut is N16W, and the data show crude WNW and N modes. The mean strike for the Los Alamos Canyon fractures is N32E, with the data showing NW and NE modes. Along the road cut fracture traverse, NW-trending fractures (mean N44W) are about 50% more abundant than NE-trending fractures (mean N40E).

The fractures are dominantly vertically oriented. The mean of all dips is 89° and 74° for the DP Tank Farm and Los Alamos Canyon fractures, respectively. When all fractures are considered together, dips are generally toward the north. The NW-trending fracture set at DP Tank Farm, however, has slightly more fractures dipping toward the south (52) than toward the north (40). In one area about 100 ft west of the location of the former West Fill Station, the dominant dip is toward the south. Fractures at the location of the former West Fill Station have an average dip of 50° from the horizontal toward the north.

Mean fracture apertures are 0.5 cm for the DP Tank Farm transect and 0.6 cm for the Los Alamos Canyon transect. There is no significant difference in mean fracture aperture within the GMFZ. At the former West Fill Station, however, the mean aperture increases to about 0.75 cm. Although the mean fracture aperture does not increase in the fault zone, the decrease in fracture spacing results in an increase in cumulative fracture aperture from about 20 cm per 100-ft interval to about 40 cm per 100 ft.

The fracture strikes, dips, and density were extrapolated and used to infer the influence of fractures on infiltration into the tuff at the location of the former West Fill Station. The data suggest a N-S elongation of infiltration, with a slight inclination toward the west. If this inference is correct, a contaminant plume migrating downward along fractures from the West Fill Station might be expected to intersect the upper DP Canyon drainage to the north of the DP Tank Farm. The study did not consider the possible influence of fracture-filling materials on contaminant migration in this area; however Davenport et al. (1995, 58847) note that the filling of surficial fractures in the tuff by swelling clays (smectites) tends to clog the fractures, reducing their ability to transport water (and fluids in general).

Other Site Information

A preliminary ecological screening assessment for OU 1106 conducted in 1994 found that PRS 21-029, DP Tank Farm, is a mesa top site surrounded by disturbed areas. The area provides limited habitat for biota, does not contain sensitive habitats, and threatened or endangered species are not present there. Therefore, there is no immediate ecological risk at this site.

As noted in a walkover inspection of the site on Tuesday, June 23, 1998, the area of the former storage tanks and fill stations is covered in grass, forbs, and small shrubs, and the banks on both the south and north sides of DP Canyon are heavily wooded in ponderosa pine and Gambel oak, as well as smaller understory shrubs. Live deer have also been seen in the area, evidence that larger animals do graze at the site.

In addition, two large (4-ft-diameter) culverts, which carry storm runoff from the area of the Mari Mac Shopping Center, the Knights of Columbus Hall, the Los Alamos townsite within the drainage (Figure

2.1-3), and the Hilltop House Hotel were noted at the extreme western edge of the site just north of the Knights of Columbus building. The channel of DP Canyon, which contained only small pools of water at the time, contained debris consistent with street and parking lot runoff. The area of the localized hydrocarbon sheen was barely distinguishable, limited to a reach of about 30 ft in length starting at a point northeast of the location of the former West Fill Station and extending downstream. Some staining of rocks and a faint odor of aromatic hydrocarbons could be observed, and a depression in the canyon bottom contained an oily substance mixed with sandy sediments that also had an aromatic odor.

In a walkover of the site on August 5, 1998, a field team was able to easily find the former locations of the tanks as depressions in the fill soil that had apparently not been well compacted in the decommissioning in 1988. The former locations of the two fill stations could also be identified by comparison of the present-day topography with the aerial photographs (Appendix F-1.0) The former location of the berm, which had been removed and used for backfill at the area of the fill stations and roads (McInroy 1988, 1641), could not be determined. The remains of a drain shown on the original site plan (Zia Company 1948, 24947) (24-in.-diameter corrugated pipe) were found on the south bank of DP Canyon at a location approximately due north of the former location of the West Fill Station. This drain is discussed in Section 2.1.2 of this work plan.

A site walkover on August 11, 1998, was conducted for the purpose of identifying the area of possible petroleum hydrocarbon staining in DP Canyon north of the former tank farm. Heavy rains had fallen for several days before the visit, and a very small amount of water was flowing in the canyon drainage. No odors or obvious hydrocarbon sheens were observed associated with the flowing water, and the depression in which an oily substance mixed with sandy sediments found in the walkover on June 23, 1998 contained only sediments with no oily substance. Closer inspection of the rocks and soil in and near the watercourse showed that only very faint petroleum hydrocarbon odors and stains were present from the area of the localized hydrocarbon sheen, identified in the RFI report (LANL 1996, 52270), to a point about 100 ft upstream. It is apparent that the extent and intensity of the sheen area varies widely, possibly according to weather conditions at the time of and just before inspection. In Los Alamos, very little rain fell in June 1998, but heavy rains fell in all of July and in early August.

The remains of the corrugated metal drain pipe, which was about 24 inches in diameter and is described above, were observed to be near and to the south of the western limit of the hydrocarbon sheen area. The location of this drain corresponds with that of a storm drain on the 1948 engineering drawing (Zia Company 1948, 24947) of the tank farm that drained the former roadway area just west of the location of the former West Fill Station (Figure 2.1-2). No stains, odors, or stressed vegetation were identified near the outfall of this drain. A second drain about 18 inches in diameter was observed about 200 ft downstream from the 24-in. drain. This drain also is oriented approximately north-south, but no records were found to identify it. Photographs of the 1996 VCA show several sections of partially removed drain pipe from the location of the former East Fill Station area. This is thought to be the same drain pipe.

A site walkover on August 17, 1998, was conducted to identify the actual location of the enclosing fence at the tank farm and to attempt to identify traces of the berm, which was removed during the 1988 decommissioning. The berm was observed only on the 1986 aerial photographs and was seen to be closely following the trace of the northern fence line. The fence location was found to be incorrect on the Facility for Information Management, Analysis, and Display (FIMAD) Geographical Information System database. When the fence line was corrected on the base maps, the berm was plotted and found to be in close agreement with the 1986 aerial photograph. These revised locations have been incorporated into the new base maps used in this work plan. During this walkover, fittings or ports of one pipe for filling the former tanks from trucks were found along the southern fence line near DP Road. Tags were present on

the fence identifying with which tanks the fittings were associated. Approximate locations of the tags are shown on Figure 2.1-2.

A site walkover on August 27, 1998, was conducted to orient chemists evaluating prior data collected at the site to the site features and the sheen area. At that time, odors and staining in the localized hydrocarbon sheen area were barely observable.

Surrounding Sites

Mari Mac Shopping Center

The Mari Mac shopping center (Figure 2.1-3) is located on the mesa-top in Los Alamos within the drainage area of DP Canyon. The eastern part of Los Alamos from Fifteenth Street eastward to the intersection of Central Avenue and Trinity Drive was planned for commercial development in the initial Los Alamos Comprehensive County Plan, which was developed in 1964 (Los Alamos County 1964, 58673). The AEC, precursor to the DOE, transferred land to private ownership in Los Alamos for the development of commercial enterprises in 1962.

The Mari Mac Shopping Center was built in 1977. Before this time, the site of the shopping center was used for miscellaneous vehicle parking (see aerial photographs dated 1958, 1965, and 1974 in Appendix F-1.0) and as temporary housing for Laboratory employees with trailer homes. Quonset huts were also constructed in this area for employee housing. Potential contamination associated with the Mari Mac Shopping Center has not been documented, and no PRSs have been identified at this site (LANL 1992, 7667). However, the shopping center and surrounding commercial and light industrial areas that drain into the head of DP Canyon are potential sources of low levels of contamination in DP Canyon of some metals (e.g., lead), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and other organic compounds that could be associated with town site runoff.

PRS 00-031(a)

PRS 00-031(a) (Figure 2.1-3) is associated with the site of a former gasoline service station that was located at the present site of the Hilltop House Hotel. This PRS is not listed in Table A of Module VIII of the HSWA Permit dated May 23, 1990, and revised May 19, 1994 (EPA 1990, 1585).

PRS 00-031(a) is a potential soil contamination source associated with the former location of the Zia Company gasoline service station that was operated at the east end of the Los Alamos town site from circa 1943 until 1968, when the service station was transferred to private ownership. The site is not currently active; the gasoline pumps and tanks have been removed and the site of the former service station is currently the asphalt parking area and driveway for the Hilltop House Hotel. The site slopes gently to the southeast toward the intersection of Fourth Street and Trinity Drive. Stormwater runoff from the site flows to the southeast, enters a stormwater collection system, and discharges southeast of Trinity Drive into the culverts at the head of DP Canyon, which is located about 200 ft southeast of the site (Figure 2.1-3).

The former location of the gasoline pumps was east of what is now the hotel lobby and in the area of the covered registration parking. The assumed former location of the original USTs used by the Zia Company and later by a private operator was beneath the parking area northeast of the hotel lobby (LANL 1992, 7667, Figure 5-55, p. 5-118). During the 1988-1989 renovation of the hotel, new gasoline pumps were

installed at the north end of the hotel and on the south side of Central Avenue, and new fiberglass gasoline storage tanks were installed northwest of the hotel building to supply the new pumps.

Potential contamination associated with PRS 00-031(a) could have resulted from leaks and spills associated with the service bays, the gasoline pumps and the associated piping, and underground tanks that were connected to the pumps. Leaks or spills, if they occurred, could have migrated to the head of DP Canyon through surface and subsurface transport. Given dates of operation and the predominance of gasoline containing tetraethyl lead during that period, any leaks or spills at the station could have resulted in low levels of lead contamination in surrounding soils, but potential soil contamination could also be associated with the disposal of used oil, grease, and solvents that were used during operation of the service station. Although the potential for contamination was present, documentation of leaks or spills has not been found, and releases are not known to have occurred.

If releases had occurred, potential contaminants may have been transported into the soil or tuff surrounding the underground fuel tanks. Subsurface releases could have migrated downward or laterally in the tuff along flow unit boundaries or fractures in the tuff. Migration of releases may have followed flow unit boundaries along the natural dip of the tuff units, which would be in the direction of DP Canyon, where seeps could have formed. Surface spills from the gasoline service station would have been directed along stormwater runoff pathways into DP Canyon.

PRS 00-027

PRS 00-027, the DP Road Storage Area, is a potential soil contamination source associated with the site of the former DP Road Storage Area. This PRS is not listed in Table A of Module VIII of the HSWA Permit dated May 23, 1990, and revised May 19, 1994 (EPA 1990, 1585). PRS 00-027 is described in Chapter 5.7 of the RFI work plan for OU 1071 (LANL 1992, 7667). It is located on private property owned by the Santa Fe Diocese and is currently the location of the Knights of Columbus Hall and parking lot (Figure 2.1-3) at the east side of Los Alamos town site at the intersection of Trinity Drive and DP Road. The site is on the south side of the head of DP Canyon and north of DP Road. Much of the site is now covered with asphalt and/or concrete as part of the parking area around the Knights of Columbus Hall. The northern portion of the site is an unpaved sand and gravel parking area.

This site was first used as a fuel tank farm beginning in 1946 and was converted to a drum storage area in mid-1948. Potential contamination at PRS 00-027 is attributable to petroleum products leaking from storage tanks, drums, and drainlines. The potential contaminants associated with PRS 00-027 are primarily fuel products, including BTEX, as well as volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), TPH, target analyte list (TAL) metals, and pesticides/PCBs.

Potential contaminants released from the DP Road Storage Area would have been either absorbed by the surficial material and bedrock at the site, transported by way of stormwater runoff or eroded contaminated soil, or possibly transported by way of fracture flow into upper DP Canyon. Therefore, any contaminants from this PRS may have impacted sediments and/or bedrock at the site and/or sediments in DP Canyon. Potential contamination at PRS 00-027, similar to potential contamination from PRS 00-031(a), would be attributable to petroleum products leaking from tanks, drums, and drainlines and primarily include fuel products, as well as those noted above.

PRS 00-030(a)

PRS 00-030(a), the DP Road Storage Area septic tank system, is presently located on private property owned by the Santa Fe Diocese, which owns the Knights of Columbus Hall on the site (Figure 2.1-3). The site is located at the head of DP Canyon and is bounded on the north and west by Trinity Drive and on the south by the parking lot for the Knights of Columbus Hall (PRS 00-027) and DP Road. The site has been highly disturbed since 1943. By the time of the RFI (1996), the site had been raised in elevation with backfill materials and was used as a secondary reserve parking area.

Documentation (LANL 1992, 7667) of the septic system at this site indicates that it was used for sanitary wastes. Although these sanitary wastes are not expected to relate to the localized hydrocarbon sheen area in DP Canyon, they might have provided a source for other low levels of organic compounds found in DP Canyon.

DOE Fire Station No. 2

Activities involving the use and disposal of hazardous materials by fire department personnel at Fire Station No. 2 have not occurred (Canepa 1998, 57608, Enclosure A).

Pine Glen Apartments

The Pine Glen apartments are located on the north side of DP Canyon immediately across the canyon from the DP Tank Farm and south of Trinity Drive/East Road (Highway 502) (Figure 2.1-3). The apartments were constructed in 1976. Before construction of the apartments, the site is shown on aerial photographs to have been vacant land (Appendix F-1.0). No historical records documenting the use of this site have been acquired. Aerial photographs of the site taken before 1986 show the site as barren with few vehicle tracks crossing the land. The construction permit for the apartments notes that no utilities were present near the property.

2.2.1.2 Sampling

Sampling and analysis activities at the DP Tank Farm and in surrounding areas have been extensive. This section is organized according to the chronology of investigations related to DP Tank Farm, supplemented with information collected from other investigations related to DP Canyon as follows:

- Predecommissioning Sampling and Analysis Activities (1984 and 1985)
- Decommissioning Sampling and Analysis Activities (1988)
- RFI Field Investigation Sampling and Analysis Activities (1994)
- Background Comparisons and Screening Assessment of Data Collected in the 1994 RFI
- UST Investigation Sampling and Analysis Activities (1995)
- Evaluation of Data from the 1995 UST Field Investigation
- Hydrocarbon Sheen and DP Canyon Sampling and Analysis (1994–present)
- VCA Confirmatory Sampling and Analysis Activities (1996)

- Evaluation of VCA Confirmatory Sampling and Analysis Data
- Other Sampling and Analysis Data and Evaluation

Predecommissioning Investigation Sampling and Analysis Activities (1984 and 1985)

Historical evidence of sampling and analysis activities before decommissioning is often incomplete, although there is clear evidence that some activities occurred at DP Tank Farm before 1988. This section provides a summary of predecommissioning sampling and analysis activities based on the evidence available.

Copies of a sketched field map of the tank farm provide evidence of sampling activities before the removal of the tanks in 1988. One copy of the map (provided in Appendix A-1.0 of this work plan), dated January 17, 1985, is labeled "DP Road-Gas Tank Farm Soil Sampling Locations." Notations on the map indicate that 11 samples were taken at locations marked on the map: one at each of the two fill stations, one at the east side of tank TA-21-ATF-10, one at the east side of tank TA-21-ATF-9 with another at the west side, and the remaining taken from locations in the "catchment ditch," which the map depicts along the length of the earthen berm at the northern fenceline (Ahlquist 1985, 1635). Two locations on the south side of DP Road are identified as controls. Four "ports of liquid/fuel sampling" are labeled A–D. Another version of this map (Ahlquist 1985, 37310) (provided in Appendix A-2.0 of this work plan) shows all of the above plus Phoswich measurement locations, indicated by small dots, and related markings. A larger dot is designated to indicate an "additional soil sampling site." No such dots are clearly visible on the copy of the map available for this report.

This latter version of the map accompanies the copy of a hand-written summary page dated April 22, 1985 entitled, "DP Fuel Farm Phoswich Survey" (Ahlquist 1985, 37310). A subsequent page containing the results of the survey appears to be missing. However, the author remarks in another memorandum (Ahlquist 1985, 1636), also dated April 22, 1985, that the Phoswich survey at this site was taken on April 19, 1985, and that "no radioactivity above background was detected." Further remarks state that results are pending for core samples taken of the "fuel-soaked soil in the two loading dock areas to see if the spilled diesel fuel may have driven lead from spilled gasoline to lower depths." Later, in written comments on the TA-21 work plan for Chapter 14 (Ahlquist 1991, 58960), the author of the remarks does not recall "taking samples at depth." Clarifying documentation could not be found. Results of such sampling, if any, are not known.

Analytical results for EP toxicity lead and arsenic, and net total organics for the surface soil and control samples, locations for which are indicated by the maps, are summarized in a copy of the handwritten table submitted in 1985 (LANL 1985, 37841) (provided in Appendix A-1.0 of this work plan). The results show lead and arsenic concentrations in the EP toxicity leachate of samples at below detection (<0.1 mg/L) for lead (with the same result in the control samples) and up to 0.0042 mg/L for arsenic (slightly greater than the highest value in the controls). Both concentration values are well below the criteria of 5.0 mg/L for each for the characteristic of EP toxicity (Title 40 CFR Part 261.24, Identification and Listing of Hazardous Wastes, Table I). The net total organic concentrations were up to 20,000 mg/kg. A memorandum attached to LANL (1985, 37841) gives the exact date of the soil sample collection as November 27, 1984, followed by the collection of soil sample controls and liquid samples from the tanks on January 17, 1985. Details of the analytical results for the liquid samples are not provided. The author notes only that the liquid samples A–D were "fuel- range petroleum distillates with sample A containing 30-50% ethyl alcohol." This reference to the analytical results corresponds to the report of another earlier sampling activity. A memorandum dated October 7, 1980 (Bend 1980, 3688), states that samples of the fuel in each tank were analyzed with regard to specifications for use as a motor fuel. The findings were

that all but one sample qualified with cetane ratings "within the allowed numbers of 43 to 48." The cetane rating associated with the remaining sample, which was taken from a tank containing 10,000 gallons, was 41.3.

Decommissioning Sampling and Analysis Activities (1988)

It was believed that all tanks and structures were removed from DP Tank Farm in 1988. A recent walkover of the site, however, found the remains of one fill port near DP Road suggesting that piping in that area may not have been completely removed. During decommissioning, only a gasket associated with one tank, TA-21-ATF-10, was found to have leaked. Approximately 4 yd^3 of visibly contaminated soil were removed from the area underlying the leak. The remaining tanks and underground distribution piping were reported to have been in good condition. In addition, soil near the two fill stations was excavated and then sampled and analyzed by the EP toxicity procedure; lead concentrations were less than 2 µg/L (LANL 1991, 7529). The excavated soils reportedly contained elevated concentrations of benzene, toluene, and xylenes, but concentrations in the soil remaining were considerably lower. At that point, the area around the excavations was considered clean and was backfilled. Details are discussed below.

Tank TA-21-ATF-11 was the first tank excavated in the decommissioning in May 1988. Field notebook entries (McInroy 1988, 1641) state that excavation of this tank occurred on May 17, 1988. The tank was identified as a gasoline tank that was "bone dry." Once the tank was removed, six soil samples were taken from the soil beneath and/or around the former location of the tank to be analyzed for EP toxicity lead (Foreman 1988, 1627) (provided in Appendix A-3.0 of this work plan). Results showed concentrations of lead in the EP toxicity leachate at below detection (<1.0 µg/L).

The second tank removed, tank TA-21-ATF-17, was also identified as a gasoline tank. Ten samples were taken from the soil beneath and/or around the former location of this tank. These samples were analyzed for EP toxicity lead with the same results as those from tank TA-21-ATF-11; lead concentrations were below detection at <1.0 µg/L (Foreman 1988, 1626) (provided in Appendix A-3.0 of this work plan).

Another six samples were taken from the soil beneath and/or around the former location of tank TA-21-ATF-7, which was also identified as a gasoline tank (Foreman 1988, 1628) (provided in Appendix A-3.0 of this work plan). Results of the analysis for EP toxicity lead showed all but one sample with leachate lead concentrations below detection (<1.0 µg/L). One sample had a leachate lead concentration of 238 µg/L, still well below the 5.0 mg/L criteria for the characteristic of EP toxicity (Title 40 CFR Part 261.24, Identification and Listing of Hazardous Wastes, Table I). A duplicate sample taken at the same location showed the leachate lead concentration below detection.

Further soil sampling took place following the excavation of the locations formerly occupied by the East and West Fill Stations (Williams 1988, 1629; Begay 1988, 58934) (provided in Appendix A-3.0). Samples taken from the holes that remained after removal of contaminated soil from the surface at the former locations of the fill stations plus samples of the soil removed from both locations ("15 truckloads at 5 ids a piece" [McInroy 1988, 1641]) were analyzed for EP Toxicity lead and BTEX. Results showed lead concentrations in EP toxicity leachate were all below detection at <1.0 µg/L. Samples of both the soil remaining after excavation at the area of the former West Fill Station and of soil excavated from the area showed concentrations of benzene up to 26 µg/kg, toluene up to 1127 µg/kg, and xylenes up to 354 µg/kg. Samples of both the soil remaining after excavation at the area of the former East Fill Station and of soil excavated from the area showed concentrations of benzene up to 670 µg/kg, toluene up to 340 µg/kg, and xylenes up to 1032 µg/kg.

Finally, two sets (six samples each) of soil samples were taken at the same locations on two separate days, June 27, 1988, and July 6, 1988, from the drainage ditch on the downslope side of a 14-in. drain pipe with gate valve in the berm at the northeast corner of the site. The first set of samples (Begay 1988, 1623) was analyzed for BTX; the later set (Williams 1988, 1624) was analyzed for EP toxicity lead (provided in Appendix A-3.0 of this work plan). Results showed two detects for xylenes only, 5.3 and 8.2 µg/kg. Analyses of the EP toxicity leachate showed lead concentrations below detection at <2.0 µg/L.

Field notebook entries on May 17, 1988 and on May 25, 1988 (McInroy 1988, 1641), indicate that vapor measurements were taken during the excavation activities. No details regarding these measurements were available at the time this work plan was prepared.

The information in the following three subsections was taken largely from the RFI Report for PRS 21-029 (LANL 1996, 52270, Section 5.1 pp. 22 through 29). Editorial changes were made for consistency with this work plan and to add details identified in review of original records.

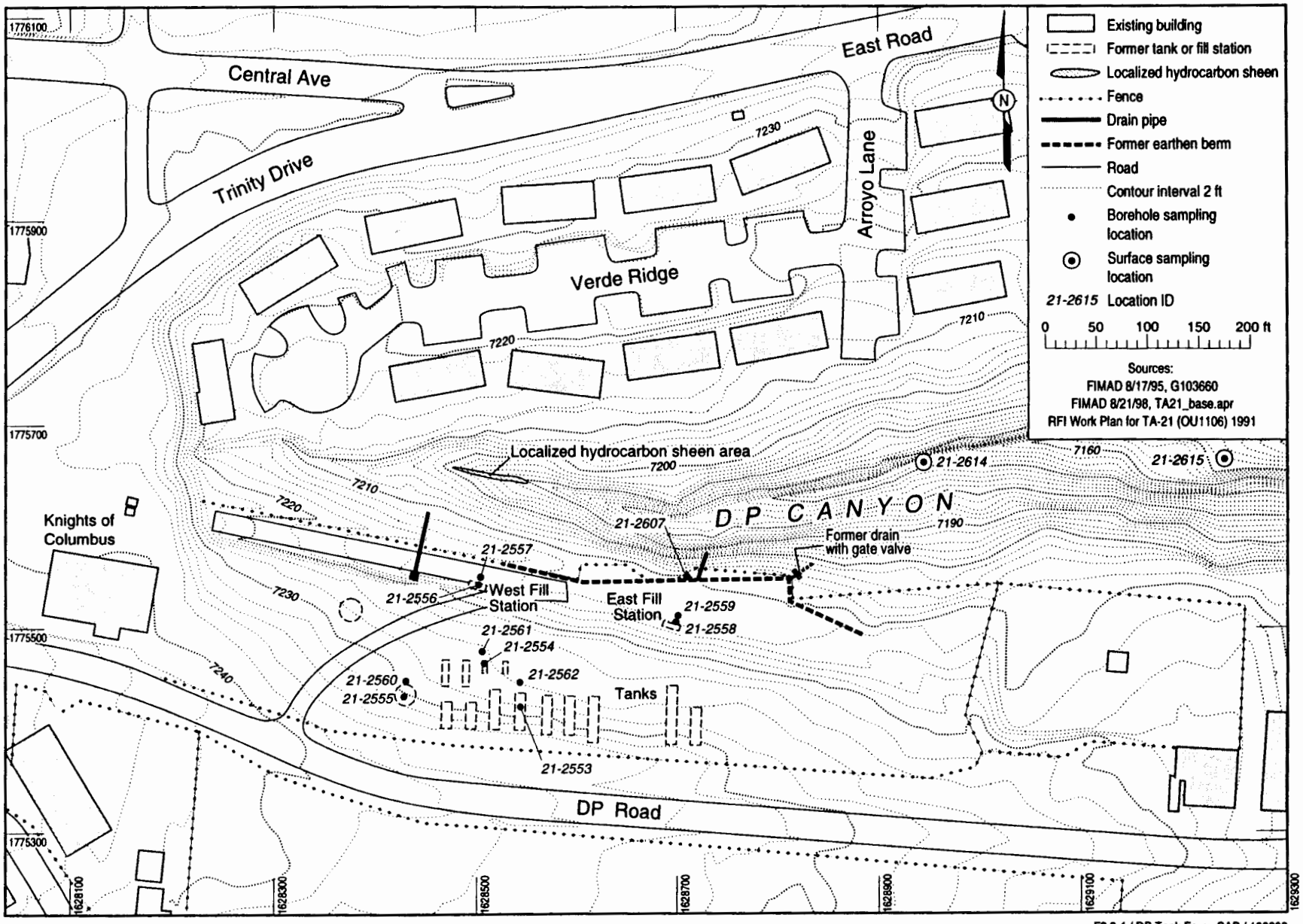
RFI Field Investigation Sampling and Analysis Activities (1994)

RFI Phase I activities were conducted in August and September 1994. A geodetic survey was performed in August 1994 to determine the locations of former tanks and structures at DP Tank Farm. Drill sites and surface sampling locations were surveyed to document the location of each sample.

Subsurface Sampling

A total of 11 boreholes (Figure 2.2-1) was drilled to depths ranging between 10 ft bgs and 94 ft bgs, and subsurface material was collected by scooping the pulverized tuff fragments directly off the auger flights. Borehole locations are described in Appendix B-2.0 of this work plan. Two boreholes were placed near the former locations of each of the two fill stations and at tanks TA-21-ATF-6, TA-21-ATF-10, and TA-21-ATF-13. According to the TA-21 work plan, the planned nominal depth of each borehole was 10 ft bgs (LANL 1991, 7529). However, in several boreholes adjacent to the fill stations, photoionization detector (PID) readings indicated that subsurface contamination extended below 10 ft. Therefore, the field work differed from the work plan in that drilling and sampling continued until contamination was no longer detected with a PID. All PID results are presented in Appendix B-4.0 of this work plan. The field work also differed from the work plan in that one additional borehole (21-2607) was added to the drilling plan after field screening detected high concentrations of VOCs in the two boreholes at the location of the former East Fill Station (Figure 2.2-1). This borehole was located directly north of the location of the former East Fill Station and adjacent to the fence at the northern boundary of the site. While the work plan called for additional boreholes to bound the horizontal and vertical extent of contamination at the former locations of the two fill stations, additional boreholes were delayed to allow for a complete review of results.

Recovered core was field screened for gross beta and gamma radiation and for VOCs immediately after the core barrel was opened and before the core was logged and sampled. VOCs in the workers' breathing zone and emanating from the core were monitored with a PID. Drill cuttings were also screened for VOCs as the cuttings were discharged from the borehole. The air within and around each borehole was monitored for combustible gases. A portion of each sampled core was analyzed in the field using headspace analysis to provide a quick indication of the presence of VOCs in soils or tuff. Results of headspace analysis were used as a gross indication of the presence of VOCs and to help determine if drilling should continue. Core extracted from each borehole was lithologically logged. Boreholes were backfilled with a cement/bentonite grout mix.



F2.2-1 / DP Tank Farm SAP / 100398

Figure 2.2-1. Locations of samples collected during the 1994 investigations of DP Tank Farm, PRS 21-029.

The results from field screening activities are presented in Appendixes B-4.0 and B-5.0 of this work plan. Field-screening results for radioactivity showed that no borehole or soil sample had radiation levels greater than background. Field screening for VOCs during drilling operations near the locations of the former fill stations often yielded VOC concentrations of up to several thousand parts per million. Combustible gas readings of up to 100% of the lower explosive limit (LEL) were detected in the borehole or at the top of the auger flights as drilling continued. When these high LEL percentages were encountered, the borehole gases were displaced from the borehole by inserting dry ice into the hollow stem of the auger flights.

Subsurface samples were submitted to the Laboratory's Sample Management Office (SMO) for dispersal to fixed laboratories for analysis of VOCs, SVOCs, metals, and ethanol. Samples were also collected and submitted to analytical laboratories for analysis of gross alpha, beta, and gamma radiation. Results of analyses are provided in Appendixes B-6.0, B-7.0, B-8.0, and B-9.0; chromatograms of the organic analyses are provided in Appendix B-11.0 of this work plan.

Surface Sampling

The RFI work plan (LANL 1991, 7529) called for two surface soil samples to be taken in the area downgradient of the 14-in. pipe with gate valve through the berm in the northeast corner of the former berm. One was to be located 5 ft downgradient of the pipe (LANL 1991, 7529; Figure 14.5-1, p. 14-46), corresponding to the area sampled by McInroy (1988, 1641) during the 1988 decommissioning. The second sample was to be taken somewhere in the next 20 ft of the drainage pattern (McInroy had sampled in six locations downslope from the pipes, as discussed in the previous subsection).

The two soil samples were not taken in the vicinity of the outlet of the pipe as planned but in the canyon bottom. The first location (21-2614) is approximately 155 ft northeast of the pipe, and the second location (21-2615) is another 300 ft or so further downcanyon east of the fire tower (Figure 2.2-1).

Samples were collected from the top 6 in. of soil at the two locations and submitted to the SMO for analysis of VOCs, SVOCs, ethanol, metals, and for radionuclides by gamma spectroscopy. Additional samples were submitted to the Laboratory's Mobile Radiological Analysis Laboratory (MRAL) for determination of gross alpha, beta, and gamma radiation. Results of analyses are provided in Appendix B tables, as noted above, of this work plan.

Background Comparisons and Screening Assessment of Data Collected in the 1994 RFI

The results of the background comparisons and screening assessment of the 1994 RFI data are discussed in Section 5.2 of the RFI report (LANL 1996, 52270). The results are re-evaluated and summarized below based on changes reflected by a focused revalidation of the data and the recent availability of background data for tuff units.

Inorganics

Twenty-nine samples collected from soil and tuff in the 1994 RFI were analyzed for inorganic chemicals. At the time this investigation occurred, it was not anticipated that distinction between soil and tuff would be necessary for background comparison purposes, and background comparisons were performed using the soil background data that was available. These background comparisons indicated that the area of DP Tank Farm exhibited background levels of all inorganic chemicals, but that two samples to the northeast of DP Tank Farm, in DP Canyon, exhibited concentrations of lead and zinc that were greater

than background but well below any action levels. Since that time, background data has been collected for the geologic units that underlie the top soil layers, and focused revalidation of the inorganics data done in preparation of this work plan has caused some minor changes in the data set. Consequently, re-evaluation of the 1994 RFI inorganics data compared with background data is appropriate.

Although the depth of soil and fill material varies across the DP Tank Farm site, the sample collection and borehole logs (Appendixes B-1.0 and B-2.0) provide some indication that the soil/fill profiles are on the order of several feet in depth. The fill material is reported as a soil/tuff mixture, although there is some indication of a thin soil layer on the surface at some locations. Samples from depths much greater than a few feet are probably tuff samples. Section 2.1.1 provided some discussion that indicates the difficulties of characterizing soil profiles at DP Tank Farm because of the operational history of the site. Because of the uncertainty in the nature of the medium sampled in each case, background comparisons have been performed by combining the site data and making more qualitative comparisons to the soil and tuff background data sets. Appendix B-10.0 contains details of the background comparisons performed, including graphical analysis and statistical test results.

Twenty-three inorganic chemicals (aluminum, silver, arsenic, barium, beryllium, calcium, cadmium, cobalt, chromium, copper, iron, mercury, potassium, magnesium, manganese, sodium, nickel, lead, antimony, selenium, thallium, vanadium, and zinc) were analyzed in the 29 samples (Appendix B-6.0 provides the complete data set). Concentrations greater than soil background were reported for lead and zinc; cadmium was reported in four samples at concentrations that exceed the soil detection limit for cadmium, which is used as its nominal background value; and, silver, which was not detected in any sample, has detection limits for every sample that exceed the background detection limit for silver. For the remaining 19 inorganic chemicals, comparisons with background soil data, based on the depth of the samples taken, did not indicate elevated concentrations. These results are consistent with those presented in the RFI report (LANL 1996, 52270) in which lead and zinc were identified as greater than background in the soil samples from the two locations in DP Canyon.

Comparison of site data for major elements, such as iron and aluminum, indicates concentrations more consistent with tuff background than with soil background. This indication is consistent with the sample collection and borehole logs that indicate that the tuff interface occurs at depths of a few feet to several feet depending on the location of the borehole. It is not possible to completely separate tuff samples from soil samples because the 2.5-ft core segments collected from the boreholes often seem to have overlapped the tuff interface and, in those cases, credit cannot be assigned definitively to either medium.

Further background comparisons were performed (Appendix B-10.0) using the tuff background data set (background data from Qbt2, 3, and 4) to contrast with the soil background comparisons. A few elements besides lead fail background comparisons when the tuff background data set is used; however, when interpreted collectively (i.e., both soil and tuff background comparisons), the only element that clearly exhibits concentrations greater than background is lead. Arguments could be made for elevated concentrations of some other elements (e.g., barium, copper, nickel), but sound counter arguments can also be made depending on the medium used for comparison. Overall, the background comparisons suggest that lead is present at levels greater than background; zinc is also present at levels greater than background, but only in samples from the two locations in DP Canyon (note that zinc does not fail background comparisons if the tuff background data are used); and other elements appear to be at background levels, although some questions remain concerning medium identification of samples.

Lead and zinc were detected in all 29 samples. Based on the analyses presented in Appendix B-10.0, only three detects for zinc are considered indicative of values that exceed background. These samples

are from the two locations to the northeast of the DP Tank Farm site in DP Canyon and might represent sediment samples (Figure 2.2-1). The remaining samples are indicative of background concentrations of zinc in soil and tuff. Lead concentrations greater than background were also observed in these three samples. However, some other samples potentially exhibited lead concentrations greater than background. Again, the difficulty lies in using the correct mixture of the background data sets for this determination, but the presence of low levels of lead in the subsurface might not be unreasonable given the industrial use of this site and the fact that leaded gasolines were distributed at DP Tank Farm.

Even if low levels of lead contamination are present in the subsurface of DP Tank Farm, the reported values for lead in the subsurface are considerably less than the SAL for lead (400 mg/kg). Similarly, the SAL for zinc (22,000 mg/kg) is considerably greater than the zinc concentrations reported at this site. In general, based on these background comparisons and comparisons with SALs, the inorganics data do not suggest that an immediate or future threat to human health or the environment exists at DP Tank Farm. Site history does not suggest the presence of inorganic chemicals as contaminants at this site with the possible exception of lead, and the data support this assertion.

As noted earlier, there are many potential anthropogenic sources for low-levels of contaminants to exist in DP Canyon, which the data presented support to some degree. These sources include the Los Alamos town site that drains into DP Canyon, the commercial facilities on DP Road, and several PRSs that might impact DP Canyon. As discussed below, the presence of elevated lead, zinc, and other inorganic chemical concentrations in DP Canyon samples is confirmed in data from the DP Canyon investigation and environmental surveillance monitoring data (see discussion below).

The data presented do not indicate that inorganic constituents are present at levels greater than background at the DP Tank Farm site, with the possible exception of concentrations of lead in the subsurface that might be slightly greater than background. Based on a similar analysis of the inorganic constituent data available at the time of preparing the RFI report (LANL 1996, 52270), inorganic constituents were removed from further consideration before further investigation of the DP Tank Farm site in 1995. This reanalysis does not provide sufficient evidence to revisit that decision, which was based on screening assessment and background comparisons.

Organic Chemicals

A total of 31 soil and tuff samples were analyzed for organic chemicals (Appendix B-8.0 provides the complete data set). Organics analyses focused on the VOC and SVOC suites. Detected organic compounds fall into three categories; suspected laboratory contaminants, petroleum-related products, and PAHs. Suspected laboratory contaminants include acetone, bis(2-ethylhexyl)phthalate, butanone[2-], butylbenzylphthalate, and di-n-octylphthalate. Acetone and bis(2-ethylhexyl)phthalate are common laboratory contaminants and were detected in blank samples associated with the DP Tank Farm investigation (Appendix B-3.0). The other three organics listed are common laboratory contaminants, although none were identified in blank samples associated with this investigation. However, all are chemicals ubiquitous in urban environments and manufactured products.

PAHs were not reported as detected in the RFI report (LANL 1996, 52270). This was because validation procedures differed at that time from those that are applied now. Recent validation revealed several PAHs that were detected in three samples from two locations. These are the DP Canyon locations in which lead and zinc were detected at concentrations greater than background. The PAHs reported as detected in these samples are benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, and phenanthrene. The presence of PAHs in DP Canyon can possibly be explained

because of the industrial activities in the area and the large drainage area of DP Canyon, which encompasses many roads and parking lots (Section 2.1.1). The presence of elevated PAH concentrations in DP Canyon samples is also confirmed in data from the DP Canyon investigations and environmental surveillance monitoring data (see discussion below). Two PAHs were also detected in samples from borehole 21-2556 at the location of the former West Fill Station. These were phenanthrene, which was detected in four samples, and fluorene, which was detected in one sample. Table 2.2-1 provides a summary of these data, a complete listing of which is provided in Appendix B-8.0. These two PAHs were detected at concentrations that are substantially lower than their SALs (1800 mg/kg for fluorene and 1500 mg/kg for phenanthrene). PAHs are the heavy-end remains of the distillation and/or volatilization of fuels such as diesel, as well as being common in oils and asphalts. Their presence in these samples possibly reflects an accumulation of small slops of fuel followed by extensive volatilization and weathering over a long period of time.

The 1994 RFI at DP Tank Farm was aimed at determining the nature of contamination, although VOCs and SVOCs were anticipated to be present based on the knowledge of the operational history of the site (Section 2.2.1). However, the full suite of analyses routinely performed at that time were requested, and conclusions were drawn based on the analytical results obtained. The suite consisted of analyses for inorganics, gamma spectroscopy isotopes, tritium, VOCs, and SVOCs. The suite did not, therefore, include more specific analysis of petroleum-related products or petroleum hydrocarbons.

The presence of petroleum-related products is consistent with the conceptual model and historical knowledge of the DP Tank Farm site (Section 2.1.1). Petroleum-related products were detected around the areas of the former West Fill Station and the former East Fill Station in this phase of the investigation. Several petroleum hydrocarbons were identified in the RFI report (LANL 1996, 52270), three of which at concentrations that exceeded SALs (benzene, 1,2,4-trimethybenzene, and 1,3,5-trimethylbenzene). Based on the updated information presented in Appendix B-8.0, these remain the only three petroleum hydrocarbons with concentrations exceeding SALs, although SALs are not available for some of the other detected organics (Table 2.2-1). The Class column of Table 2.2-1 notes those organic constituents that are known to be found in petroleum-related products, those that are PAHs commonly associated with asphalts, motor oils, and runoff from street surfaces and those that are considered to be laboratory contaminants based on the QC issues discussion in Appendix B-3.0.

Petroleum hydrocarbons were detected in the VOC and SVOC suites in samples from the boreholes drilled at the locations of the former West and East Fill Stations but were not detected in boreholes drilled around the former locations of the tanks. Chromatograms of the analyses performed in 1994 are included in Appendix B-11.0. Visual inspection of the chromatograms provides a means to qualitatively classify the nature of contaminants at the site. Chromatograms associated with the former East and West Fill Station boreholes clearly indicate the presence of diesel or similar fuel (Lombardo 1995, 58959). The analytical data reflect the fact that VOC and SVOC target analytes are components of these fuels. Review of the SVOC chromatograms also indicates that petroleum hydrocarbons are present at some boreholes near the former tank locations.

The chromatographic signature at these tank locations is consistent with a much heavier product such as lubricating or motor oil. VOC and SVOC target analytes are not important components of motor oils and were typically not at detectable concentrations at these tank locations. Appendix B-11.0 provides a more detailed description. The purpose of classifying the hydrocarbons becomes more apparent when comparing information or data directly related to DP Tank Farm with data from the area of the localized hydrocarbon sheen area in DP Canyon (see below).

TABLE 2.2-1

1994 SUMMARY OF DETECTED ANALYTES AT DP TANK FARM, PRS 21-029

Analyte	Total Number of Analyses	Number of Nondetects	Range of Nondetects (mg/kg)		Number of Detects	Range of Detects (mg/kg)		Class	SAL* (mg/kg)
			Minimum	Maximum		Minimum	Maximum		
Acetone	31	18	0.006	29	13	0.002	14	lab contaminant	1400
Benzene	31	29	0.005	7.3	2	6.7	8.1	petroleum-related	0.62
Benz(a)anthracene	31	28	0.31	39	3	0.25	0.32	PAH	0.56
Benzo(a)pyrene	31	28	0.31	39	3	0.27	0.35	PAH	0.056
Benzo(b)fluoranthene	31	28	0.31	39	3	0.45	0.63	PAH	0.56
Benzo(g,h,i)perylene	31	28	0.31	39	3	0.24	0.28	PAH	
Bis(2-ethylhexyl)phthalate	31	29	0.046	39	2	0.87	1.8	lab contaminant	32
Butanone[2-]	31	22	0.009	29	9	0.009	27	lab contaminant	6900
Butylbenzene[sec-]	31	30	0.005	7.3	1	2.8	2.8	petroleum-related	
Butylbenzylphthalate	31	30	0.32	39	1	0.2	0.2	lab contaminant	930
Chrysene	31	28	0.31	39	3	0.3	0.4	PAH	56
Di-n-octylphthalate	31	29	0.32	39	2	0.15	0.19	lab contaminant	1100
Ethylbenzene	31	23	0.005	7.3	8	3	110	petroleum-related	230
Fluoranthene	31	28	0.31	39	3	0.58	0.76	PAH	2000
Fluorene	31	30	0.31	39	1	9.7	9.7	PAH	1800
Indeno(1,2,3-cd)pyrene	31	28	0.31	39	3	0.18	0.22	PAH	0.56
Isopropylbenzene	31	24	0.005	7.3	7	1.2	10	petroleum-related	160
Isopropyltoluene[4-]	31	19	0.005	0.031	12	0.14	19	petroleum-related	55
Methylnaphthalene[2-]	31	19	0.31	1.4	12	8	110	petroleum-related	
Naphthalene	31	20	0.31	3.6	11	8	50	petroleum-related	
Phenanthrene	31	24	0.31	37	7	0.42	16	PAH	1500
Propylbenzene[1-]	31	24	0.005	7.3	7	1.4	37	petroleum-related	
Pyrene	31	28	0.31	39	3	0.58	0.68	PAH	
Toluene	31	22	0.005	7.3	9	0.005	260	petroleum-related	520
Trimethylbenzene[1,2,4-]	31	18	0.005	0.031	13	0.002	270	petroleum-related	51
Trimethylbenzene[1,3,5-]	31	19	0.005	0.031	12	2.1	65	petroleum-related	21
Xylene (Total)	31	18	0.005	0.031	13	0.009	630	petroleum-related	

*SAL = screening action level

The 1994 RFI had not clearly identified any COPCs other than petroleum hydrocarbons. The localized hydrocarbon sheen area in DP Canyon was also discovered in 1994 during field operations. At that time the sheen area was observed in one location north of the DP Tank Farm site approximately centered between the West and East Fill Stations. The presence of petroleum hydrocarbons and the sheen area in DP Canyon was considered sufficient cause to postpone further field activities until the data had been reviewed and the regulatory setting had been evaluated.

The nature of contamination was considered identified; however, the extent of contamination still needed to be determined. Issues raised concerning regulatory authority were discussed with the administrative authority, and a decision was made in agreement with the administrative authority to pursue characterization of extent of contamination consistent with the NMED UST regulations (documentation of this agreement has not been found). Field activities, in accordance with the NMED UST regulations (NMED 1996, 58202) EIB/USTR-12 §1205, to characterize the extent of contamination were pursued in May 1995 (LANL 1995, 59364).

Radionuclides

A total of 31 soil and tuff samples were analyzed for radionuclides using gamma spectroscopy, 12 of which were analyzed for tritium by liquid scintillation. The radionuclides data are presented in Appendix B-7.0. Although 31 samples were analyzed by gamma spectroscopy, potential historical contaminants were only detected in 13 samples. Isotopes of interest that were analyzed by gamma spectroscopy include americium-241, cobalt-60, cesium-134, cesium-137, sodium-22, uranium-235, europium-152, and ruthenium-106. Only americium-241, cobalt-60, cesium-137, and uranium-235 were detected. Background data only exist for three radionuclides from this suite (cesium, americium, and uranium), and the background data sets for americium and uranium are based on alpha spectroscopy analysis. Background comparisons for cesium-137 indicate background levels at DP Tank Farm. The levels reported for the remaining radionuclides are all very low, often indicating an inability of the gamma spectroscopy method to adequately detect the analyte of interest. In addition, the already low uranium-235 concentrations are likely biased high because of spectral interference from background levels of radium-226 in the soils.

Tritium was also reported as detected in the 12 samples submitted for tritium analysis. All of the tritium results reported are less than the background screening values for soils (0.76 pCi/g) and for the tuff units (0.3 pCi/g, which is a detection limit in the background data set). Consequently, tritium, like the other radionuclides, is not thought to be present at DP Tank Farm except at background levels.

Based on historical knowledge, radionuclides are not expected to be contaminants at this site, and the gamma spectroscopy and tritium data strongly support this contention. Based on a similar analysis of the radionuclides data available at the time of preparing the RFI report (LANL 1996, 52270), radionuclide constituents were removed from further consideration before further investigation of the DP Tank Farm site in 1995.

UST Investigation Sampling and Analysis Activities (1995)

Based on the results from the 1994 RFI, conclusions were drawn that the only COPCs identified at the DP Tank Farm site were associated with petroleum products. Concentrations of TPH detected at the site exceeded 100 mg/kg (ppm), which necessitated a reportable release to the NMED UST Bureau. Therefore, the 1995 investigation proceeded with a focus on complying with the requirements of the UST regulations (NMED 1996, 58202) for investigation and aimed at defining the extent of the petroleum-related products contamination. The 1995 UST investigation activities included borehole drilling and subsurface sampling, surface water and stream bed sampling, field screening, and MCAL analysis.

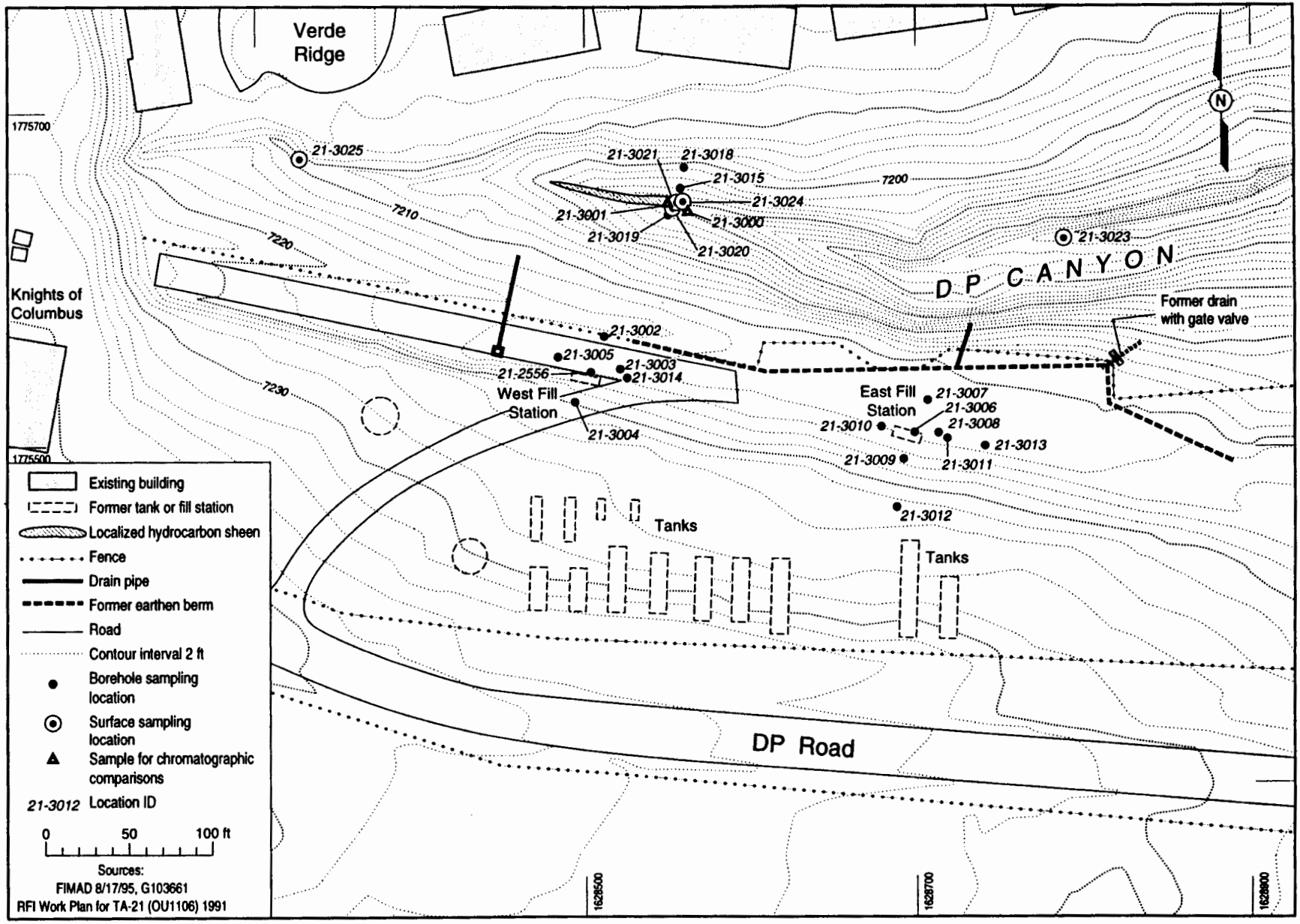


Figure 2.2-2. Locations of samples collected during the 1995 investigation of DP Tank Farm, PRS 21-029.

F2.2-2 / DP Tank Farm SAP / 100398

The following summary is based on information contained in the RFI report (LANL 1996, 52270, pp. 26–28).

Subsurface Sampling

Thirteen boreholes were drilled during the period May 17 through May 31, 1995, in the UST investigation (Figure 2.2-2). Placement of the boreholes was determined by the NMED UST Bureau requirement that the zone of subsurface contamination be horizontally and vertically bounded in four directions. Borehole locations are described in Appendix C-2.0 of this work plan.

At the location of the former West Fill Station, four vertical boreholes (21-3002, 21-3004, 21-3005, and 21-3014) were placed along the arms of a four-armed array centered on borehole 21-2556, which was drilled in 1994 (Figure 2.2-2). Each borehole was placed approximately 20 ft from the center of the array. Boreholes were drilled to a minimum depth of 35 ft bgs. In addition, an angled borehole (21-3003) was drilled to investigate possible fracture infiltration of contaminants. Borehole 21-3003 was drilled beginning east of a line from the fill station to the drainage at a 45° angle dipping toward the west to a total linear depth of 45 ft. Considering the geometry of the borehole, the end of the borehole would have been at a depth of 32 ft at a location about midway between boreholes 21-2556 and 21-3005.

At the location of the former East Fill Station, five vertical boreholes and one angled borehole were drilled in an initial array, and two more vertical boreholes were added to bound the extent of contamination (Figure 2.2-2). The initial borehole (21-3006) was located adjacent to the former fill station and drilled to a total depth of 65 ft bgs. Subsequent vertical boreholes were placed 20 ft apart along the arms of a four-armed array centered on borehole 21-3006 and drilled to a minimum depth of 30 ft bgs. Because contamination was found at boreholes 21-3006 and 21-3011, borehole 21-3012 was drilled 20 ft further to the south, and borehole 21-3013 was drilled 20 ft further to the east. An angled borehole (21-3008) was also drilled beginning 15 ft east of borehole 21-3006 at a 45° angle dipping to the west to a total linear depth of 50 ft. Considering the geometry of the borehole, the end of the borehole would have been at a depth of 35.4 ft at a location just south of borehole 21-3010.

Recovered core was field screened for gross beta and gamma radiation and VOCs immediately after the core barrel was opened and before the core was logged and sampled. VOCs in the workers' breathing zone and emanating from the core were monitored with a PID. A portion of each sampled core was analyzed in the field using headspace analysis to provide a quick indication of the approximate concentration of VOCs in soils or tuff. Results of headspace analysis were used as a gross indication of the presence of VOCs and to help determine if drilling would continue within a borehole. Drill cuttings were also screened for VOCs as the cuttings were discharged from the borehole. The air within and around each borehole was monitored for combustible gases. Screening results were recorded on sample collection logs and are summarized Appendixes C-4.0 and C-5.0 of this work plan.

Core extracted from each borehole was lithologically logged. Boreholes were backfilled with drill cuttings and capped with a 2-ft-thick concrete surface seal. Cuttings were placed in the borehole in the reverse order from which they were displaced, such that materials removed from the bottom of the borehole were returned to the bottom and so on. Samples were submitted to the MCAL for analysis of acetone, butanone[2-], benzene, BTEX, diesel, trimethylbenzenes, and TPH. Acetone and butanone[2-] were included in the analytical suite to try to resolve issues concerning the potential for laboratory contamination based on the results reported from the 1994 RFI. The trimethylbenzenes were included because they had been identified as COPCs based on the 1994 RFI.

As part of the 1995 UST investigation, water and core samples were also taken in DP Canyon to investigate the localized hydrocarbon sheen area. Those samples and analyses are discussed in a following subsection entitled, "Hydrocarbon Sheen and DP Canyon Sampling and Analysis (1994–present)." Results of analyses of these samples are provided in Appendixes C-8.0 and C-9.0 of this work plan.

The results of field-screening activities conducted during the 1995 UST investigation at DP Tank Farm are presented in Appendixes C-4.0 and C-5.0 of this work plan. Field-screening results for radioactivity showed that no borehole or soil samples had radiation levels greater than background. Field-screening results for VOCs showed high concentrations in soil samples from several boreholes, primarily those drilled at the location of the former East Fill Station and, to a much lesser extent, in three depth intervals at borehole 21-3003 at the location of the former West Fill Station. Analytical results are provided in Appendixes C-6.0 (West Fill Station) and C-7.0 (East Fill Station) of this work plan.

Evaluation of Data from the 1995 UST Field Investigation

The intent of the 1995 UST investigation was to delineate both the vertical and horizontal extent of the petroleum hydrocarbon contamination at the locations of the former East and West Fill Stations and to further investigate the source of contamination at the localized hydrocarbon sheen area in DP Canyon. Figure 2.2-2 shows the three areas of concern and the locations of the samples collected in 1995. The data collected in 1995 are separated into three distinct groups: East Fill Station data, West Fill Station data, and data from DP Canyon around the area of the localized hydrocarbon sheen. The data collected in 1995 are presented in Appendixes C-2.0 through C-9.0 of this work plan. The regulatory limits for TPH, BTEX, and benzene concentrations noted in figures presented in this section refer to the NMED UST regulations (NMED 1996, 58202) EIB/USTR-12, §1209, Paragraph D(3)(a) and Paragraph D (3)(b) relating to the remediation of highly contaminated soils. These regulatory limits do not apply to the soils at PRS 21-029, DP Tank Farm, because the soils were not highly contaminated; the regulatory limits are used as a point of reference only.

East Fill Station Location

Boreholes 21-3006, 21-3008, 21-3009, and 21-3011 exhibited comparatively high concentration levels of benzene, BTEX, and TPH in some samples. TPH was detected in samples from these boreholes at concentrations in excess of 1000 ppm, BTEX was detected at concentrations in excess of 500 ppm in samples from boreholes 21-3006 and 21-3008, and benzene was detected at concentrations greater than 10 ppm in samples from the same two boreholes. Figures 2.2-3, 2.2-4, and 2.2-5 provide graphical summaries of the vertical extent of contamination for TPH, BTEX, and benzene, respectively using data from both the 1994 RFI and 1995 UST investigations. It should be noted that soil data were collected from selected, discrete depths in each borehole; breaks in the figures represent depths at which soil samples were not collected. The pattern of concentrations for each of these constituents is similar. The comparatively high concentrations indicated in these boreholes start from near the surface and continue to a depth of as much as 35 ft bgs, particularly in boreholes 21-3006 and 21-3008. Figures 2.2-6, 2.2-7, and 2.2-8, which portray average concentrations in samples over the full depth of the boreholes by spatial location of the boreholes, indicate similar results. The large proportion of nondetects, together with the information portrayed in Figures 2.2-3 through 2.2-8, indicate that the release is contained within an area that is maximally defined by boreholes 21-3007, 21-3010, 21-3012 and 21-3013 and a volume bounded vertically by a depth of approximately 35 ft bgs (note that borehole 21-3008 was angled at 45° to the west).

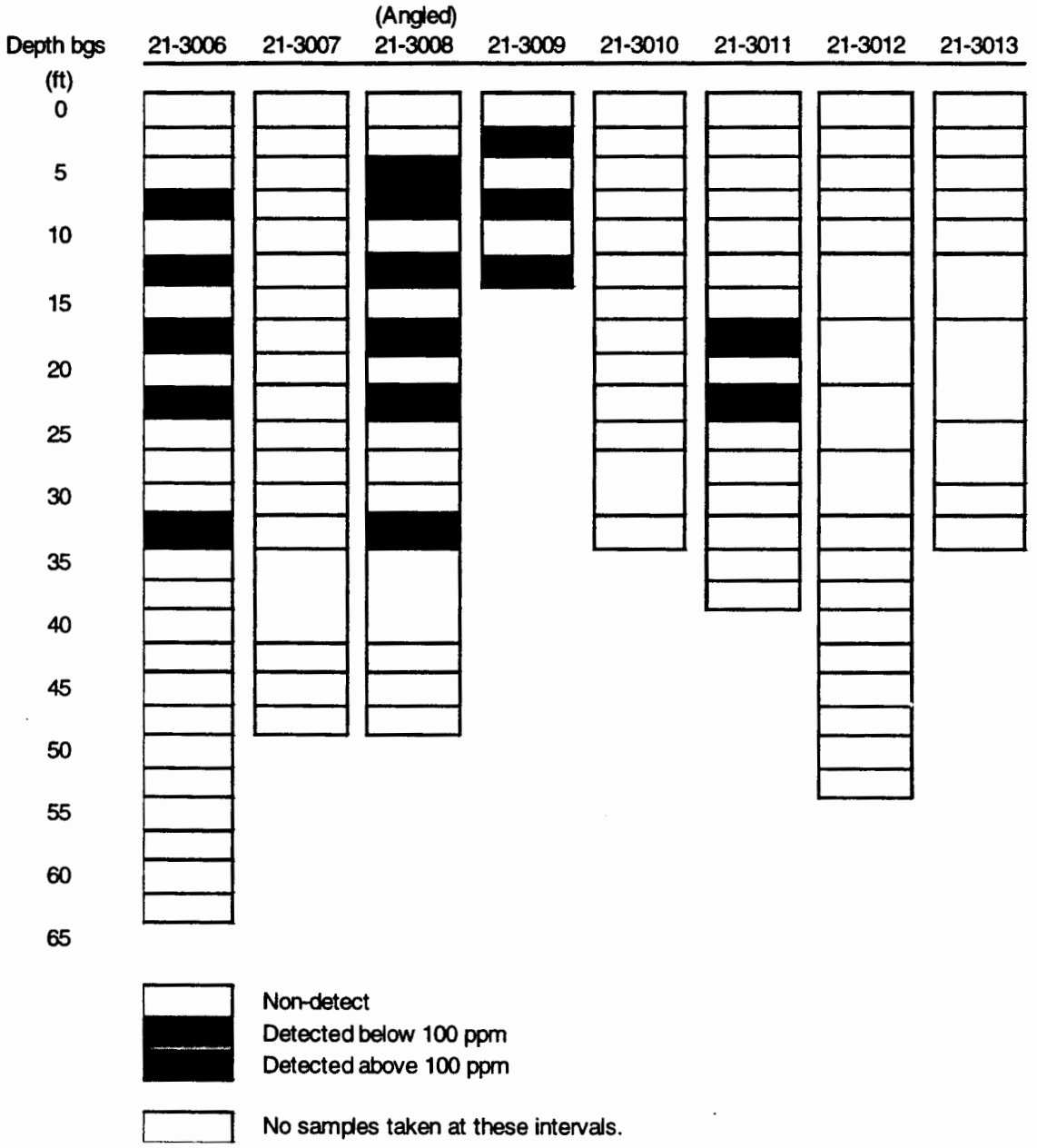


Figure 2.2-3. DP Tank Farm East Fill Station TPH data by borehole.

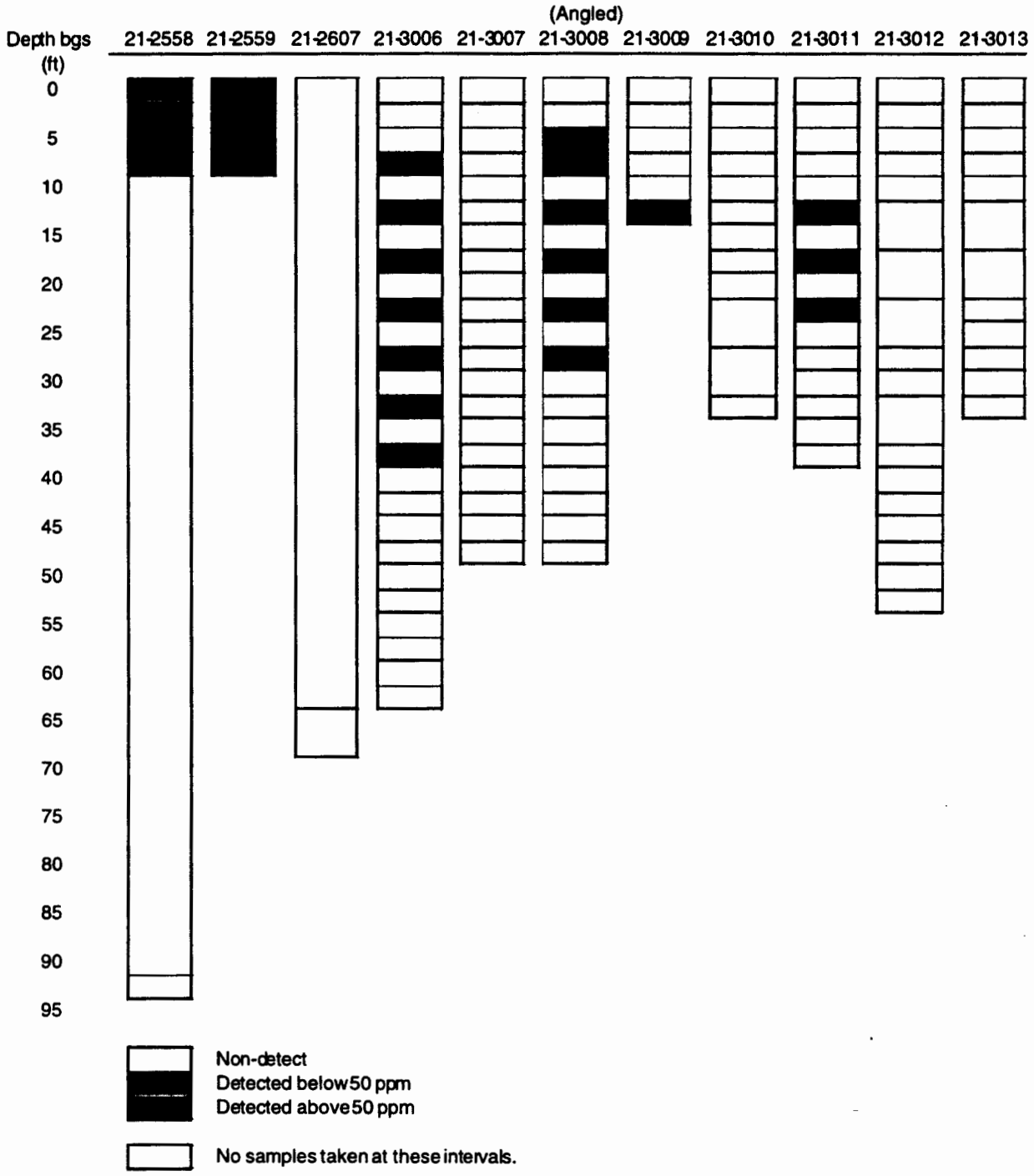


Figure 2.2-4. DP Tank Farm East Fill Station BTEX data by borehole.

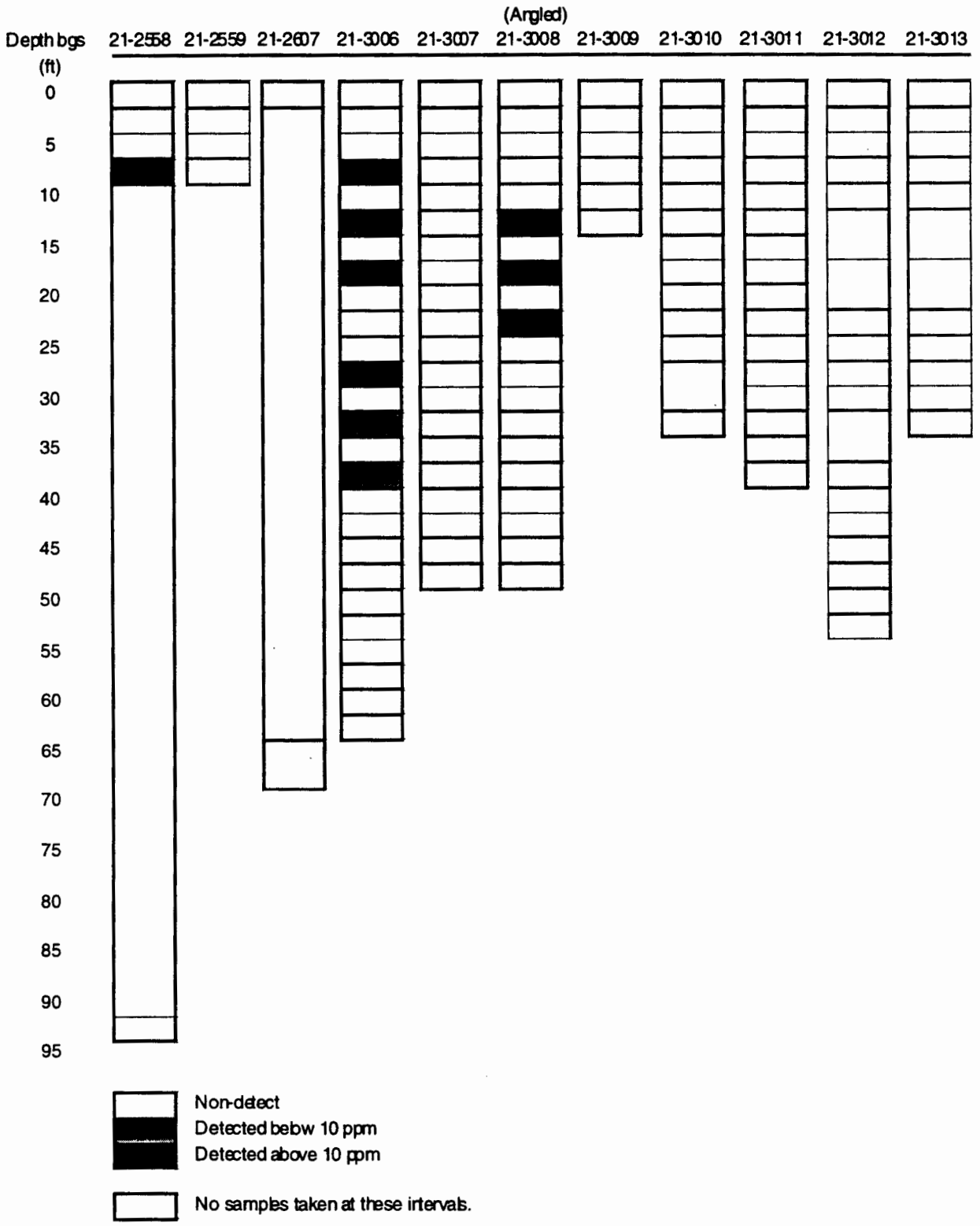


Figure 2.2-5. DP Tank Farm East Fill Station benzene data by borehole.

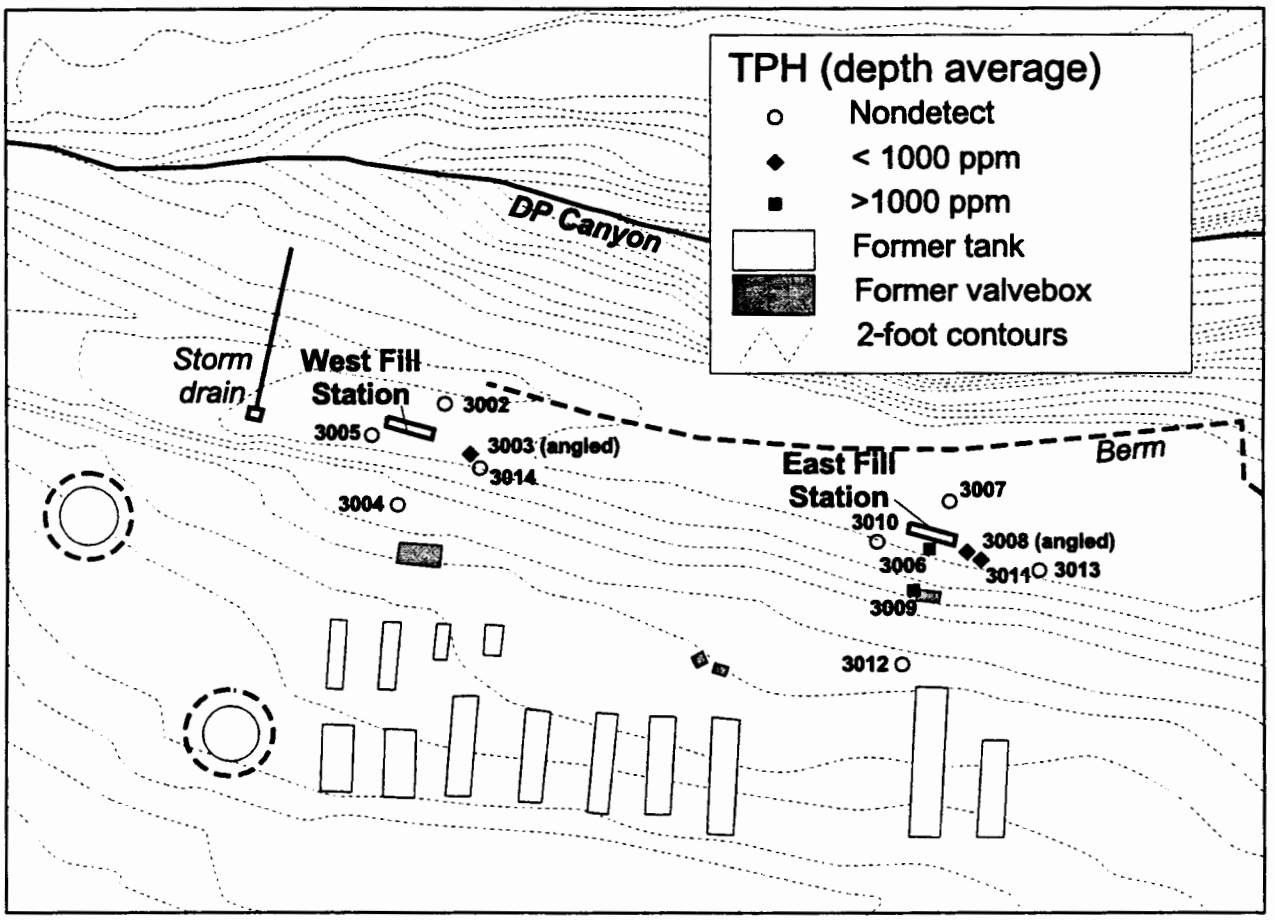


Figure 2.2-6. DP Tank Farm TPH data summary.

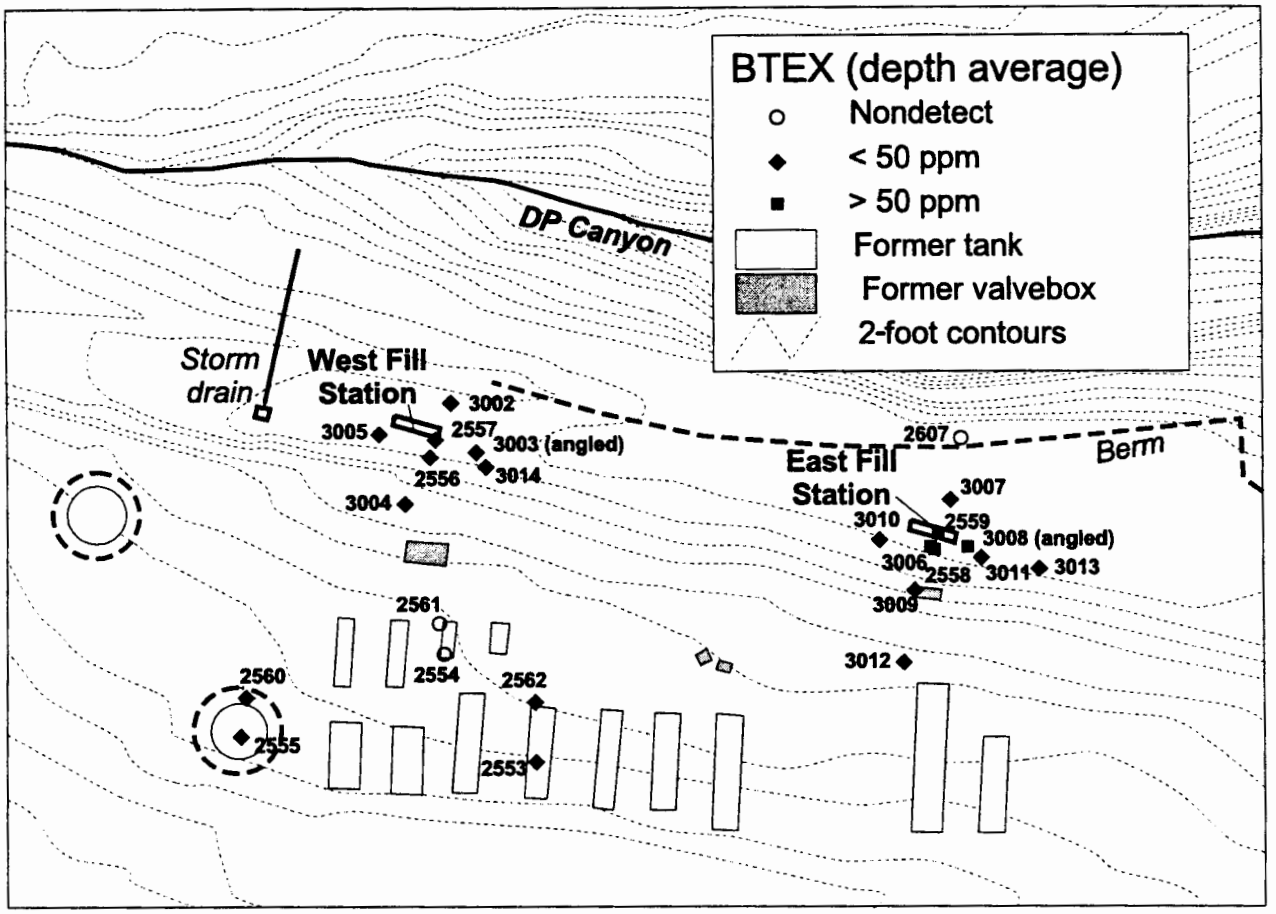


Figure 2.2-7. DP Tank Farm BTEX data summary.

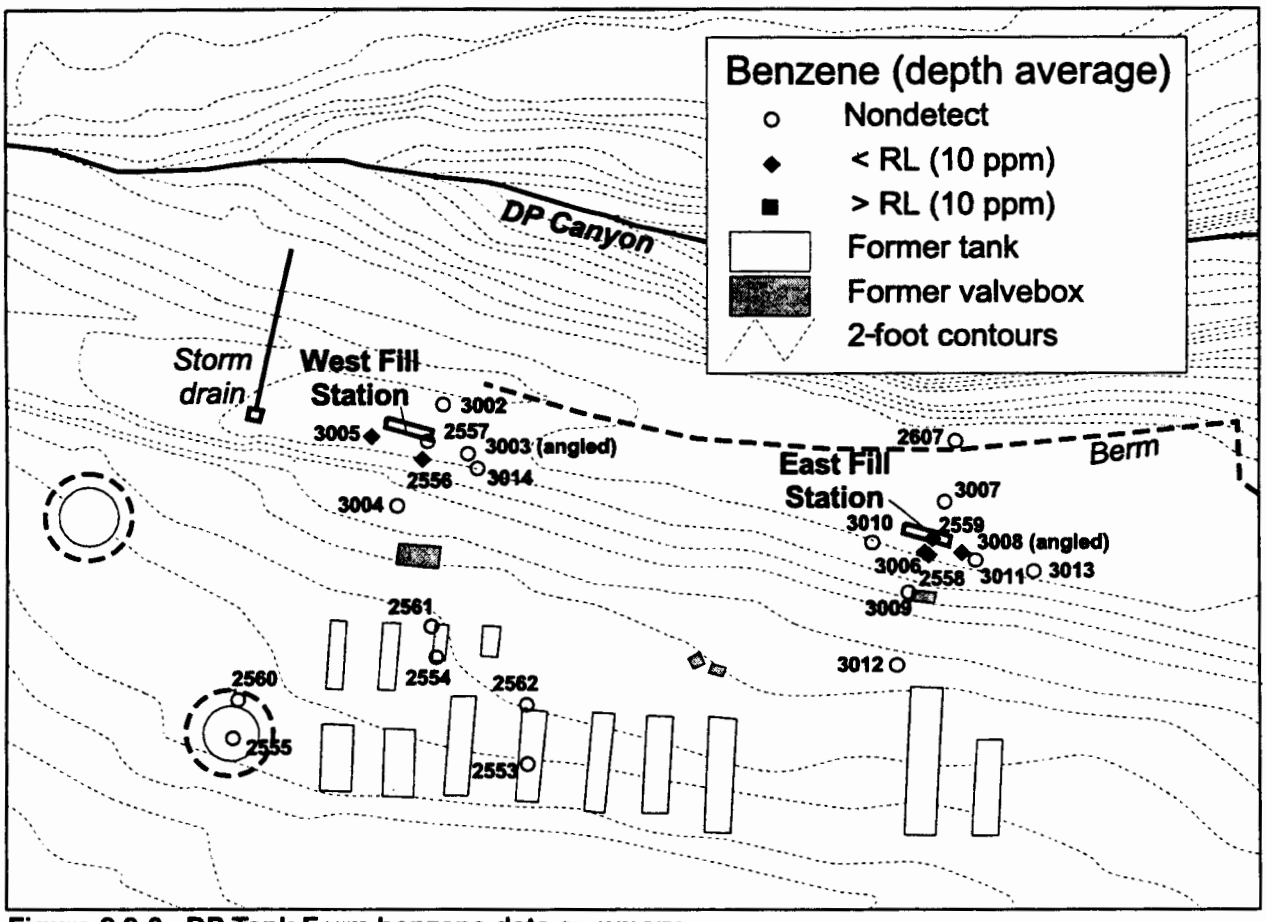


Figure 2.2-8. DP Tank Farm benzene data summary.

The results from the 1994 RFI are consistent with the information gathered in the 1995 UST investigation, showing that BTEX was present at concentrations greater than 500 ppm at depths between 5.0 and 10.0 ft in boreholes 21-2558 and 21–2559 (Figure 2.2-1 for borehole locations and Figure 2.2-4). These boreholes were located adjacent to the 1995 UST borehole 21-3006. Note that TPH data are not available from the 1994 RFI data, but the BTEX components serve as a useful indicator of the petroleum hydrocarbon contamination.

West Fill Station Location

The results of the 1995 UST investigation at the location of the former West Fill Station were used to argue that neither TPH, BTEX, nor benzene were detected in samples collected from any of the boreholes at concentrations greater than 1000, 500, and 10 ppm, respectively (LANL 1996, 52270). These results agreed with results of the 1994 RFI, which showed that neither BTEX nor benzene were detected at concentrations in excess of 500 and 10 ppm, respectively, at the former West Fill Station.

However, TPH, BTEX, and benzene were detected in samples collected from the location of the former West Fill Station. Figures 2.2-6, 2.2-7, and 2.2-8 show the horizontal extent of contamination at the location of the former West Fill Station for each of the hydrocarbon groups of interest. Figures 2.2-9, 2.2-10, and 2.2-11 show the vertical extent. Figures 2.2-10 and 2.2-11 indicate that the vertical extent of contamination at the location of the former West Fill Station might not have been determined. The levels detected were all below the UST thresholds of interest, and the depth of the boreholes was great enough that extent was considered bounded according to the needs of the investigation. In particular, no large subsurface petroleum hydrocarbon accumulation was found. Figures 2.2-7 and 2.2-8 provide a similar picture of the BTEX and benzene data. The TPH data, by contrast, suggested that the vertical and horizontal extent of the petroleum hydrocarbons was adequately determined (note that borehole 21-3003 was angled at 45° to the west).

Summary

The presence of petroleum hydrocarbons in the subsurface at the locations of the former East and West Fill Stations was confirmed during the 1995 UST investigation. In addition the vertical and horizontal extent of contamination at these two locations appeared to be reasonably defined. The petroleum hydrocarbon concentrations at the location of the former West Fill Station were significantly lower than those from the location of the former East Fill Station, and the extent of the contamination was significantly less than at the former East Fill Station. The information gathered in the RFI 1994 and 1995 UST investigations prompted a recommendation for no further action (NFA) at this site, based on NFA criterion 3 (currently Criterion 4 in the IWP) (LANL 1996, 55574, p. 3-11); the site was characterized and/or remediated under a different authority (in this case, the NMED UST regulations), which adequately addresses corrective action (LANL 1996, 52270). In addition, preliminary risk assessments (unpublished) performed at the time suggested that no adverse human health effect was likely.

DOE LAAO at that time indicated their preference to remediate the site based on a desire to ensure that future activities at this site, e.g., construction activities, would not require disposal of New Mexico special wastes. Based on these criteria, a decision was made to remediate the area of former East Fill Station. The area of the former West Fill Station was not included in the remediation activities because reported concentrations at that site did not exceed the New Mexico special waste thresholds for TPH (1000 ppm), BTEX (500 ppm) or benzene (10 ppm), as discussed in Section 2.1.2.

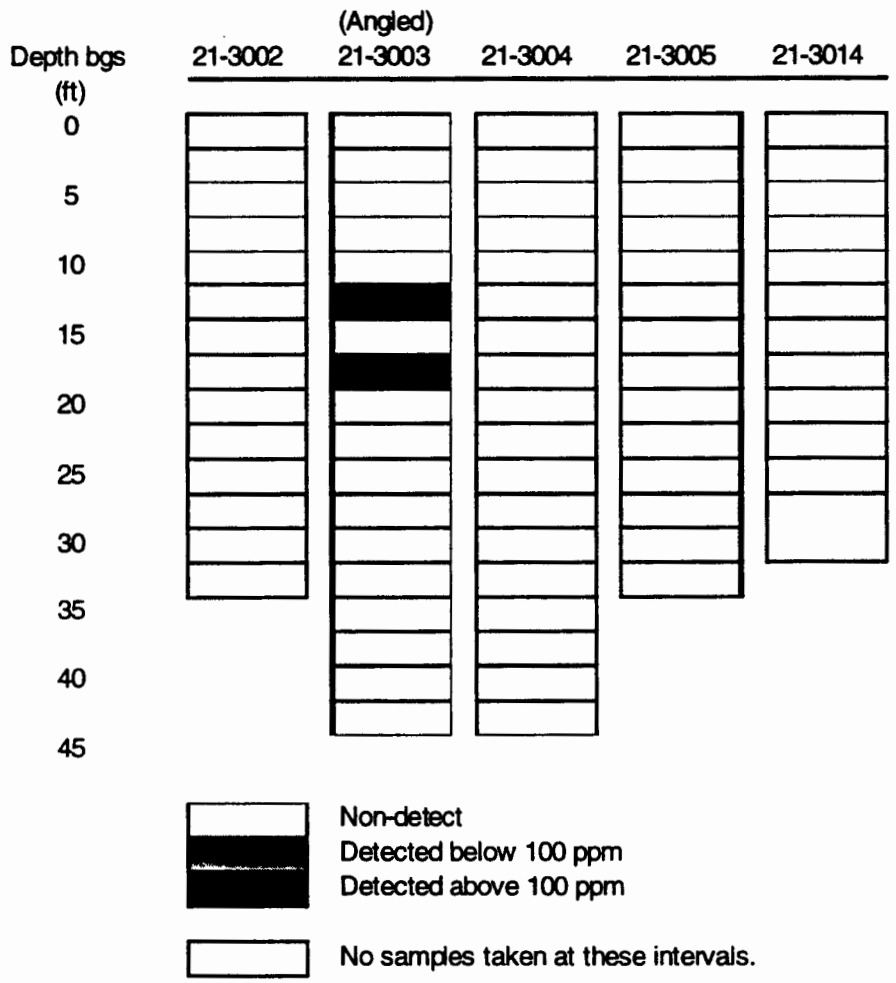


Figure 2.2-9. DP Tank Farm West Fill Station TPH data by borehole.

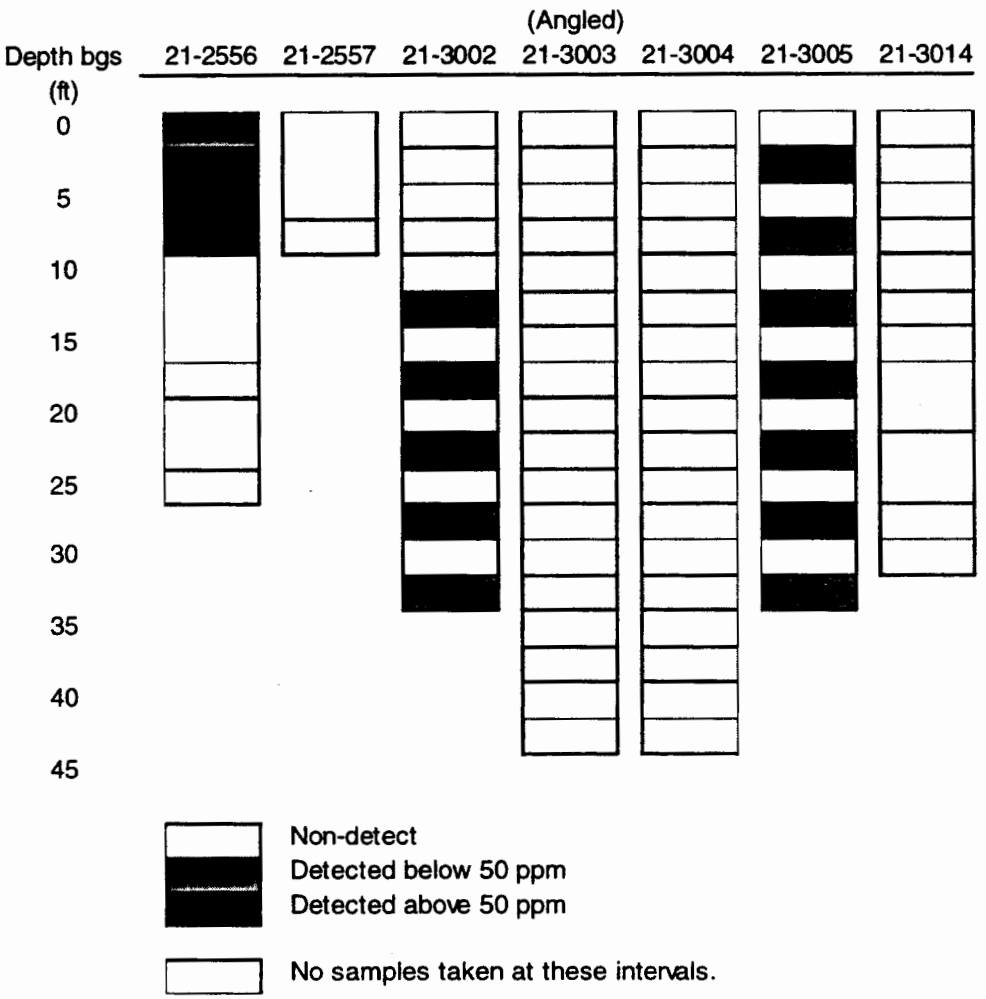


Figure 2.2-10. DP Tank Farm West Fill Station BTEX data by borehole.

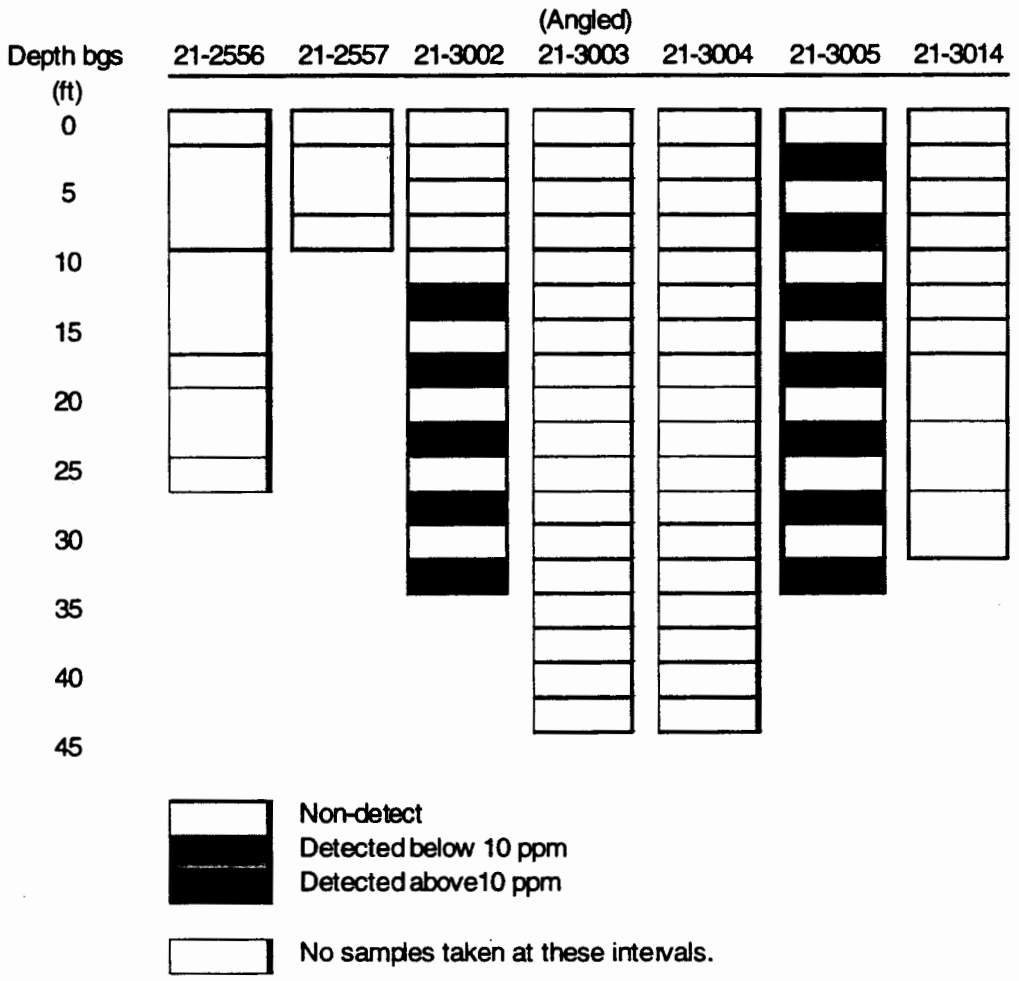


Figure 2.2-11. DP Tank Farm West Fill Station benzene data by borehole.

Discussions with the NMED UST Bureau proceeded to determine the conditions under which the UST Bureau would close the DP Tank Farm site. The NMED UST Bureau was concerned about the presence of the localized hydrocarbon sheen area in DP Canyon to the north of DP Tank Farm and decided that closure could not be granted until the New Mexico Surface Water Bureau was satisfied that the sheen area posed no threat to human health or the environment. That determination has not been made but is the critical path for further investigation of this site.

The next steps in the chronology of events include preliminary investigation of the localized hydrocarbon sheen area and excavation of the petroleum hydrocarbon contaminated soils at the location of the former East Fill Station. At this time, a connection between the sheen area and DP Tank Farm has not been made, so investigation of the sheen area is considered necessary to further understanding of the nature of the sheen contamination. In addition, removal of the petroleum hydrocarbon contaminated soils at the location of the former East Fill Station, if it is related to the sheen area, would resolve issues related to the source of the sheen area.

Hydrocarbon Sheen and DP Canyon Sampling and Analysis (1994–present)

During 1994 RFI field work, ER Project personnel discovered what appeared to be a "seep of petroleum-related products discharging slowly and intermittently from a small area in the DP Canyon drainage directly north of the West Fill Station" (LANL 1996, 52270, p. 28). The location of this seep, which is better characterized as a *localized hydrocarbon sheen* (Jansen and Taylor 1997, 56512), is shown on Figure 2.2-2. To briefly reiterate the discussion in Section 1.0 above, the terms *localized hydrocarbon sheen area* or *sheen area* are used to refer to this area of DP Canyon.

The results of the 1994 RFI indicated that the only contaminant source at DP Tank Farm was petroleum-related products. In order to determine if the localized hydrocarbon sheen area could potentially be related to this source or to other sources, samples were collected after the 1994 RFI on April 5, 1995, from the sheen area sediments and from drummed core materials taken at the location of the former West Fill Station in May 1994. These samples were sent to a fixed laboratory where they were analyzed qualitatively using chromatographic peak patterns to identify contaminants. The chromatograms suggested that both the former West Fill Station core and the localized hydrocarbon sheen area sediments (tuff) most likely contained diesel range petroleum hydrocarbons. As stated in the analyst's report, the localized hydrocarbon sheen area soil sample "most likely contained a 'weathered' diesel fuel" when compared to standards consisting of diesel range organics (DRO) and 25%, 50%, and 75% weathered DRO provided by Restek (Lombardo 1995, 58959). The "weathered" DRO standards are produced in a laboratory by heating fresh diesel fuel to volatilize and drive off the lighter fractions of the fuel. This process results in standards that are DRO lean in volatile compounds compared to a fresh diesel fuel sample. The process would not be expected to simulate well the total weathering process because of interactions of diesel fuel with rocks, soils, and water, or biological degradation of the fuel; Lombardo (1995, 58959) also noted that "a perfect match" of fuel in an environmental sample to a standard was not expected." Chromatograms obtained in this special study are provided in Appendix C-10.0 of this work plan. Further review and expert opinion confirmed that the localized hydrocarbon sheen area soil samples contained weathered diesel (Loescher 1998, 58989).

Because the qualitative analysis indicated a potential relationship between the localized hydrocarbon sheen area and the former West Fill Station, the DP Canyon channel was investigated in 1995 to determine if the petroleum-related products in the sheen area are associated with the petroleum-related products contamination at the location of the former West Fill Station. Sampling locations are shown in Figure 2.2-2. All boreholes were drilled with a Bosch Rotohammer equipped with 3-ft, 2.5-in.-diameter,

solid-stem auger flights. The total depth drilled for each borehole was 9 ft bgs. Several attempts were made to collect samples with a drive sampler and a bucket auger, but the hard tuff bedrock prevented extraction of a clean, undisturbed sample (LANL 1996, 52270).

Samples of surface materials or tuff were collected at four locations along the stream bed (Figure 2.2-2): location 21-3025 was approximately 230 ft upstream from the localized hydrocarbon sheen area, location 21-3023 (with duplicate) was approximately 250 ft downstream from the sheen area, and locations 21-3020 (with duplicate) and 21-3021 (with duplicate) were at or near the sheen area. A total of seven samples (including three field duplicates) were collected (LANL 1996, 52270).

To characterize the level of petroleum hydrocarbon contamination in the water, four surface water samples were collected from the stream in DP Canyon (Figure 2.2-2). Two of the water samples were collected from the localized hydrocarbon sheen area. Because disturbance of the sheen area would produce a visible sheen on the water surface, the first (21-3024) of these samples was collected before the sheen area was disturbed and the second (21-3024) was collected after the sheen area was disturbed. A visible sheen was noted in the samples collected after the sheen area was disturbed. The remaining two water samples were collected upstream (21-3025) and downstream (21-3023) from the sheen area at the same locations from which the surface material samples were collected (LANL 1996, 52270).

The following information was obtained from the logs of samples collected pursuant to the plan (LANL 1995, 59364) available at the Laboratory SMO.

On June 1, 1995, three water samples were taken at the following locations: one was 250 ft downgradient from the localized hydrocarbon sheen area (location 21-3023, sample 0121-95-0243); one at the sheen area (location 21-3024, sample 0121-95-0244); and one in the channel "at the edge of the concrete ditch" (location 21-3025, sample 0121-95-0245). Also on this day, four samples of tuff at depths from 3 to 9 ft were taken from a borehole drilled on the north side of the channel, adjacent to the sheen area (location 21-3015, samples 0121-95-0171 through -0174). The samples are described in the collection logs as being pulverized tuff from auger cuttings.

A week later on June 8, 1995, sampling continued with two more boreholes and another water sample being collected. Four samples of tuff at depths from 1.5 to 9.0 ft were taken from a (second) borehole drilled approximately 20 ft north of the sheen area (location 21-3018, samples 0121-95-0218 through -0221). The samples are described in the collection logs as gray pulverized tuff taken off the screw auger as it was pulled from the hole. A (third) borehole, drilled 5 ft south of the sheen area yielded another four tuff samples (location 21-3019, samples 0121-95-0223 through -0226). These four samples were also taken at depths from 1.5 to 9.0 ft and are described as gray pulverized tuff taken from the screw auger as before. The sample extracted at the 4- to 5-ft depth (-0224) is further described as "moist," the sample at the 6- to 7-ft depth (-0225) as having a "high water content," and the deepest sample (8 to 9 ft, -0226) as "saturated." The borehole sampling activities on this day were followed by the collection of a surface water sample at the localized hydrocarbon sheen area (location 21-3027; sample 0121-95-0247). The collection log comments state that "a petroleum sheen flowing in the water was captured for this sample."

Several days later, on June 14, 1995, seven soil samples, including three field duplicates, were taken from four locations in the DP Canyon area. A gray tuff sample (location 21-3023, sample 0121-95-0185) and its field duplicate (sample 0121-95-0186) were taken from an "outcrop in the drainage." According to the collection log comments, "tuff was chipped into a bag and then smashed with a hammer." A hand auger was used to take a gray tuff, "very moist" sample (location 21-3020, sample 0121-95-0228) and its

duplicate (sample 0121-95-0229) at a 0–5 in. depth on the south side of the channel at the localized hydrocarbon sheen area. These samples were also bagged and smashed. A "petroleum odor was noticeable" for both the sample and its duplicate. A similar sample was taken on the north side (location 21-3021, sample 0121-95-0233 and duplicate sample 0121-95-0234). This sample and its duplicate were described as moist gray tuff, with comments that a "faint odor of petroleum was detected." Finally, a single sample was taken in the channel (location 21-3025, sample 0121-95-0187). Comments state that "material collected below [the] cement channel and consisted of gravel and sediment." The sample was taken at a depth of 0 to 0.5 ft and was described as gravel with sediment.

All surface material or tuff samples and water samples collected in DP Canyon were submitted to the MCAL for analysis of VOCs and TPH. Because the 1994 RFI found acetone and methyl ethyl ketone, both of which were likely laboratory contaminants, analyses for these constituents were also performed. Results of analyses of these samples are provided in Appendixes C-8.0 and C-9.0 of this work plan.

Summary

Analyses of four water samples collected at three locations (Figure 2.2-2) in the channel showed undetectable concentrations of all analytes.

Of the 19 soil samples collected at seven locations in the channel and the banks to the north and south, diesel was measured at location 21-3020 (in the channel soil) in all four samples at concentrations ranging from >569 to >1796 mg/kg, and TPHs were measured at three of the seven locations as follows:

•	Location 21-3015	North bank, all four samples (decreasing with depth)	<51 to 131 mg/kg
•	Location 21-3018	North bank, one of four samples (the surface sample)	296 mg/kg
•	Location 21-3020	Channel, all four samples	>569 to >1796 mg/kg

Analyses of the remaining 10 samples from three locations showed undetectable TPH concentrations. That is, all detections of diesel and TPH were in soil samples collected at the localized hydrocarbon sheen area and in two boreholes up the stream bank to the north (away from the site). No analytes were detected in soil samples collected downstream or in one borehole up the stream bank to the south of the sheen area.

The data did not confirm or deny a relationship of the localized hydrocarbon sheen area with sources at DP Tank Farm. The data indicated, if anything, a different source for the sheen area, such as activities on the north bank of DP Canyon related to the Pine Glen Apartments or contamination related to an upstream source such as the DP Road Storage Area (see Section 2.1.1). A monitoring plan was established to visually investigate the sheen area on a quarterly basis and to sample the sheen area once a year for two years to gain a better understanding of the transport system from the sheen area. An objective of this work plan is to gain a much more complete understanding of the sheen area, its extent, and the direction from which it appears to originate. Some further rationale for this approach is provided by considering the VCA activities performed at the location of the former East Fill Station in 1996.

VCA Confirmatory Sampling and Analysis Activities (1996)

As discussed in detail in Section 2.1.2, remediation at the location of the former East Fill Station was conducted in May 1996 in accordance with the VCA plan (LANL 1996, 55344). Approximately 1720 yd^3 of petroleum-contaminated soil and tuff were removed, loaded on trucks, and transported offsite for land farming.

The following discussion of the confirmatory sampling and analyses, including the figures, is taken from the VCA report prepared in August 1996 (LANL 1996, 55347, pp. 8–13).

In accordance with the approved VCA plan (LANL 1996, 55344), petroleum hydrocarbon-contaminated material was to be excavated to a maximum depth of 35 ft bgs. Cleanup levels were stipulated as 1000 ppm for TPH, 500 ppm for BTEX, and 10 ppm for benzene, which are the New Mexico special waste thresholds for these chemicals. After DOE approval of the VCA plan, but before initiation of field activities, the cleanup level for benzene was lowered to 1 ppm to reduce the potential health risk associated with the presence of benzene in the subsurface at concentrations greater than the SAL (at that time 1.4 ppm). A cleanup level of 1 ppm was chosen so that a deed restriction would not be necessary if the site were developed for commercial use.

Samples were collected from the side walls and bottom of the excavation for analysis by the MCAL so that results could be received within 24 hours. In those cases where MCAL results exceeded the cleanup levels, fixed-laboratory confirmatory samples, which were collected at the same time as MCAL samples, were not submitted for analysis. If MCAL results indicated that petroleum hydrocarbon contaminant concentrations were below cleanup levels, samples were submitted to the fixed laboratory for confirmation.

Confirmatory samples were collected from the side walls and bottom of the excavation at the same time and from the same locations as MCAL samples. Samples were submitted to a fixed laboratory for analysis of BTEX by Environmental Protection Agency (EPA) SW-846 Method 8020 and TPH in the form of diesel by modified EPA SW-846 Method 8015. Sample locations are shown in Figures 2.2-12 and 2.2-13. Some of the sample analytical results were estimated data. However, the analytical results were significantly below action levels. For these reasons, the data qualifications did not affect the usability of the data. The data are provided in Appendix D of this work plan.

Analytical results for all final confirmation samples indicate that benzene concentrations were below the 1 ppm cleanup level and total BTEX concentrations were below the 500 ppm cleanup level. The 1000 ppm cleanup level for TPH was also met with the following four exceptions of the 23 samples submitted for fixed-laboratory analysis (Figures 2.2-12 and 2.2-13).

- Sample 0121-96-0038 was located in the northern portion of the excavation on the west side wall at a depth of approximately 20 ft bgs. This sample contained TPH at a concentration of 2700 ppm.
- Sample 0121-96-0044 was located in the northern portion of the excavation on the west side wall at a depth of approximately 28 ft bgs. This sample contained TPH at a concentration of 3700 ppm.
- Sample 0121-96-0042 was located on the bottom of the northern portion of the excavation at a depth of approximately 32 ft bgs. This sample contained TPH at a concentration of 6100 ppm.
- Sample 0121-96-0027 was located on the bottom of the southern portion of the excavation at a depth of approximately 15 ft bgs. This sample contained TPH at a concentration of 1300 ppm.

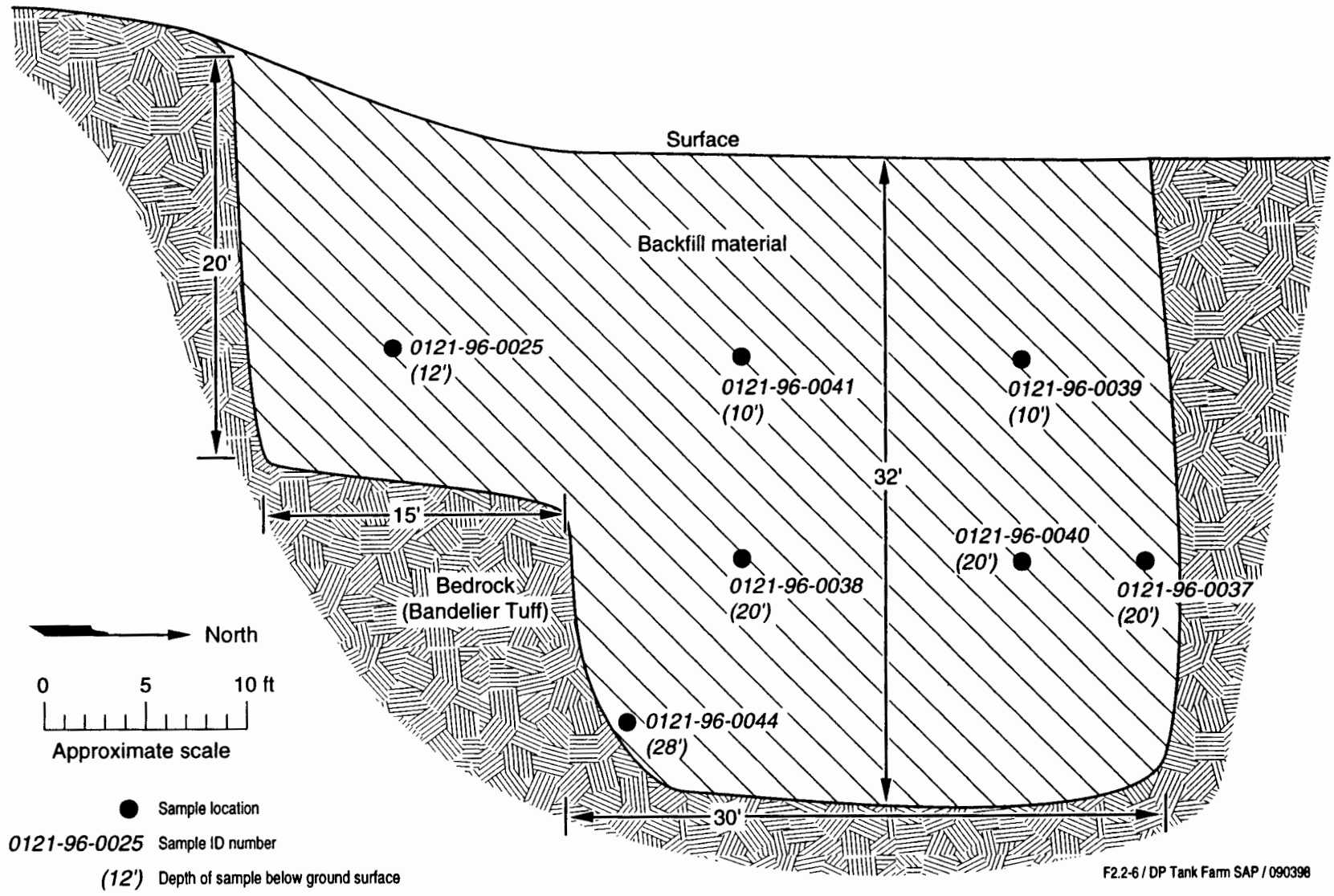


Figure 2.2-12. Approximate locations of confirmatory samples collected from west sidewall of excavation.

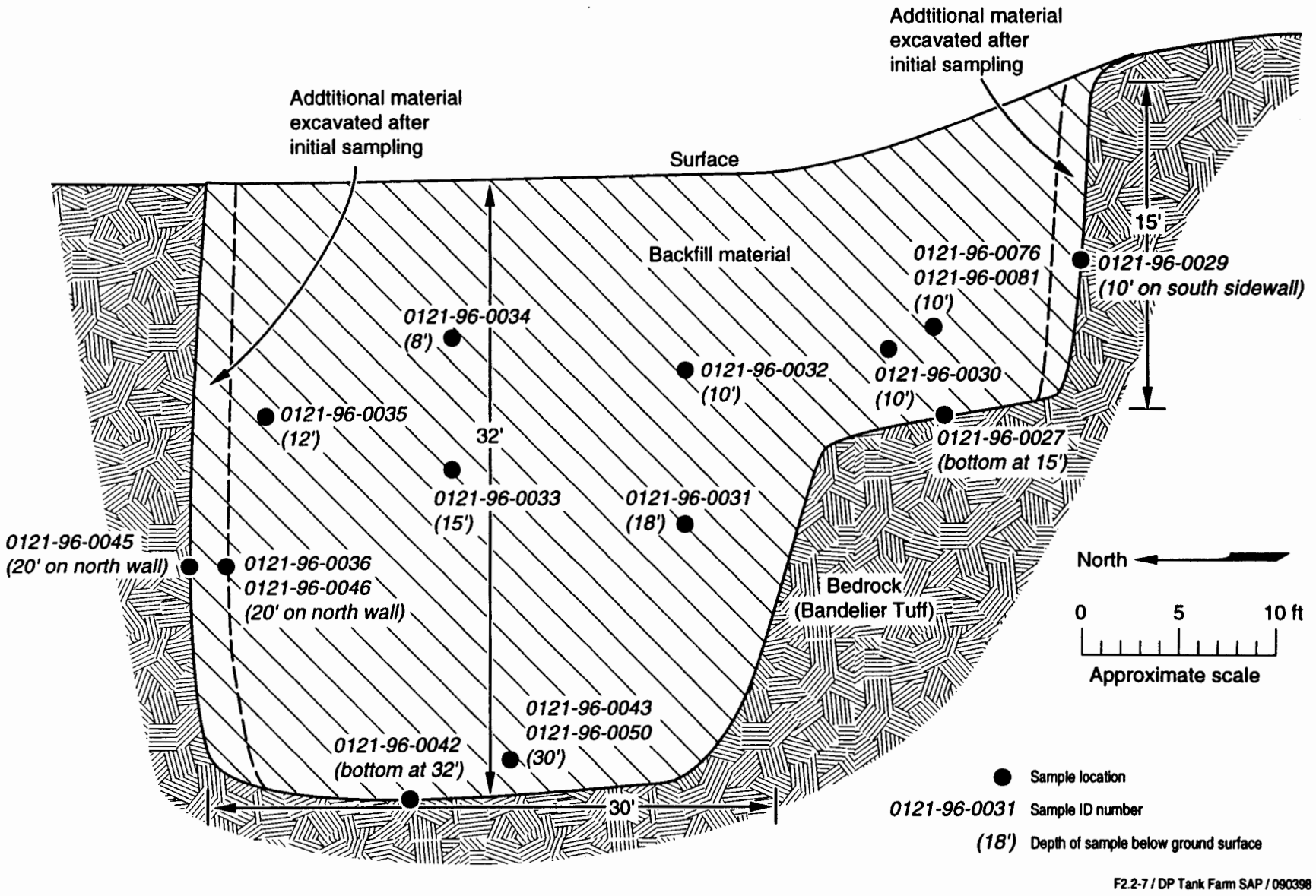


Figure 2.2-13. Approximate locations of confirmatory samples collected from east sidewall of excavation.

All of these samples were composed of crushed tuff removed from stained areas on the side walls or bottom of the excavation (see photographs in Appendix F-3.0 of this work plan). As described in the RFI report for PRS 21-029, the tuff bedrock at the site is highly fractured (LANL 1996, 52270). The stained areas were observed in the tuff adjacent to some of these fractures.

Contaminated soil with petroleum-related products at concentrations above cleanup levels was removed from the site with the exception of stained material associated with fractures in the tuff. Stained tuff was observed adjacent to and along fractures. In some places, the stained material extended as much as 3 to 4 ft from fractures. Samples 0121-96-0027, 0121-96-0038, 0121-96-0042, and 0121-96-0044 were crushed tuff samples collected from areas on the side walls and bottom of the excavation adjacent to fractures.

Although analytical results indicated that the cleanup level for TPH had not been met for these samples, no further removal was conducted because the small volume of contaminated material remaining was associated with staining that was observed adjacent to and along fractures (that is, the samples were biased toward stained material not bulk tuff). In addition, it was considered very unlikely that a developer would excavate to the depth of the contamination (20 to 32 ft bgs) during construction activities.

Evaluation of VCA Confirmatory Sampling and Analysis Data

During the VCA, several samples exhibited concentrations of TPH in the several thousands mg/kg (ppm). Soil was further removed from those locations until a depth of approximately 30 ft was reached for much of the excavation. Of interest is that the sampling and analysis activities clearly indicated that the vertical extent of the contamination had not been bounded by the 1994 RFI and 1995 UST investigation data. Whereas the 1994 RFI and 1995 UST data indicate that extent of contamination had been bounded at the location of the former East Fill Station, the sampling methods used (cores from boreholes) did not provide sufficient characterization of the subsurface distribution of petroleum hydrocarbon contaminants. The 1996 VCA sampling and analysis activities imply that the petroleum hydrocarbons are present in and around fractures and that fractures may play an important role in the distribution of these contaminants. The 1996 VCA involved removal of a substantial portion of petroleum-hydrocarbon-contaminated material but also demonstrated the difficulty of characterizing contamination that is associated predominantly with fractures.

The removal of 1720 yd^3 of contaminated soil also reduced the potential for adverse human health and environmental effects. Preliminary risk assessments had indicated that adverse effects were not likely, based on the data available at the DP Tank Farm site. The residual contamination is largely in the subsurface, and there is no direct pathway to receptors other than upward movement of the more volatile hydrocarbons to the surface. Even in the case of significant upward migration, however, adverse human health effects would be extremely unlikely unless a building were placed directly on top of the subsurface contamination and that building was not properly vented.

As indicated in Section 2.1.1 (discussion of fractures), it is possible that fracture flow to the north could transport petroleum-related products to DP Canyon. However, the actual paths of the fractures is uncertain, and there are other potential sources for the localized hydrocarbon sheen area in DP Canyon. Because of the difficulty of pursuing contamination through fractured media, the objective of the next phase of investigation at DP Tank Farm is to better understand the sheen area, its extent, and the direction of its origination. Information gathered will reduce uncertainties about the conceptual model at the site. Also, because of the nature and known extent of the subsurface contamination on the mesa at DP Tank Farm and the perceived lack of risk to human health or the environment, there is greater benefit

from investigating the sheen area, which has more direct impact on the local environment, than further investigating the areas of the former East and West Fill Stations.

Other Sampling and Analysis Data and Evaluation

Previous Investigations at PRS 00-031(a)

The Phase I RFI sampling and analysis plan for PRS 00-031(a), Hilltop House Gasoline Station, was completed in 1992 and included plans for geophysical surveys to find the precise locations of any remaining UST and associated piping; it also included plans for soil borings to determine the nature of any potential contaminant in subsurface soil and/or tuff beneath the UST (LANL 1992, 7667, p. 5-116). A GPR geophysical survey and a magnetic survey were performed at the site March 20, 1993, to locate any UST or underground pipelines. The results of the survey showed that no USTs were present at the site. However a "rubble pit" was located in the parking area northeast of the hotel lobby area (LANL 1993, 15022; LANL 1993, 15023).

Based on these findings and the fact that the former UST at the site had been reported to have been removed when the gasoline pumps were relocated to the north side of the hotel (Francis 1997, 58707), no borings have been completed, and no sampling and analyses have been performed at PRS 00-031(a). It should be noted, however, that no records (beyond anecdotal reports) of the tank removal have been found, and no person present at the tank removal who could comment on the condition of the tanks and the soil beneath and around the tanks at the time of removal has been identified. Thus, the absence of contaminated soils at this PRS has not been verified.

Previous Investigations at PRS 00-027

Phase I RFI field activities at PRS 00-027 DP Road Storage Area were conducted in the spring and fall of 1996 according to the RFI work plan for OU 1071 (LANL 1992, 7667, Section 5.7). The RFI activities that were performed are summarized below.

- A geodetic survey was conducted to determine the locations of structures associated with the DP Road Storage Area.
- A geophysical survey was conducted using electromagnetic induction and magnetic methods to locate subsurface structures.
- A soil vapor survey was conducted in the vicinity of the former tank and drum storage areas to determine whether vapor-phase contamination exists in subsurface soils underlying the site. Soil vapor samples were analyzed for BTEX. A field screening for organic vapors was also conducted during this survey.
- Subsurface sampling was conducted at 21 borehole locations that were selected based on the locations of former fuel storage cells and areas of potentially contaminated soil, based on results from the soil vapor survey. The depths of boreholes ranged from 20 ft to 60 ft bgs. Subsurface samples were analyzed for VOCs, SVOCs, TPH, TAL metals, and pesticides/PCBs. A select number of samples were also submitted to the MCAL and MRAL for screening.
- Passive air sampling was conducted at nine locations that were selected on structural features within the Knights of Columbus building. The samples were analyzed for VOCs.

The preliminary data collected in the Phase I RFI at PRS 00-027, DP Road Storage Area, are provided in Appendix E-3.0 of this work plan.

Previous Investigations at PRS 00-030(a)

Phase I RFI field activities at PRS 00-030(a), DP Road Storage Area septic tank system, were conducted along with the activities at PRS 00-027, DP Road Storage Area, and preliminary data is provided in Appendix E-3.0 of this work plan. The activities were conducted in the spring of 1996 according to the RFI work plan for OU 1071 (LANL 1992, 7667, Section 5.7). The following provides a summary of the RFI activities that were performed.

Site engineering and geodetic surveys were conducted April 3 and 4, 1996, to locate the former fuel dispatch office and the septic tank. The footprint of the foundation of the former dispatch office was located (LANL 1996, 59576, p. 4). The septic tank and associated pipelines were located by trenching completed June 18, 1996.

The top of the septic tank was located beneath 9 ft of backfill material. It was uncovered and entered through a manhole at the northwest corner of the tank. The septic tank contained 3 to 4 in. of dry sludge. Samples were collected of the sludge inside the tank and soil outside the tank near the inlet and outlet pipe connections (LANL 1996, 54354, p. 10). The results of the analysis of the samples were reported in the VCA report for PRS 00-030(a), and a human health risk assessment was performed (LANL 1996, 59576, p 20).

After receipt of the sample analytical results and the data assessment, a variety of remedial alternatives were considered. The method selected consisted of crushing the septic tank in place when the sample analyses and assessment confirmed that no human health risk was present associated with COPCs at the site.

Environmental Surveillance Program Data Relevant to DP Canyon

The following text, briefly describing the history of the Laboratory's environmental surveillance program, was taken from the Core Document for Canyons Investigations (LANL 1996, 55622, pp. 2-8 through 2-10).

Environmental monitoring for chemical and radiochemical quality of surface water, groundwater, and sediments began with studies by the US Geological Survey in 1945 (Purtymun 1964, 11822; Purtymun and Kunkler 1967, 0202; Purtymun 1967, 11785; Purtymun 1975, 11787; Environmental Protection Group 1993, 23249). The Laboratory became increasingly involved in this work after 1949 and in 1970 initiated a formal environmental monitoring program, which includes sampling and analysis of these media. This program continues, as required by DOE Order 5400.1, General Environmental Protection Program, under the direction of the Laboratory's Environment, Safety, and Health (ESH) Division.

The Environmental Surveillance Group began systematic environmental monitoring in 1966. Results of this monitoring are reported in the Laboratory's annual environmental surveillance reports and other special reports (e.g., Environmental Protection Group 1990, 6995; Elder and Knoell 1986, 6670; Montoya 1991, 6997).

The Laboratory also maintains a groundwater monitoring network to detect any effects that Laboratory activities may have on the quality of the regional aquifer. The Laboratory's Groundwater Protection

Management Program Plan addresses environmental monitoring, resource management, aquifer protection, and hydrogeologic investigations (LANL 1995, 50124). Groundwater protection activities at the Laboratory include installation of an extensive groundwater monitoring system for assessment of water quality, in conjunction with the Laboratory's hydrogeologic work plan (LANL 1996, 55430).

The existing groundwater monitoring network in the Los Alamos area consists of a variety of supply wells, test wells, observation wells, and springs located on-site and outside the Laboratory boundary. Scientists routinely sample and analyze water from wells and springs for radioactive and toxic constituents, for basic water-quality parameters, and for evidence of resource depletion. Results are published in the annual environmental surveillance report (e.g., Environmental Protection Group 1994, 45363) and the annual water supply report (e.g., Purtymun 1994, 41290).

Information on groundwater monitoring and sampling requirements, design criteria, and sampling procedures and equipment can be found in the Groundwater Monitoring Plan, Appendix F of the Groundwater Protection Management Program Plan (LANL 1995, 50124), and the hydrogeologic work plan (LANL 1996, 55430).

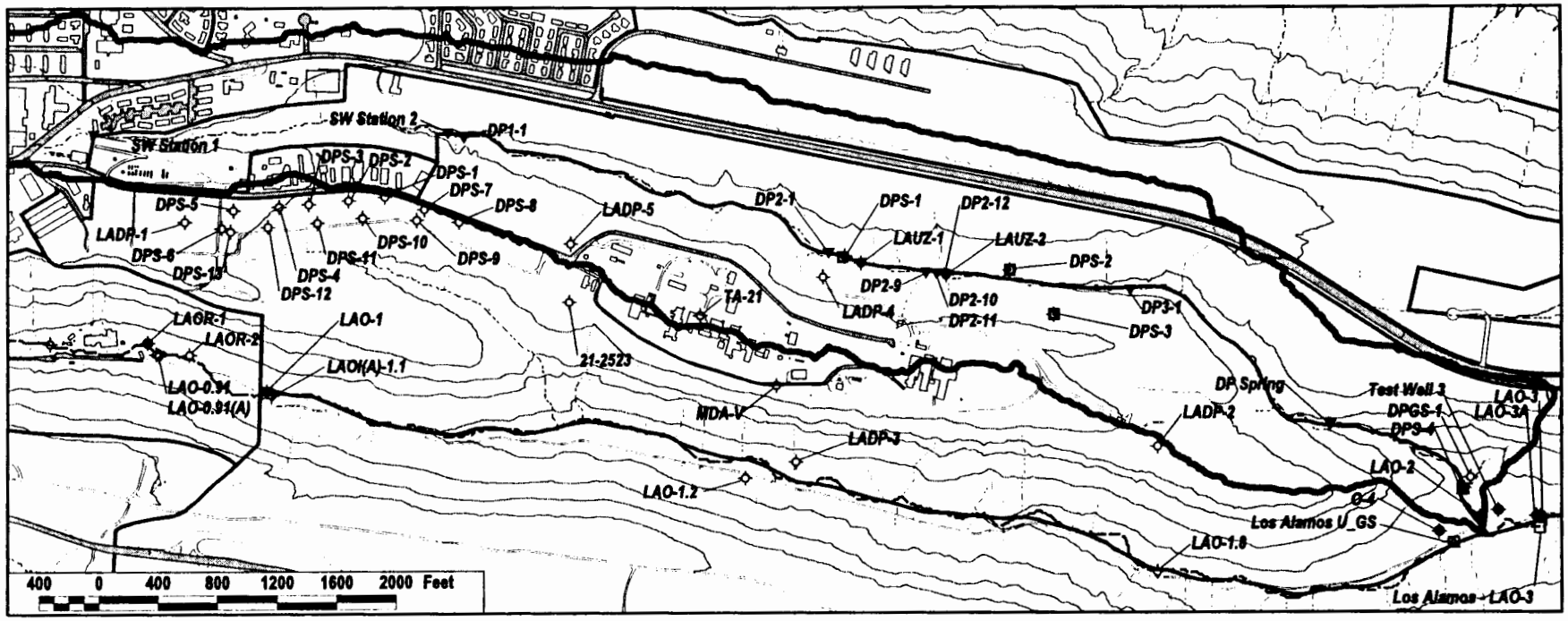
Appendix E-2.0 of this work plan provides data on organic chemical analyses of samples collected at environmental surveillance stations in, and possibly influenced by contaminants in, DP Canyon. Data are provided for the following sampling locations; coordinates and maps of these locations are available from FIMAD and are shown on Figure 2.2-14.

Surface Water	DPS-1, DPS-4
Alluvial Groundwater	LAO-2, LAO-3, LAO-3A, LAO-4, and LAO-4.5C
Regional Aquifer	Test Well (TW)-3

Analyses for organic chemicals have been conducted for several years in all media. Samples for organic analysis relevant to this work plan have been taken at DPS-1, DPS-4, LAO-2, LAO-3, LAO-3A, LAO-4, and LAO-4.5C. Several organic chemicals were detected, the bulk of which are probably laboratory contaminants (acetone and phthalates). Benzene was detected in 1 of 30 samples at a concentration of 4 µg/L (qualified J, detectable at 10 µg/L). Naphthalene was also detected in 1 of 38 samples at a concentration of 5 µg/L (qualified JB, detectable at 10 µg/L, and found in the laboratory blank). The remaining detected chemicals are not associated with petroleum hydrocarbons. These data do not suggest the presence of petroleum-related hydrocarbons downstream from DP Tank Farm. The inorganic chemicals and radionuclides data cannot be used to support discussions pertaining to DP Tank Farm. Inorganic chemicals were rarely detected above background, and radionuclide data are affected by radionuclide contamination associated with other sources downstream from DP Tank Farm.

Canyons Investigations

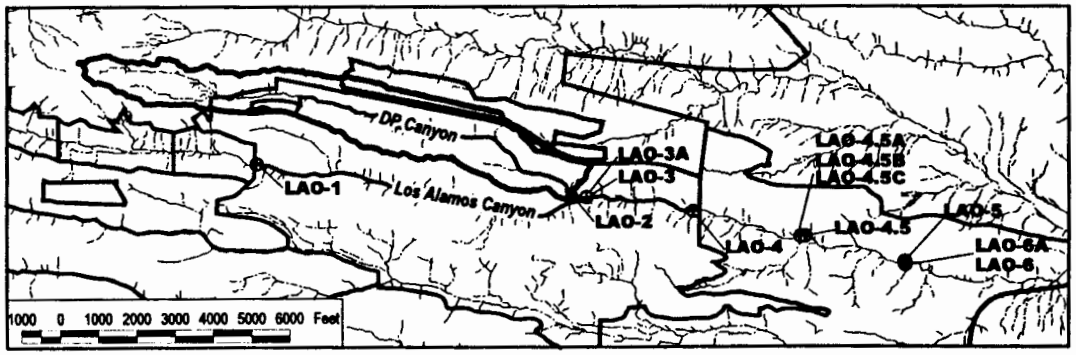
The ER Project's canyons investigations program is described in the canyons core document (LANL 1996, 55622). Investigations in DP Canyon are underway in accordance with the Task/Site Work Plan for Operable Unit 1049 - Los Alamos Canyon and Pueblo Canyon (LANL 1995, 50290) and the associated sampling and analysis plan (LANL 1997, 56919). Preliminary organic data collected in DP Canyon are available for sediments in canyon reaches DP-1, DP-2, DP-3 and DP-4; alluvial groundwater from wells LAUZ-1 and LAUZ-2; DP Spring; and surface water runoff near the culverts behind the Knights of Columbus Hall at the head of DP Canyon (SW Station 1) and immediately east of the commercial area on DP Road east of the DP Tank Farm (SW Station 2).



Drainage
Dirt road
Paved road
Structure
TA Boundary
DP Canyon watershed

Sampling locations:
- Wells/ borings
- Groundwater
- Runoff
- Sediment
- Surface water
- Canyons data

Contour interval = 100 ft



F2.2-14 / DP Tank Farm SAP / 100698

Figure 2.2-14. Surveillance and canyons investigations sampling locations in DP Canyon.

Preliminary data are provided in Appendix E-1.0 of this work plan, and a qualitative summary is provided below, for samples and sampling locations relevant to this work plan—samples collected at reach DP-1, wells LAUZ-1 and LAUZ-2, surface water stations SW-1 and SW-2, and DP Spring. Sampling locations are shown in Figure 2.2-14. Only data on organic analyses are presented and discussed here as relevant; these data have been validated only at the baseline level at this time. The inorganic and radionuclide data are not relevant to this work plan and are not presented or discussed. All data will be focus validated, presented, and discussed in detail in DP Canyon reach reports scheduled for completion in FY1999.

The only samples in which organic chemicals were measured above detection levels in this data set were water samples collected at SW Stations 1 and 2 on August 22, 1997, following a period of several days of summer thunderstorms; in alluvial wells (LAUZ) 1 and 2; and at DP Spring (Figure 2.2-14).

The organic chemicals detected in water samples collected at SW-1 and -2 consisted solely of PAHs and phthalates. PAHs are generally associated with petroleum products and the incomplete combustion of organic materials and with asphalt, runoff from asphalt sheets, and weathered oils. The presence of PAHs in any stream receiving storm water runoff from urban streets would be expected. Phthalates are used as plasticizers in many commercial plastics and are widespread in the environment (as well as being common laboratory contaminants). Five PAHs and two phthalate compounds were detected at SW-1 (at the head of the DP Canyon channel up-channel of the DP Tank Farm site), but only one PAH and two phthalates were detected at SW-2 (down-channel of the DP Tank Farm site). The concentrations of PAHs ranged from 1 to 1.7 µg/L, and the concentration of phthalates ranged from 1 to 9 µg/L.

Examination of the chromatograms (provided in Appendix E-1.2 of this work plan) of the SVOC analyses of the four water samples (one sample filtered and one sample unfiltered at each location) collected at SW-1 and SW-2, showed the presence of DRO compounds in low concentrations in three of the for samples. The concentrations were not quantified because DRO standards are not run in the SVOC analyses; thus, only relative concentrations can be discerned among the four samples. The two samples collected at SW-1, which is up-channel from the DP Tank Farm site and the former drain from the area of the former West Fill Station, both showed low concentrations of DRO; the unfiltered sample contained slightly more than the filtered sample. Of the two samples collected at SW-2, which is down-channel of DP Tank Farm site, the filtered sample showed slight evidence of DRO, but the unfiltered sample showed no evidence of DRO, which may call the quality of the data into question. The apparent DRO concentration in the filtered sample taken at SW-2 was less than the DRO concentration in either of the two samples taken at SW-1.

At LAUZ-1, acetone and bis(2-ethylhexyl)phthalate were detected in one sample at concentrations of 30 and 22 µg/L, respectively. At LAUZ-2, bis(2-ethylhexyl)phthalate was detected in one sample at a concentration of 36 µg/L. These phthalate concentrations are higher than those observed at SW-1 and SW-2. However, the presence of acetone (which has a very short environmental half-life and is a very common laboratory contaminant) in one of these samples suggests that the compounds may in fact have been introduced at the analytical laboratory. This issue cannot be resolved at this time because the data have not undergone a focused validation.

The only detected organic chemical in the sample collected at DP Spring was 1,2-dichloroethane at 7.6 µg/L. This chlorinated solvent is not associated with petroleum hydrocarbons and is not consistent with the detected organic chemicals in the upper parts of DP Canyon. This datum has not been validated.

The main findings from the canyons investigations and the ESH-18 environmental surveillance data that are pertinent to the DP Tank Farm investigation are that petroleum hydrocarbons are not found

downstream from the localized hydrocarbon sheen area at DP Tank Farm. These findings confirm the analytical results from the three samples collected in DP Canyon as part of the DP Tank Farm 1995 UST investigation and the results from previous investigations of the sheen area, as described above. This indicates that the petroleum-related products that are in the sheen area, if they are migrating down-channel at all, are not migrating in measurable quantities.

Analyses of Split Samples Collected by the Laboratory and by NMED in DP Canyon

Samples were collected August 1, 1997, as described below. Results of analyses of the Laboratory's half of the split samples are provided in Appendix E-4.1, and the chromatograms of the organic analyses are provided in Table E-4.2 of this work plan. Results of analyses of NMED's half of the split samples were requested but were not provided for this work plan. Appendixes E-4.3 and E-4.4 of this work plan are designated to contain the analytical data and chromatograms when those are provided by NMED.

Sample logs and chain-of-custody records show that Laboratory field personnel took a total of 12 samples, 7 soil samples and 5 water samples, from DP Canyon in the general area due north of the DOE Fire Station training tower (Figure 2.1-1), as directed by John Tymkowicz of NMED. Presumably, these same samples were split between the Laboratory and NMED for analysis. Results of analyses for organic chemicals in the Laboratory's half of the split samples showed no detects in the water samples and only sporadic detects of PAHs in soil samples. A comment on the analytical sheet from the analyzing laboratory reads, "free of RCRA constituents."

2.2.2 Conceptual Model

2.2.2.1 Nature and Extent of Contamination

The geologic unit underlying PRS 21-029 is the Tshirege Member, Unit 3 ignimbrite of the Bandelier Tuff, designated Qbt3 by Goff (1995, 49682) and Broxton et al. (1995, 50121). Beneath the site, Unit 3 is approximately 50 ft thick and is overlain by a variable thickness of disturbed soil and fill. As described in Section 2.1.1, abundant fractures extend through the Tshirege Unit 3 ignimbrite at DP Tank Farm. The presence of the GMFZ, extending in a north-south direction through PRS 21-029, is expressed in the form of a significant increase in fracture density (Wohletz 1996, 58846). The location of the former West Fill Station coincides with the eastern edge of the GMFZ. Fractures in the eastern portion of the site (east of the location of the former West Fill Station) are largely unaffected by the fault zone (Wohletz 1995, 58845).

Average fracture spacing at the DP Tank Farm is about 5 ft but decreases to about 2 ft within the GMFZ. Most of the fractures have strikes between NW and NE, but some have nearly E-W strikes. The average fracture aperture is about 0.5 cm, and apertures are not significantly different within the GMFZ, although locally at the former West Fill Station apertures average about 0.75 cm. Although fracture-filling materials are common in the fractures of Unit 3 (Wohletz 1995, 54404), the nature of the fracture-filling materials has not been characterized at DP Tank Farm or at TA-21 in general. As described in Section 2.1.1, however, at the DP Tank Farm fractured Bandelier Tuff shows signs of incipient weathering and usually has a clay-rich soil matrix along bedrock fractures. Smectite, a swelling clay that may reduce the bulk-rock permeability when present in fracture systems in the tuff, has been commonly observed in near-surface fractures at other locations of the Laboratory.

As described in Section 2.1.1, other potential sources of petroleum-related contamination exist or have existed in the watershed of upper DP canyon. These sources include PRSs associated with the former

Zia Motorpool (PRS 00-031[b]) where the Los Alamos National Bank building and parking lot now stands; the underground fuel tanks for the former government filling station (PRS 00-031 [a]) near the intersection of Trinity Drive and Central Avenue at the present location of Hilltop House Hotel; and the DP Road Storage Area (PRS 00-027) where the Knights of Columbus Hall and parking lot now stand. Additionally, nonpoint sources of petroleum hydrocarbons from street and parking lot runoff are contributed from the area of the Mari Mac Shopping Center, Trinity Drive and vicinity, and to a lesser extent, from the light industry along DP Road.

The stream in DP Canyon is ephemeral, flowing significantly only after heavy rains and periods of spring snowmelt. Runoff from the watershed containing the potential release sources described above enters the head of DP Canyon near the Knights of Columbus Hall just upstream of the DP Tank Farm site through two 4-ft-diameter culverts. As noted in Section 2.1.1, in 1946 the head of DP Canyon extended westward about 200 ft from its present location. The original head of the canyon has been filled largely with construction debris and fill soil. In the localized hydrocarbon sheen area, alluvium is not present in the channel, and therefore, alluvial groundwater is not present. It is unlikely that contamination in DP Canyon could affect the regional aquifer, which is at a depth of approximately 1200 ft bgs at this location, by leakage through the channel. A perennial spring (DP Spring), located on the north side of lower DP Canyon 0.62 mile east-southeast of well LADP-4 (Figure 2.2-14), discharges at a rate of 1–4 gal. per minute (Broxton 1995, 50119; Purtymun 1995, 45344). The source of water at DP Spring is being investigated further.

The visibility and extent of the localized hydrocarbon sheen area in DP Canyon appears to vary depending on site conditions. When observed in 1995, the sheen area was noted to be highly localized, but a sheen on standing water could be generated by standing on loose tuff in the stream channel. Later site visits sometimes revealed no visible or olfactory evidence of hydrocarbon contamination. After a long dry spell in the early summer of 1998, a more extensive sheen area was observed, and the dry stream bed and channel banks exuded organic vapors. More recently, after a period of heavy rainfall, inspection of the rocks and soil in and near the channel showed that petroleum hydrocarbon stains were present from the sheen area identified in the RFI report (LANL 1996, 52270) to a point about 100 ft upstream. Nevertheless, no hydrocarbon sheen was observed in the flowing or standing water present at the time of the site visit.

The nature of contamination at the DP Tank Farm site has been identified as petroleum-related products or petroleum hydrocarbons. The presence of petroleum-related products was noticed during the 1980s when preparing for and ultimately excavating the tanks. Sampling and analysis activities and anecdotal information indicate that Number 2 fuel oil, diesel, kerosene, unleaded and leaded gasoline, ethanol, and possibly, Stoddard solvent were distributed at DP Tank Farm. Analyses for lead in soil and/or tuff occasionally indicated lead contamination, which presumably is associated with the use of leaded gasolines, although whether because of one or more spills, leaks, or simply locally concentrated vehicle exhaust, is unknown.

The 1994 RFI confirmed the presence of petroleum-related products in the vicinity of the former East and West Fill Stations. Data interpretation performed at that time did not determine the presence of petroleum hydrocarbons in the vicinity of the former tanks. In addition, inorganic chemicals and radionuclides were not identified as contaminants at this site. Further examination of the 1994 RFI data for preparation of this work plan confirms the previous findings for radionuclides, raises concerns about background comparisons for inorganics, and suggests that petroleum hydrocarbons might be present in the vicinity of the locations of the former tanks.

The difficulty with the background comparisons concerns identification of the media sampled. DP Tank Farm has been subjected to considerable construction and reconstruction since its inception in the mid-1940s. Soil profiles are difficult to determine, and fill material has been used for regrading activities at several times during the history of DP Tank Farm. The boreholes and core sample logs indicate that a mixture of soil and tuff samples were collected, although the records are not sufficient to be able to definitively differentiate all samples. Background comparisons performed on the 1994 RFI data for the report (LANL 1996, 52270) used the soils background data set that was available at that time. More recently, a tuff background data set has been prepared. Comparisons with soil background data reveal no release of inorganics at the DP Tank Farm site (the DP Canyon samples associated with this investigation identified zinc and lead as elevated compared with background). Comparison with the tuff background data indicates the potential for the presence of other inorganic chemicals. A more qualitative comparison that accounts for both soil and tuff background comparisons indicates that lead might be present at the site at low levels but greater than background. The assessment is problematic because of the difficulty of differentiating the medium of each sample collected.

The 1994 RFI samples were subjected to VOC and SVOC analyses, which was common practice at the time. Re-evaluation of the chromatograms for samples collected in the area of the tanks indicates the presence of petroleum hydrocarbons in the subsurface near the former locations of tanks TA-21-ATF-6 and TA-21-ATF-10. Based on this more current assessment of the 1994 RFI data, it may be concluded that the extent of hydrocarbon contamination at the DP Tank Farm has not been finally established. The chromatograms indicate that the hydrocarbons in these samples can be classified as motor or lubricating oil; concentrations cannot be quantified but they are known to be low. This classification is the same as that applied to the petroleum hydrocarbons found in two DP Canyon channel soil samples collected in the 1995 UST investigation downstream of the localized hydrocarbon sheen area, whereas the petroleum-related products in soil samples collected at the sheen area in the 1995 were classified as "weathered diesel." The original source of this motor or lubricating oil in subsurface soil at the two tanks cannot be determined. However, it could not have resulted from the weathering of any of the fuels distributed at the tank farm because the heavier oil components of petroleum are not present in the fuels. Thus, the original source being a leaking tank is extremely unlikely. Other possible original sources include oil sprayed for dust suppression during the period of operation or simply occasional disposal of used motor oil by individuals.

Originally, conclusions drawn from the 1994 RFI data were used to develop a sampling and analysis plan consistent with NMED UST requirements for further investigation of petroleum hydrocarbon contamination. Based on this interpretation of the 1994 RFI data, petroleum hydrocarbons were the only contaminants identified at the site, and their presence was noted at the locations of the former East and West Fill Stations only. The 1995 UST investigation, therefore, focused on the extent of petroleum hydrocarbon contamination at the locations of the former East and West Fill Stations. Sample analysis focused specifically on TPH, diesel, BTEX, benzene, and other hydrocarbons identified in the 1994 RFI.

The 1995 UST investigation appeared to reasonably determine the extent of contamination at the locations of both former fill stations; however, the VCA performed in 1996 at the location of the former East Fill Station clearly demonstrated that fractures were an important factor that limited the potential for completely determining extent. The 1996 VCA resulted in removal of 1720 yd^3 of soil at the location of the former East Fill Station to a depth of approximately 32 ft. Remaining contamination was associated with fractures and stained areas adjacent to those fractures. The economic and environmental costs of continuing the excavation were considered too great for the purpose of removing an evidently small quantity of additional petroleum hydrocarbons located in fractures well below ground surface. The bulk of

the petroleum hydrocarbon contamination was concluded to have been removed because the excavation encompassed all subsurface material where either fill and/or the tuff matrix itself was contaminated.

In the 1994 RFI, field surveys identified a localized hydrocarbon sheen area in DP Canyon. The 1995 UST investigations proceeded to determine if the sheen area might be associated with contamination at DP Tank Farm. Sampling and analysis around the area of this sheen proved inconclusive with regard to source. Organic compounds were not detected in water samples, and soil or tuff samples revealed contamination on the north bank of DP Canyon. Contamination on the south bank was not found, but because only one borehole was drilled on the south bank, the few data there permit no firm conclusions. Other potential sources of contamination were recognized, and a monitoring program involving visual inspection of the sheen area was established. Visual inspections have recorded variable findings ranging from the localized presence of an observable sheen on the water surface to an extensive (approximately 100 ft) section of the DP Canyon streambed that appeared to be impacted.

The chromatograms of samples analyzed from the locations of the former East and West Fill Stations in the 1994 RFI clearly identify diesel as the classification of the petroleum-related products present at these locations. Sediment and tuff samples collected from auger holes in the area of the sheen were classified as weathered diesel. However, chromatograms of two channel samples collected downstream from the sheen area in 1995 were classified as motor oils, similar to the classification of subsurface samples collected at the former locations of tanks TA-21-ATF-6 and TA-21-ATF-10 in the 1994 RFI. Evaluation of chromatograms from samples taken from the DP Road Storage Area (PRS 00-027) also are classified as motor oils as well as diesel and, possibly, jet fuel (Loescher 1998, 58988).

The predominant nature of the contamination at DP Tank Farm and in DP Canyon in the area of the sheen is petroleum-related products including undifferentiated alkanes and alkenes, benzene and substituted benzenes, and to a lesser extent, PAHs, including phenanthrene and fluorene. There is also the potential for the presence of low levels of lead contamination and a smaller possibility of the presence of other metals above background on the mesa top in the area of the tank farm. Lead, zinc, and to a lesser extent, a few other metals were also observed above sediment background values in DP Canyon sediment samples, although their origin cannot be positively ascribed to any particular source.

The full extent of contamination is not well established at DP Tank Farm or in DP Canyon. Petroleum-related product contamination around the locations of the former East and West Fill Stations, associated with the localized hydrocarbon sheen area in DP Canyon, was well documented in previous assessments. However, the assessment performed in preparation of this work plan indicates that other types of contamination at other locations may exist as well. The following is a summary of where either the nature and/or the extent of contamination has not been well defined at DP Tank Farm and the adjoining area in DP Canyon.

1. Excavation in the area of the former East Fill Station for the 1996 VCA revealed fractures as a possible subsurface transport mechanism. Characterization of contamination extent in fractures has not been performed (and is problematic to perform because of the difficulty in locating fractures by geophysical techniques or by borehole advancement).

2. Petroleum hydrocarbons as motor oils have been identified in samples from boreholes at and near the former locations of tanks TA-21-ATF-6 and TA-21-ATF-10, in which case extent has not been well defined at these locations.

3. Inorganic chemicals have been identified at concentrations possibly above background values in soils/tuff at DP Tank Farm.

4. Investigation of historical records has resulted in the identification of additional potentially affected areas on the mesa top that have not been fully investigated.

5. The extent of the DP Canyon localized hydrocarbon sheen area has not been established in either the surface or subsurface environments.

2.2.2.2 Fate and Transport

In this section, environmental fate and transport mechanisms are discussed relative to the petroleum-related product contamination observed at DP Tank Farm and in DP Canyon. Although inorganic chemicals may also be present above background levels at these locations, the principle contaminants associated with this site are petroleum hydrocarbons. The immediate concern is to determine the origin and potential impacts of the localized hydrocarbon sheen area in DP Canyon, where contamination is potentially available to human and ecological receptors. An understanding of contaminant transport is essential for designing a sampling plan that targets the correct media and locations at an appropriate spatial scale. An understanding of contaminant fate processes may also affect sampling design but is primarily important for assessing the environmental persistence of contamination.

The three principle areas of importance for contaminant transport associated with the localized hydrocarbon sheen area and the potential sources of petroleum-related contaminants in the watershed of upper DP Canyon are

1. on the mesa top (at the DP Tank Farm site),

2. from the DP Canyon watershed (i.e., DP Road Storage Area or other possible sources) to the canyon bottom, and

3. within DP Canyon.

Several mechanisms of contaminant transport are considered potentially significant for past, present, and/or future redistribution of petroleum hydrocarbons relative to these areas

- subsurface migration of free petroleum product in tuff fractures as nonaqueous phase liquid,
- water-driven subsurface migration of petroleum hydrocarbons in fractures or through the tuff itself,
- subsurface migration of VOCs in the vapor phase through fractures or through the tuff itself,
- surface migration of free petroleum product as nonaqueous phase liquid, and
- surface migration of petroleum hydrocarbons in a dissolved state or adsorbed on sediment particles.

The Mesa Top

Both surface and subsurface migration of free petroleum product may have contributed to the movement of petroleum-related products on the mesa-top. Spilled product would be expected to move on the

surface downgradient, ultimately moving into the subsurface where fracture flow may be the dominant transport mechanism. The fracture staining observed in the 1996 VCA confirmatory sampling and analysis is evidence of this subsurface migration in tuff fractures. Some water-driven product migration on the mesa top might also have occurred in response to rainfall events.

From The DP Canyon Watershed To The Canyon Bottom

Surface and/or subsurface migration of free petroleum product are considered to be the most likely mechanisms by which petroleum-related products could have been introduced in bulk into DP Canyon.

Subsurface migration, if the source(s) of contamination were localized mesa-top releases of free petroleum product that infiltrated into the ground, is a possible cause for the localized hydrocarbon sheen area observed in DP Canyon. This implies that there is, or was, a sufficient amount of free product available at the release location to act as a driver for pushing product through the fractures. It is assumed, because the effective porosity of unfractured tuff is relatively low, that fractures would be the preferential path was for migration over longer distances. Possible source areas of contamination related to this transport mechanism include (1) PRS 21-029, the former tanks and fill stations at DP Tank Farm; (2) PRS 00-031(a), the site of a former gasoline service station that was located at the present site of the Hilltop House Hotel; (3) PRS 00-027, the former DP Road Storage Area adjacent to DP Canyon on the Knights of Columbus property; (4) PRS 00-030(a), a septic tank and associated piping that served the former fuel dispatch office associated with PRS 00-027; and (5) the property north of DP Canyon, which is currently occupied by the Pine Glen Apartments and may have been used by a contractor in the late 1940s or early 1950s to park vehicles.

Fractures in the tuff beneath the location of the former West Fill Station show a predominant NW to NE strike and a northward dip. Therefore, a surface or near-surface petroleum-related product release infiltrating the tuff would likely have migrated mostly to the north along fractures, intersecting the drainage on the north side of the DP Tank Farm site. However, the presence of fracture-fill materials, such as smectites, may have inhibited significant infiltration from a surface release.

Surface migration, if the source(s) of contamination were mesa-top releases of free petroleum product that ran over the ground and into DP Canyon, is a possible cause for the localized hydrocarbon sheen area observed in DP Canyon. This release mechanism would probably be associated with one or more discrete high-volume release events; none are known to have occurred during the period of operation of the DP Tank Farm. Although each of the five source areas described for subsurface migration could potentially have contributed petroleum-related products to DP Canyon by way of overland flow as well, DP Tank Farm is perhaps the most likely candidate based on circumstantial evidence discussed below.

Sometime between 1974 and 1986, an earthen berm was constructed along the north side of the access road, from just east of the location of the former West Fill Station eastward and curving around the eastern downhill end of the area. The purpose of the berm was, presumably, to contain any large fuel release. A 14-in. pipe with gate valve through the berm was located at the northeast corner of the berm to permit flow of fluids (water or product presumably) into DP Canyon. However, McInroy (1988, 1641) noted at the time of decommissioning in 1988 that there was no visual evidence that any fuel had ever been released through the gate valve. A storm drain ran underneath the access road near the location of the former West Fill Station northward into DP Canyon. The areas contributing runoff to this storm drain included the mesa-top near and uphill at the West Fill Station, the access road itself, and the road connecting the DP Tank Farm with the DP Road Storage Area to the west (now PRS 00-027 and the Knights of Columbus Hall and parking lot). The upstream limit of the localized hydrocarbon sheen area in

DP Canyon is just downstream of the point where discharge from the storm drain would run underneath the access road near the West Fill Station and would enter DP Canyon. Another storm drain daylighted in DP Canyon near the location of the former East Fill Station. The location of the inlet to this drain is not known.

Within DP Canyon

The most likely mechanisms by which petroleum-related products could have been and could continue to be physically redistributed within DP Canyon include (1) surface migration of petroleum hydrocarbons in a dissolved state or adsorbed on sediment particles, (2) water-driven subsurface migration of petroleum hydrocarbons in fractures or through the tuff itself, and (3) subsurface migration of VOCs in the vapor phase through fractures or through the tuff itself.

Mechanism 1 is considered to be the only significant mechanism for surface redistribution of petroleum hydrocarbons within DP Canyon. In general, transport of petroleum-related products today is most likely because of water-borne movement of contaminated sediments. The environmental half-life of low molecular weight petroleum hydrocarbons in surface and near-surface sediments is relatively short because of their tendency to volatilize into the atmosphere. These hydrocarbons would generally also be the most soluble and the most susceptible to microbial degradation. Higher molecular weight compounds are preferentially associated with sediments because of their lower volatility and solubility. As petroleum-related products weather in the environment in this way they tend to become enriched in the higher molecular weight compounds that bind to solid particles.

Weathering of fuels, including diesel, occurs by both evaporative and biological mechanisms. Both mechanisms are readily apparent in the chromatograms of samples collected at the DP Tank Farm site, as discussed above. As compared to fresh diesel, loss of lighter end components is observed, indicative of evaporative loss. In fresh diesel, the predominant peaks are the linear alkanes, primarily nC-10, and nC-11 to nC-24. Bacteria preferentially degrade these alkanes resulting in chromatograms showing the biologically resistant isoprenoids (phytane, pristane) as the dominant peaks. Isoprenoids were the dominant peaks in all chromatograms where diesel was the observed contaminant. Such weathering can occur relatively quickly or over a period of many years depending on biological activity, nutrients and oxygen availability. Lubricating and motor oils do not exhibit defined peaks, and thus, no comparable estimate of weathering is possible.

Water-driven transport in fractures (Mechanism 2) may have resulted in the migration of surface and near-surface petroleum-related products present in DP Canyon into the tuff beneath the channel. Surface water is available in sufficient quantities within DP Canyon during storm events and snowmelt runoff to potentially result in significant infiltration. This infiltration can provide a driver for subsurface petroleum-related product advective migration. If petroleum-related products entered DP Canyon in bulk in the past, they may have moved vertically and/or laterally as nonaqueous phase liquids. This movement may have been enhanced by fractures and the effect of infiltration of surface water during storm events. Conversely, subsurface petroleum-related products may today be mobilized to the surface by the development of a saturated zone because these products are generally lighter than water. The variations in extent and intensity of the localized hydrocarbon sheen area in DP Canyon may be caused in part by the competing influences of dilution and remobilization of subsurface contamination. The effect of this transport mechanism on surface contamination in DP Canyon should diminish in importance over time because of the effects of petroleum-related product weathering and dilution, if no new petroleum-related product is entering the system.

Vapor-phase transport (Mechanism 3) is the only means by which subsurface petroleum-related product may impact receptors in the environment on the mesa tops. In the subsurface, VOCs would be expected to reside primarily in the air phase because of the low moisture content and poor adsorption characteristics of tuff. Although VOCs tend to be exhausted rapidly from surface and near-surface soils because of the short distance to the atmosphere and repeated wetting and drying with precipitation events, they may persist in free petroleum product for considerable periods of time. Because vapors may diffuse throughout a relatively large volume of tuff in an area of subsurface contamination, they may be useful as readily measurable indicators of regions where subsurface petroleum-related product contamination persists. In turn, this information may be used to assist in attributing a source to the contamination observed in DP Canyon.

The following types of contaminant fate processes are considered relevant for the accumulation or removal of petroleum hydrocarbons within DP Canyon:

1. aerobic microbial biodegradation;
2. volatilization from surface and near-surface regions, possibly aided by advective flow of air driven by periodic pressure differences between the atmosphere and subsurface tuff;
3. chemical degradation, including oxidation, hydrolysis, and/or photolysis;
4. effectively irreversible adsorption of hydrocarbons on solid surfaces; and
5. bioaccumulation of higher molecular weight hydrocarbons in fauna and flora.

Some or all of these environmental fate processes may be described by first-order kinetics. Fugacity-based models of partitioning among solid/water/air/biota phases could be used to determine equilibrium distribution among these environmental compartments, but quantifying transfer rate coefficients would be difficult. Still, modeling may be appropriate to assist in evaluating the rate of natural attenuation of the contaminants or determining the appropriate length of a monitoring program.

The fate mechanisms listed above are ordered in what is considered to be their approximate ranking of importance. This ranking is approximate because, for any specific chemical, one or another mechanism may be more or less important. The first three mechanisms (Fates 1, 2, and 3) are judged to contribute more significantly to the removal of petroleum hydrocarbons from the physical environment of DP Canyon than Fates 4 and 5.

Human Exposure Model

Areas on the mesa top (e.g., DP Tank Farm) are most likely to experience industrial/commercial land use in the near future pending land transfer from DOE to Los Alamos County. Because residual petroleum-related product contamination at DP Tank Farm is apparently confined to subsurface tuff, the only potentially complete exposure pathway at these locations is inhalation of VOCs migrating to the surface via diffusion and/or advection. If petroleum hydrocarbons are subsequently discovered at locations in surface or near-surface soil, additional pathways may include direct soil ingestion, dermal uptake by way of skin contact, and inhalation of contaminated soil as dust. Soil ingestion and dust inhalation are also of potential concern as exposure pathways for inorganic chemicals in surface or near-surface soil.

Development of DP Canyon for commercial or residential uses is not feasible because of topographic constraints. Land use in the canyon might best be considered recreational. Potentially, complete

exposure pathways for petroleum hydrocarbons and inorganic chemicals in DP Canyon are identical to those described for the mesa top, although dust inhalation is considerably less important because of the moist sediments and dense vegetation in the canyon. The ephemeral occurrence of surface water in upper DP Canyon suggests that exposure to this medium is unlikely to be of significant human health concern but will be evaluated nevertheless.

Ecological Exposure Model

Ecological receptors are unlikely to be impacted by contamination at the locations of the former East and West Fill Stations assuming that residual petroleum hydrocarbon contamination is in the subsurface. The primary exposure pathways that may impact ecological receptors are associated with the localized hydrocarbon sheen area in DP Canyon. The surface and near-surface contamination at the sheen area makes contaminants available for root uptake by terrestrial plants. Ingestion and dermal contact are the most likely pathways for terrestrial animals to be exposed to the contaminants at this site. Terrestrial animals could ingest contaminated water and sediments deposited downstream from the sheen area. Ephemeral pools in the channel support temporary aquatic communities (mainly invertebrates, possibly some plants). Pools in the vicinity of the sheen area could contain contaminants, which would be available to these aquatic receptors through ingestion or dermal contact pathways. Because of the volatility of several contaminants potentially present at the sheen area, inhalation of organic vapors must be considered a possible exposure pathway; it is considered an unlikely pathway, however, because of the small area where vapors are present and the mobility of vertebrate receptors. Foliar uptake of organic vapors is typically not a significant pathway. Exposure to contaminants by way of inhalation of fugitive dust is also unlikely, as the area is both moist and well vegetated, limiting air entrainment of particulates.

2.2.2.3 Data Gaps

The following data gaps pertain to the assessment of petroleum hydrocarbons and inorganic chemicals at the DP Tank Farm site and in DP Canyon in the localized hydrocarbon sheen area.

1. What is the source, or sources, of petroleum hydrocarbons associated with the localized hydrocarbon sheen area in DP Canyon?

2. What is the extent of subsurface petroleum hydrocarbon contamination associated with the localized hydrocarbon sheen area in DP Canyon?

3. What is the extent of petroleum hydrocarbon and inorganic chemical contamination in channel sediments associated with the localized hydrocarbon sheen area in DP Canyon?

4. What is the extent of petroleum hydrocarbon and inorganic chemical contamination in surface and near-surface media at potentially affected but previously unsampled locations at the DP Tank Farm site?

5. What is the extent of subsurface petroleum hydrocarbon contamination in tuff in the area of the former tanks at the DP Tank Farm site, particularly the former locations of tanks TA-21-ATF-6 and TA-21-ATF-10?

Information on the source and subsurface extent of the petroleum hydrocarbon contamination in DP Canyon will be useful in determining whether the localized hydrocarbon sheen area exists as a localized phenomenon or is connected to residual contamination elsewhere in the environment. This will be helpful in predicting future trends in petroleum hydrocarbon release at the sheen area and whether any remedial

activities are either warranted or feasible. Information on the extent of the petroleum hydrocarbon contamination at the sheen area in DP Canyon sediments will allow bounding of the affected area for evaluating human and ecological impacts. This information may also help to develop decisions on the design of any possible surface water monitoring program by indicating the region in which surface water transport has been active in mobilizing hydrocarbons from the sheen area.

Additional information on surface and subsurface petroleum hydrocarbon contamination is necessary at DP Tank Farm to specify the nature and extent of contamination at all locations potentially affected by historic activities. Additional information on the locations of past releases and chromatograms of the residual petroleum hydrocarbons that reveal the type of petroleum-related product released may be useful for determining whether one or more sources at DP Tank Farm are the origin of some or all of the petroleum hydrocarbon contamination observed in DP Canyon in the sheen area.

Obtaining data on inorganic chemical concentrations on the mesa top and in DP Canyon will allow a complete assessment of human and ecological environmental impacts at these locations. Inorganic chemical data at the tank farm and, in particular, in drainages leading from the tank farm into DP Canyon may be useful in determining whether past tank farm activities could be a source for inorganic chemicals observed in DP Canyon sediments.

2.2.3 Sampling Activities

The nature of the contamination described in Section 2.2.2.1 is predominantly organic chemicals associated with petroleum products. These compounds have been measured at the DP Tank Farm site at the locations of the former East and West Fill stations as well as in the subsurface at and near the former locations of certain tanks. Furthermore, petroleum hydrocarbons are known subsurface contaminants at the DP Road Storage Area near the head of DP Canyon and may have been released to the environment at other locations in the watershed of upper DP Canyon. One or more of these source areas is suspected of being the origin of the petroleum-related contamination observed at the localized hydrocarbon sheen area in DP Canyon. The principal objective of the sampling and analysis activities described in this section is to determine the extent and possible origin of the petroleum hydrocarbon contamination at the sheen area. Additional objectives are to determine the nature and extent of petroleum hydrocarbon and inorganic chemical contamination on the mesa top and the nature and extent of inorganic chemical contamination in DP Canyon at the sheen area.

This sampling plan is partially iterative. Although general directions are provided on how field surveys and initial analyses will be used to direct later sampling in DP Canyon, the specific numbers and locations of samples cannot be determined *a priori*. For example, although no water samples are proposed to be taken in these activities, the information collected is intended to support decisions on whether and how a monitoring program should be designed to include periodic sampling of water in DP Canyon. An addendum to this sampling plan will be prepared once the site observations have been performed that identify the exact number, depths, and locations of samples in channel and banks of DP Canyon. On the mesa top, existing information is generally adequate to specify in this work plan the number and locations of all samples. The decisions to be supported by the sampling activities described in this section and the criteria for data adequacy are discussed further in Section 3.1, Data Quality Objectives.

2.2.3.1 Contaminant Source

Because the original sources of the contamination at PRS 21-029 DP Tank Farm, namely the fuel tanks, and all other sources potentially associated with the DP Canyon localized hydrocarbon sheen area have

been removed, no contaminant source sampling and analysis is possible. All sampling and analysis activities will target environmental media.

2.2.3.2 Media Characterization

A combination of analytical and observational measurements will be used to obtain information to fill the five data gaps described in Section 2.2.2.3. The definition of the surface and subsurface extent of contamination on the mesa top and in DP Canyon is expected to be more definitive than the attribution of a source for the localized hydrocarbon sheen area in DP Canyon.

The data acquisition process can be separated into seven activities, each of which is intended to address one or more of these data gaps. These activities are described below. Following the description of these activities, a summary of requested samples and analyses is provided.

Activity 1: A geophysical survey will be performed on the south side of the site near DP Road to locate any remaining pipes and filling ports used originally to fill the tanks when the tank farm was operational. The presence of the remains of one port along DP Road suggests that pipe removal may not have been complete in the 1988 decommissioning.

This activity will provide information for responding to the fourth data gap: What is the extent of the contamination in unsampled regions of the tank farm? If additional filling ports are identified during the geophysical survey, they will be included in the sampling described for Activity 6. If piping is identified, it will be removed as part of ER Project activities under this work plan. During excavation and removal, field personnel will use visual observation and PID measurements to determine whether the piping may have leaked at one or more locations. PID measurements will be made by placing suspect soil or fill into an appropriate container and inserting the PID tip into the container.

If there is no evidence of petroleum-related product contamination based on visual observation and/or PID measurements, no samples will be collected for submittal to an analytical laboratory. The likelihood of identifying contamination associated with a point release (such as might occur because of a leak in a pipe) by sampling a location along the pipe at random is small. Additionally, the fact that no release is identified in a few randomly placed samples would not prove that no release had occurred. For these reasons, it is proposed that field observation and PID measurement be used as a basis for determining release status.

If evidence of one or more releases is identified, samples will be collected for fixed-laboratory analysis. Samples will be submitted for inorganic chemical, BTEX, SVOC, and TPH as diesel and motor oil range organic chemicals. The number of samples and their spatial distribution will be guided by the dimension and depth of any contamination encountered. As a general rule, samples will be located both within the area of contamination identified in the field and beyond, to bound the likely extent of contamination.

Activity 2: A detailed reconnaissance of DP Canyon will be performed in the area of the localized hydrocarbon sheen before sampling. Additional periodic inspections of the canyon and adjacent banks will also be performed during wet and dry conditions to determine if additional areas of petroleum-related product contaminants may be present and to evaluate the variability and evolution of the sheen area over time.

This activity is primarily associated with responding to the third data gap: What is the extent of contamination in channel sediments? A more detailed initial reconnaissance is proposed with the specific

objective of more precisely defining the observable bounds of contamination. In addition to obtaining visual and olfactory evidence of contamination, as described below, the banks adjacent to the approximately 100 ft of sheen area in the channel should be examined carefully to determine whether any evidence of petroleum-related product exists beyond the channel bottom. If fractures are conduits for subsurface migration, evidence of seepage may be uncovered where fractures are exposed on the channel banks or on the canyon walls (the latter being the area between the mesa top and the channel banks). It may be necessary to remove surface soils in some locations to expose tuff for this survey. If fracture-fill material is found at one or more locations on the channel banks, it should be subjected to PID headspace analysis to better determine if petroleum hydrocarbons may be present. The results of this reconnaissance will be used to guide sediment sample collection in Activity 3.

A number of individuals have observed the localized hydrocarbon sheen area at different times during the past few years and recorded different observations on the presence and extent of visual staining, sheens, and odors. This variability is likely due to both changing conditions in the canyon (primarily seasonal changes) and the variable perceptions of observers. A protocol is therefore proposed to standardize the frequency of observation, the types of information to be collected, and to what activities the term observation refers. This protocol is intended to standardize the information collected to ensure that consistent observations are made and recorded.

It is recommended that a team of two individuals record observations monthly during dry seasons and as often as every two weeks during the summer rainy season for a period of a year to allow for discussion and field interpretation. At least one, and ideally both, individuals should be the same across site visits to minimize the effect of individual variability on the records. The investigation should begin in the area where the localized hydrocarbon sheen has historically been observed, between the pipe that drained the location of the former West Fill Station and the original sheen area location some 100 ft downstream. The channel upstream and downstream of this stretch and the channel banks in these locations should also be observed to determine if the extent of the sheen area may be larger than previously recognized. In particular, the channel at the head of DP Canyon where culverts deliver storm runoff from the town site into the canyon to the upper boundary of the sheen area should be studied to determine if any evidence of petroleum-related contamination exists in this area. This area is also adjacent to the potential sources at the former DP Road Storage Area and the former Hilltop House Hotel gasoline USTs.

The following information should be recorded from each observation event:

1. date and time of visit;
2. presence of standing or running water;
3. location(s) where odor, staining, or sheens are noted and their relative intensity;
4. medium in which stains or sheens are observed (sediments, tuff, water);
5. how odors were identified (e.g., ambient air, in loose tuff or sediments held to the nose); and
6. photographs of the sheen area should be taken as well.

Site visits are proposed on a monthly basis at a minimum to allow for observation of changes that may be correlated with season and proximity to a precipitation event. Precipitation information for correlation with recorded observations will be obtained from the Laboratory meteorological records.

Collecting information in this manner will not only facilitate a better understanding of the variability of observable contamination but also serve as input to the site conceptual model of how hydrologic conditions may affect the redistribution of petroleum-related products in the environment. Additionally, this information might eventually be useful for supporting an evaluation of whether the petroleum hydrocarbon contamination is increasing, decreasing, or remaining constant.

Activity 3: Sediment samples within, upstream, and downstream of the approximately 100-ft length of the localized hydrocarbon sheen area will be collected and analyzed. The objectives of these samples are to evaluate the extent of water-borne contamination associated with the sheen area, evaluate the nature and extent of inorganic chemical contamination, and possibly aid in identifying the source of petroleum hydrocarbon contamination using chromatograms of organic analyses.

This activity is also primarily associated with responding to the third data gap: What is the extent of contamination in channel sediments? The first phase of this activity will be a field survey to identify sediment catchment areas in the channel.

The specific locations and numbers of sampling points will be determined during the field survey. In general, if many sediment deposition areas are identified in a 100-ft segment, the largest catchment should be sampled. It is envisioned that approximately 10 or 12 locations will be sampled in the channel to define extent, beginning with the area downstream of the culverts.

Where sediment depths are less than approximately 6 in., only a single sample will be collected; it will be integrated over the depth of sediment available. Where 12 in. or more of sediments are available, samples should be collected from discrete depth intervals of 6 or 12 in., depending on the depth, so that at least two and up to four samples are collected at the location. It is hypothesized that very deep sediment catchments of 3 ft or more may contain older sediments with different contaminant profiles than shallower sediments that are remobilized on a more frequent basis.

The samples collected will be analyzed for inorganic chemicals, BTEX, SVOCs, and both diesel range and motor oil range hydrocarbons. Evaluation of chromatograms from the analysis of previous canyon samples has revealed petroleum-related products that have the characteristics of both weathered diesel and motor or lubricating oil at different locations in DP Canyon. This indicates that there may be more than one source of petroleum-related products to the canyon. The spatial distribution of these products, as revealed by chromatograms, may assist in the identification of these sources. Inorganic chemical, BTEX, and SVOC analyses will provide information useful for assessing the potential human and ecological impacts associated with any measured contamination. In general, it is benzene, substituted benzenes, and PAHs that are the toxicologically significant components of petroleum-related products.

The sediment sampling should be performed when the canyon is dry, as is generally the case in April through June, both to facilitate sample collection and because observations to date suggest that petroleum hydrocarbons are most evident in the channel during dry periods. Grain size and amount of organic matter should be estimated for each sample.

Activity 4: Auger holes will be advanced in the channel and adjacent banks within the approximately 100 ft of the localized hydrocarbon sheen area both upstream and downstream of the sheen area. The objective of this sampling is to estimate volume of contaminated tuff associated with the sheen area and possibly to aid in identifying the source of contamination.

This activity is primarily associated with responding to the second data gap: What is the extent of subsurface petroleum hydrocarbon contamination associated with the sheen area? However, the dimensions of the contaminated zone in the area of the sheen and the chromatograms of the petroleum-related products may also provide information on the likely origin of the contamination.

The auger holes should ideally penetrate to a sufficient depth to encompass the extent of vertical infiltration of petroleum-related product. It is recognized that access limitations restrict the use of large drilling apparatus so that this objective may not be realized. However, every effort will be made to obtain samples from as deep as possible beneath the channel. The nexus of these auger holes will be the approximately 100-ft segment of channel associated with the localized hydrocarbon sheen area. The exact numbers and locations of these auger holes will be determined during the site survey, but they will generally be placed within or adjacent to the sheen area. Where topography permits, auger holes will also be advanced on the banks in an attempt to bound the dimensions of any product in the vicinity of the sheen area in a north-south direction.

A split-sleeve sampling apparatus or similar device is proposed to allow for intact removal of the tuff core and sampling of discrete intervals. Each 1-ft interval of tuff core will be crushed and placed in an appropriate container. After a period of time, the headspace in the container will be analyzed with a PID for organic vapors. Samples with positive readings will be submitted for off-site analysis of BTEX, SVOCs, and diesel range and motor oil range petroleum hydrocarbons. If two or fewer tuff intervals in an auger hole are positive for organic vapors in the field, additional intervals will be selected at random so that a minimum of three tuff intervals are submitted for fixed-laboratory analysis. If the final interval screens positive using the PID, the auger hole will be advanced one interval beyond the last at which a PID reading is positive. Approximately 12 to 15 locations will be sampled.

The intent of this sampling is to determine the extent of the zone of contaminated tuff that is assumed to exist beneath the localized hydrocarbon sheen area. Therefore, fracture-fill samples will probably not be collected, although fractures may be encountered that in fact contain petroleum-related product. It may be that fractures are observed to be contaminated, but on unfractured tuff material no contamination is visibly evident or measured with the PID. If this is the case, this sampling activity will be suspended and alternatives considered based upon the field observations.

Activity 5: Auger holes will be advanced on the canyon walls to the north, south, and west of the approximately 100 ft of localized hydrocarbon sheen area to determine if organic vapor concentrations differ in these directions. Higher organic vapor concentrations are assumed to indicate the presence of subsurface contamination in those locations and will aid in source attribution.

This activity is primarily associated with responding to the first data gap: What is the source of the contamination associated with the localized hydrocarbon sheen area in DP Canyon? However, organic vapor concentration gradients may also provide information on the approximate dimensions of petroleum-related contamination if it exists beneath the canyon walls.

As demonstrated during the 1996 VCA, heterogeneity of the fractured tuff renders the interpretation of contamination extent using borehole data problematic. The 1994 RFI and 1995 UST investigation borehole data indicated that the extent of contamination had been defined, and in fact, this appears to be the case for tuff that was obviously contaminated with petroleum hydrocarbons. However, the borehole data were ineffective in determining the extent to which petroleum-related products had migrated within fractures. A similar problem may be anticipated if borehole cores are used in an attempt to link potential mesa-top sources with the localized hydrocarbon sheen area in DP Canyon. The utility of vapor-phase

sampling for source attribution is predicated on the assumption that fracture flow is the mechanism by which petroleum-related products entered DP Canyon and that the presence of these fractures in the subsurface between the channel and potential mesa-top sources can be observed by near-surface measurement of the organic vapors emanating from these fractures.

The advantage of vapor-phase sampling is that it should integrate information on subsurface petroleum-related contamination over a relatively large area because of the ease with which vapors can disperse in a fractured environment. Therefore, the problem of missing a specific fracture with a borehole collecting a solid-phase sample is obviated. Vapor-phase samples, however, are unreliable for measurements of analyte concentrations in the soil or tuff because they are subject to a host of problems related to standardization of collection. Subsurface heterogeneity in fracture density, connectivity, and transmissivity, barometric pressure fluctuations, and tuff moisture levels are among the confounding influences that may lead to poor correlation between vapor phase concentrations and soil or tuff concentrations of a given analyte. In this sampling activity, the data quality objective is simply to determine in a qualitative manner whether vapor-phase concentrations that may be indicative of subsurface contamination are higher on the north, south, or western boundaries of the localized hydrocarbon sheen area.

Areas that may be sources for the localized hydrocarbon sheen area include (1) the DP Tank Farm site to the south of the canyon; (2) the head of DP Canyon to the west where the DP Road Storage Area, the Zia Motor Pool, and the former USTs at the present-day Hilltop House Hotel were located; and (3) the area of the present-day Pine Glen Apartments to the north, which may have been used for vehicle storage in the past.

Topographic limitations restrict the type of augering apparatus that can be used on the canyon walls to portable devices. The depth of these auger holes must be sufficient to intercept one or more fractures, the most likely conduits for vapor migration. A depth of 8 to 10 ft may be adequate for this purpose, but it is proposed that auger holes in which vapor-phase sampling is conducted initially be those on the channel banks described in Activity 4. If higher organic vapor concentration readings correlate with higher analytical results for the tuff samples, confidence in the ability of this technique to effectively discriminate between relatively higher and lower levels of contamination will be increased.

The absolute number of auger holes that will be drilled and the types of analyses that will be performed to obtain organic vapor measurements cannot be foreseen before testing of field method sensitivity. If organic vapors are measurable in the field in the auger holes adjacent to the channel, an additional three or four auger holes will be advanced in each of four locations: from the channel bank to a point midway up the slope on the north and south canyon walls adjacent to the localized hydrocarbon sheen area, from the channel bank to a point midway up the slope on the north canyon wall below the pipe that drained the area of the former West Fill Station, and from the channel bank to a point midway up the slope near the western head of the canyon where culverts enter the canyon. If organic vapors are detected below the pipe near the former West Fill Station, an additional location some 50+ ft west should then be sampled to discriminate between potential contamination associated with the pipe and possible contribution from the DP Road Storage Area.

If no organic vapors are measured anywhere but within the immediate vicinity of the localized hydrocarbon sheen area, a number of interpretations are possible. A simple explanation would be that the sheen area is the result of one or more surface releases that infiltrated the tuff *after* entering DP Canyon, in which case fracture flow from a remote source would not be detectable. Another hypothesis is that fracture flow entering the canyon is nearly horizontal after vertical infiltration at the remote source and is

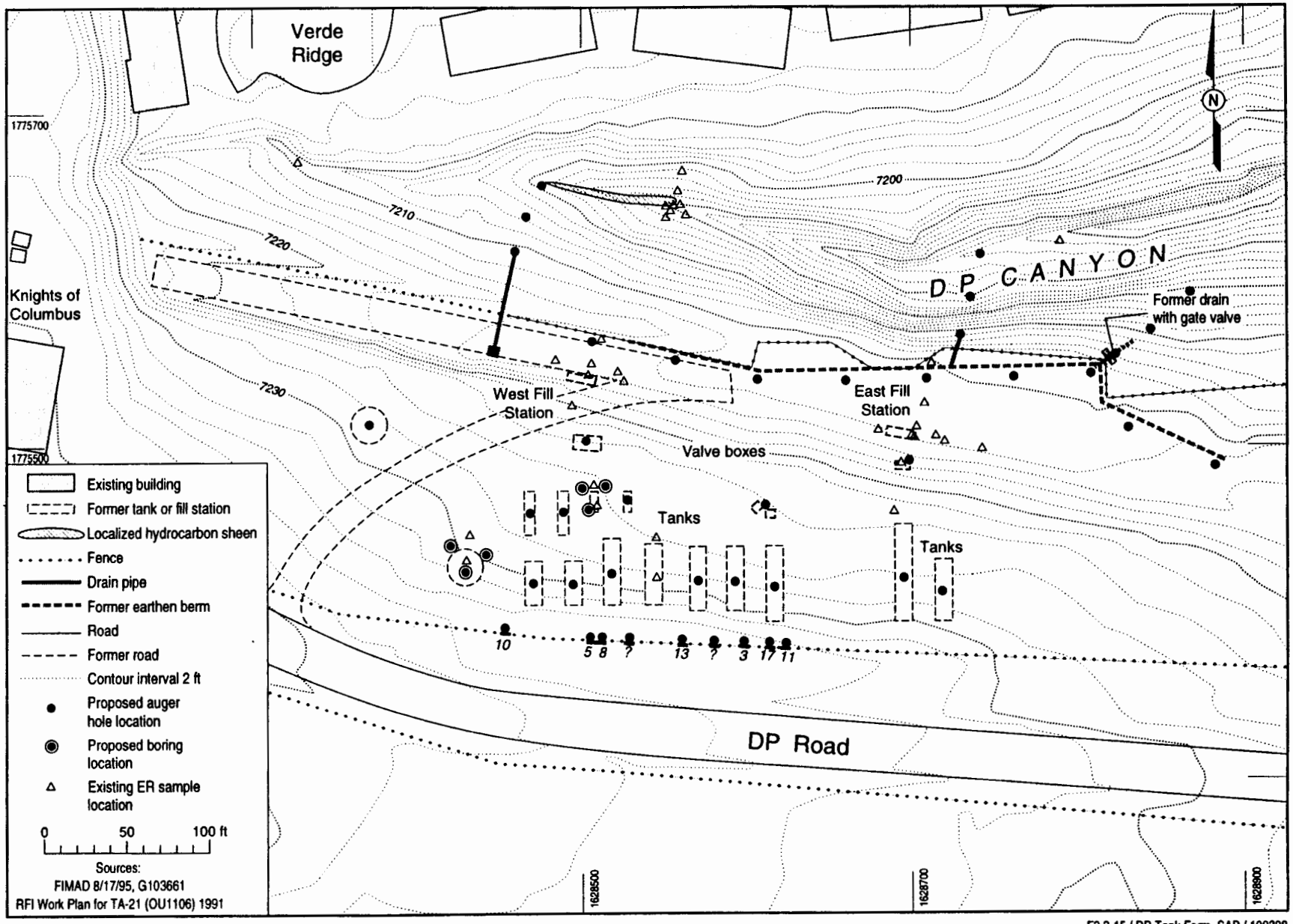
too deep to be detectable in shallow auger holes. Of course, the petroleum-related product, wherever it resides, must include a volatile component to be detectable at all by these methods. Because the interpretation of the data from the vapor study will be inherently subjective, costs and efforts associated with this activity should be kept within reasonable limits. For example, it may not be desirable to sample all additional 12 to 16 locations on the canyon walls, as described above, using costly fixed-laboratory analyses when there is no surety that the information obtained will be useful for decision making.

A number of sampling and analysis options exist for determining whether organic vapors are present in the auger holes. The simplest method is to insert a nonreactive stainless steel tube into the auger hole and obtain a reading on a PID either immediately after drilling or after a period of equilibration during which the auger hole is sealed. A variant of this method would be to pull a vacuum on the sealed borehole with a small pump and then sample the pore air entering the auger hole with the PID. Because of their simplicity and cost effectiveness, these methods are proposed for the initial attempt at defining extent using vapor samples. It is possible that these methods will either not result in any measurable reading or only return a measurable reading in those auger holes immediately adjacent to the localized hydrocarbon sheen area. To be useful for identifying deeper subsurface contamination, organic vapors must be detectable at some distance from contaminated tuff or fractures.

If the initial attempts using direct vapor measurements described above do not detect vapors, the use of other methods will be evaluated. Two other sample collection methods that should be more sensitive than those described above are the use of a passivated (SUMMA) canister for collecting a vapor-phase sample followed by off-site analysis. Another option would be to introduce an adsorbent material into a sealed auger hole and allow a period of equilibration followed by either field thermal desorption and sampling or submittal of the adsorbent for laboratory analysis. It is possible that a combination of one or more field collection and analytical techniques is optimal for delineating the size and origin of any subsurface petroleum-related product depending upon field instrument sensitivities and concentration gradients. These methods, however, will entail considerably higher analytical costs than the simpler options.

Activity 6: Surface and near-surface soil and/or fill samples will be collected at the former drain pipes, fill ports, berm, and valve boxes. This activity is primarily associated with responding to the fourth data gap: What is the extent of petroleum hydrocarbon and inorganic chemical contamination in surface and near-surface media at potentially affected but previously unsampled locations at the DP Tank Farm site? The locations of the former drain pipes, fill ports, berm, and valve boxes, and the sampling locations are shown in Figure 2.2-15.

Sample collection in the areas where the former drain pipes discharged to DP Canyon should follow the initial reconnaissance described in Activity 2 so that any visually impacted areas on the canyon walls are specifically targeted in the sampling. Based upon the results of the reconnaissance described in Activity 2, two or three locations will be sampled below each of three pipes that are believed to have drained the tank farm area. Initial field surveys have located two existing pipes, one approximately 70 ft west of the location of the former West Fill Station and the other just east of the location of the former East Fill Station. A 14-in. drain pipe with gate valve penetrated the former earthen berm at a location approximately 80 ft east of the existing pipe near the location of the former East Fill Station. The drain pipes themselves will be traced if possible to determine their point of origin. Those areas where surface runoff may have deposited contaminants will also be sampled.



F2.2-15 / DP Tank Farm SAP / 100398

Figure 2.2-15. Locations of proposed auger holes and borings, DP Tank Farm, PRS 21-029.

Surface and near-surface samples will also be collected from tuff and soil and/or backfill at the location of the former ports where tanker trucks unloaded their tanks for storage at the tank farm, in the area up-slope of the location of the former berm where ponding of water and contaminants could potentially have occurred, and at the former location of valve boxes where fuel leaks could potentially have occurred.

Auger holes will be advanced to depths of approximately 5 ft below the soil/tuff interface, or to 5 ft if tuff is absent, at these locations. The specific number of sampling locations will be determined by field investigation to correspond with the number of fill ports. One auger hole will be advanced adjacent to the former location of each fill port identified at the time of sampling, at each valve box, at approximately 50-ft intervals along the former location of the berm, and at the inlet and three locations below the outfall of each drain pipe.

A split-sleeve sampling apparatus or similar device is proposed to allow for intact removal of the tuff core and sampling of discrete intervals. Each 1-ft interval of tuff core will be crushed and placed in an appropriate container. After a period of time, the headspace in the container will be analyzed with a PID for organic vapors. Tuff samples with positive readings will be submitted for off-site analysis of BTEX, SVOCs, and both diesel range and motor oil range hydrocarbons. If only one or no interval is positive for organic vapors in the field, additional intervals will be selected at random so that at least two tuff samples are submitted for fixed-laboratory analysis from each auger hole. If the final interval is screened positive using the PID, the auger hole will be advanced one interval beyond the last at which a PID reading is positive.

Where sediment or fill depths are less than approximately 6 in., only a single sample will be collected integrated over the depth of soil available. Where 12 in. or more of material is available, samples should be collected from discrete depth intervals of 6 or 12 in., depending on the depth, so that at least two and up to four samples are collected at that location. It is hoped that the relative and absolute concentrations of contaminants at locations where sediment or fill is very deep may yield information on the magnitude and origin of releases.

All sediment or backfill samples collected will be analyzed for inorganic chemicals, BTEX, SVOCs, and both diesel range and motor oil range hydrocarbons. The chromatograms of any detected petroleum hydrocarbons may also aid in the identification of potential sources. Inorganic chemical, BTEX, and SVOC analyses will provide information useful for assessing the potential human and ecological impacts associated with any measured contamination. In general, it is benzene, substituted benzenes, and PAHs that are the toxicologically significant components of petroleum-related products.

Activity 7: Subsurface tuff samples will be collected in the former tank area of the DP Tank Farm site to evaluate the nature and extent of petroleum hydrocarbon contamination. This activity is primarily associated with responding to the fifth data gap: What is the extent of subsurface petroleum hydrocarbon contamination in tuff in the area of the former tanks at the DP Tank Farm site?

Existing data in the area of the former fuel tanks are limited to EP toxicity leachate analyses for lead and arsenic taken before and during the 1988 decommissioning and data from two 1994 RFI boreholes at each of the locations of former tanks TA-21-ATF-6, -10, and -13. The 1988 decommissioning PID data could not be obtained for confirmation of the conclusion reached in the RFI report (LANL 1996, 52270) that this area was free of contamination. However, the chromatograms from the analyses of the 1994 RFI samples at those locations indicate the presence of motor oil in low concentrations at and near the former locations of tanks TA-21-ATF-6 and -10. Reports from the 1988 decommissioning indicated that only a gasket at tank TA-21-ATF-10 had leaked.

To determine whether any other (unsampled) tanks may have leaked, a single auger hole will be advanced to a depth of approximately 5 ft below the soil-tuff interface at the approximate center of the former locations of all tanks except numbers TA-21-ATF-6, -10, and -13 (see Figure 2.2-15). Each 1-ft interval of tuff core will be crushed and placed in an appropriate container. After a period of time, the headspace in the container will be analyzed with a PID for organic vapors. Tuff samples with positive readings will be submitted for off-site analysis of BTEX, SVOCs, and both diesel range and motor oil range petroleum hydrocarbons. If only one or no interval is positive for organic vapors in the field, additional intervals will be selected at random so that at least two tuff samples are submitted for fixed-laboratory analysis from each auger hole. If the final interval is screened positive using the PID, the auger hole will be advanced one interval beyond the last at which a PID reading is positive. The type of contamination that is targeted by this sampling and analysis is petroleum hydrocarbons that exist not only in fractures but in the bulk matrix of the tuff. Experience at the location of the former East Fill Station shows that boreholes are generally ineffective at delineating the presence of contamination in fractures alone.

Soil or backfill samples will also be collected at each auger hole location and analyzed for inorganic chemicals, BTEX, SVOCs, and both diesel range and motor oil range petroleum hydrocarbons. Where soil or fill depths are less than approximately 6 in., only a single sample will be collected integrated over the depth of material available. Where 12 in. or more of material is available, samples should be collected from discrete depth intervals of 6 or 12 in., depending on the depth, so that at least two and up to four soil samples are collected at that location.

If no evidence of petroleum hydrocarbon contamination is found in the tuff, it will be concluded that the tank area was unlikely to have suffered a significant release and no additional tuff sampling will be proposed. Surface soil or backfill contamination in the absence of tuff contamination is unlikely to be associated with leaks from the tank but is more likely due to reuse of contaminated surrounding soils as backfill or to general levels of contamination from years of heavy truck traffic. Whether additional sampling and analysis is proposed if soil/fill contamination is detected will, therefore, be contingent on the volume of fill present at the location (if fill is the contaminated medium) and the results of a risk-based screening of the initial data.

The areas of former tanks TA-21-ATF-6 and TA-21-ATF-10 are suspected of having received some release of motor oil based on either existing chromatograms (tank TA-21-ATF-6) or a combination of such data and earlier reports (tank TA-21-ATF-10). Based on existing chromatograms, tank TA-21-ATF-13 is believed not to have suffered leaks or other releases during its use. The objective of additional sampling and analysis at the locations of former tanks TA-21-ATF-6 and -10 is to determine the extent of the observed contamination.

Three boreholes each are proposed at the former locations of tanks TA-21-ATF-6 and -10 to an initial depth of 15 ft with samples taken at 2-ft intervals. The boreholes will be arranged in a triangular configuration, two located at the periphery of the footprint of the former tanks and one offset one-half of the distance to the center of the footprint. Screening, analytical suites, and criteria for submittal of core intervals will follow the procedure described above with the exception that a minimum of three samples will be submitted for fixed-laboratory analysis. Sampling of soil or backfill at each borehole location will similarly follow the protocol described above.

Summary of Requested Samples and Analyses

Table 2.2-2 summarizes the minimum numbers of samples expected to be collected and the analyses requested. Actual numbers will depend on PID screening results of samples at the time of collection.

TABLE 2.2-2

SUMMARY OF SAMPLES AND ANALYSES

Activity	Method/Media	Numbers		Analyses			
		Holes	Samples[a]	BTEX and TMB[b]	SVOCs	TPH/DRO/Oil	Inorganics
	Auger Holes						
6	– Tanks	12	24	✓	✓	✓	—[c]
6	– Fill Ports	9	18	✓	✓	✓	—
6	– Berm	9	18	✓	✓	✓	—
6	– Drain Pipes	10	20	✓	✓	✓	—
6	– Valve Boxes	3	6	✓	✓	✓	—
4	– Channel	12–15	36–45	✓	✓	✓	—
7	Boreholes at Tanks	6	12	✓	✓	✓	—
3	Sediments	10–12	10–12	✓	✓	✓	✓
5	Vapor Auger Holes	12–15	PID	NA[d]	NA	NA	NA

a. The minimum numbers of samples submitted for analysis are listed. Actual numbers depend on PID screening results at the time of collection, as discussed in the text.

b. TMB is trimethylbenzene (1, 3, 5- and 1, 3, 4- isomers)

c. Analyses for inorganics (TAL) on soil/fill samples only, not on tuff samples.

d. NA = No analysis in fixed laboratory.

Schedule

The initial reconnaissance described in Activity 2 and collection of sediment and tuff samples within the DP Canyon channel should be scheduled to correspond to the dry season (approximately April through June) when evidence of petroleum hydrocarbon contamination has been most evident in the past. A time that follows a period of two or more weeks without precipitation is preferable. For mesa top and canyon bank sampling, no particular restrictions are foreseen beyond the general requirement that the ground be clear of snow cover.

3.0 DATA COLLECTION DESIGN AND PROCEDURES

3.1 Activity-Specific Data Quality Objectives

Data quality objectives (DQOs) are discussed here on the basis of the seven sampling and analysis activities described in Section 2.2.3.

In general, the discussion will focus on the following four attributes of the sampling and analysis design: (1) sampling and analysis objectives, (2) use of data for supporting the objectives, (3) inputs and assumptions required for data collection or use, and (4) contingencies for potential problems. Analytical data quality and quality assurance (QA)/quality control (QC) requirements are discussed in Sections 3.2 and 3.3. The activity numbers refer to those activities discussed in Section 2.2.3 of this work plan.

For each activity, a corresponding hypothesis (or hypotheses), necessary inputs, and utility of the activity are stated. Several activities may be associated with the effort to obtain relevant information regarding the same hypothesis. For example, Activities 3, 4, and 5 all contribute to the effort to identify the source of the petroleum hydrocarbon contamination in DP Canyon. Complete details of sampling and analysis for each activity cannot be provided because some activities are sequential. Addenda to this work plan will be prepared as completion of each activity provides information that supports planning of the subsequent activities.

Activity 1: Geophysical Survey to Locate Piping

A geophysical survey using appropriate field devices (metal detector, magnetometer, ground-penetrating radar) will be conducted in the area between DP Road and the southern-most extent of the former tanks to locate any piping and fuel-filling ports that may not have been removed during the 1988 decommissioning. Auger holes will be located near the locations of the former fill ports to maximize the chance of finding soil contaminated by petroleum hydrocarbons. When the piping is removed, visual observations and photoionization detector (PID) readings will be employed to determine whether samples will be submitted for laboratory analysis.

Hypothesis 1: Residual petroleum hydrocarbon contamination may be present in soil and/or tuff at the former locations of piping used to fill the former storage tanks at DP Tank Farm.

Inputs: Inputs include visual observations of soil and/or tuff below any piping discovered in the survey, PID measurements of soil and/or tuff from the stained areas, and Laboratory analysis of soil and/or tuff with field evidence of contamination.

Utility: The information gathered in this activity will be used for determining the nature and extent of petroleum hydrocarbon contamination on the mesa top, as it relates to piping and fill ports that may have been left behind following the 1988 decommissioning. Analytical data, if collected, will be used to identify spatial trends and determine whether inorganic chemicals are present at concentrations above background. For spatial trends to have meaning, potential confounding factors should be addressed when collecting soil or fill samples. Some important factors include the grain size, mineral origin, and fraction of organic carbon of the soil or fill sampled at any location. If these factors are not considered as part of data analysis, they may affect the interpretation of contaminant concentration trends over distance. During this sampling activity, the sample collection team will record the sediment size classification (i.e., medium sand and silt, silty clay) and relative content of observable organic matter for each sample submitted for laboratory analysis.

Contingencies: If measured levels of petroleum-related product contamination at these locations pose an imminent threat to human health and the environment, interim measures to restrict access and/or minimize the potential for further migration will be implemented. Because there are no readily available criteria for the concentrations of inorganic chemicals or petroleum hydrocarbons in soil associated with imminent, as opposed to chronic, effects, the decision to take such actions will be made in concert with notification of the regulatory authority.

Activity 2: Initial Site Reconnaissance and Periodic Site Investigations

Activity 2 can be separated into two parts: the initial site reconnaissance and the periodic site inspection of DP Canyon in the vicinity of the localized hydrocarbon sheen area. The objective of the initial site reconnaissance is to obtain additional information for biasing site-sampling activities to locations where petroleum-related product contamination is observed. Because the sampling strategy is subjective (i.e., not based on a statistical design), the defensibility of the data for supporting site decisions is especially sensitive to the logic by which sampling locations are chosen. In particular, the elements of the conceptual site model (CSM) that support the sampling design (such as the use of sediment data to define the extent of water-borne contamination in the channel) must be defensible. The critical input for both data collection and data use for this subjective sampling event is, therefore, the CSM. In effect, the CSM acts as a contingency in the event that sample locations cannot be placed solely on the basis of visual, olfactory, or PID measurement evidence.

Hypothesis 2: The patterns of variability in the observable extent of contamination associated with the localized hydrocarbon sheen area in DP Canyon may be used to refine the CSM and inform the design of a possible long-term monitoring plan.

Inputs: The protocol for sampling outlined in Section 2.2.3.2 describes the temporal frequency as well as the type and quality of information that will be used for qualitatively measuring the variability of contamination at the localized hydrocarbon sheen area.

Utility: Results obtained over time may be useful in establishing whether petroleum hydrocarbon contamination in the canyon is increasing, decreasing, or remaining steady over time. The field observations made during the site visits will be correlated with precipitation data to determine the possible influence of runoff, infiltration, and evapotranspiration cycles on the extent of observable surface and near-surface petroleum hydrocarbon contamination. The minimum inputs required are the record of field observations and a precipitation record.

Contingencies: An important contingency for both the initial and periodic site investigations is that if evidence of contamination greatly exceeding that observed to date is found, interim measures may be put in place to mitigate environmental impacts and/or access to the canyon. The New Mexico Environment Department Hazardous and Radioactive Materials Bureau, Underground Storage Tank Bureau, and Surface Water Bureau will be notified immediately, and measures to protect surface water will be implemented. For the initial reconnaissance, the site visit should be postponed if the scheduled date coincides with a recent storm event. The initial visit should be planned for the period between approximately April and June, which corresponds to a generally dry season in northern New Mexico.

Activity 3: Collect and Analyze Sediment Samples in DP Canyon

The objective of the DP Canyon sediment sampling and analysis is to establish the nature and extent of petroleum hydrocarbon and inorganic chemical contamination in channel sediments. Additionally, the

sediment data may be helpful in attributing a source to the observed petroleum hydrocarbon contamination by comparing (by way of chromatograms) the type of petroleum-related products found in the canyon with samples collected at the location of possible sources or release points on the mesa tops.

Hypothesis 3a: Nature and extent of the petroleum hydrocarbon and inorganic chemical contamination in the channel sediments has not been fully determined in previous investigations.

Inputs: Input will be additional sediment samples taken from the channel and analyzed for petroleum hydrocarbon and inorganic chemical contamination.

Utility: The most basic uses of the inorganic chemicals data for determining nature and extent are comparison of the site data with background data to determine if a release has occurred and plotting of the data to identify spatial trends with distance down-canyon and with depth. For organics data, detection status and spatial distributions will be assessed. For spatial trends to have meaning, potential confounding factors (as described under Activity 1) should be addressed when collecting the samples. To account properly for potential confounding factors, the sample collection team will record the sediment size classification (i.e., medium sand and silt, silty clay) and relative content of observable organic matter for each sample collected. It is assumed that sediment mineralogy does not vary significantly over the relatively short canyon segment that is the subject of this investigation.

Hypothesis 3b: Petroleum hydrocarbon contamination found in channel sediments is a result of activities at one or more mesa top source areas.

Inputs: Comparison of chromatograms of petroleum hydrocarbon contaminants found in DP Canyon and chromatograms from potential source areas will be used to distinguish between different sources of petroleum hydrocarbon contamination. Sample locations, depth, and ratios of individual constituents within each sample (to qualitatively determine degree of weathering) can be used to refine the part of the CSM that deals with source attribution.

Utility: To date, chromatograms of samples from DP Canyon have identified petroleum hydrocarbon contamination consistent with both weathered diesel and motor or lubricating oil. In order to use the sediment data for source attribution, diesel range hydrocarbon contamination must be distinguishable from motor/lubricating oil. This information, combined with (1) the location of petroleum hydrocarbon contaminants down-canyon (which may indicate a release point into the canyon),(2) the depth at which it is observed (deeper sediments may be relatively stable and reflect older contamination), and (3) the ratio of certain individual constituents (reflecting the degree of weathering), can be used to refine the CSM for the origin of petroleum hydrocarbon contaminants in DP Canyon.

An input that is necessary for attributing a potential source(s) to petroleum-related products in DP Canyon is an understanding of the types of materials and possible releases associated with mesa top sources. Environmental Restoration (ER) Project environmental data for the DP Tank Farm [Potential Release Site (PRS 21-029)] and the DP Road Storage Area (PRS 00-027) will be used for this purpose. It will be important, as discussed above, to schedule sampling for a relatively dry time of year both to maximize the likelihood of observing contamination and to ensure that sediment catchment areas are not holding water that could impede sampling and affect results.

Contingencies: As specified above, the measurement of petroleum hydrocarbon contamination associated with this activity at concentrations greatly exceeding previously observed levels and that may pose an imminent threat to human health and the environment will result in the implementation of interim

measures to restrict access and/or minimize the potential for further migration within DP Canyon. Because there are no readily available criteria for the concentrations of inorganic chemicals or petroleum hydrocarbons in sediments associated with acute, as opposed to chronic, effects, the decision to take interim measures will be made in concert with notification of the regulatory authority.

Activity 4: Collect and Analyze Tuff Samples in DP Canyon

The primary objective of the DP Canyon tuff sampling and analysis is to establish the nature and extent of petroleum hydrocarbon contamination in tuff below and adjacent to the channel. As with the sediment data, tuff data may be helpful in attributing a source to the observed petroleum hydrocarbon contamination by comparing the type of petroleum-related products found in the canyon with samples collected at the location of possible sources or release points on the mesa tops. The extent of tuff contamination will be defined relative to whole, competent tuff and is not expected to be defined relative to contamination that may exist in fractures within the tuff.

Hypothesis 4: The nature and extent of the petroleum hydrocarbon contamination in the DP Canyon tuff has not been adequately characterized.

Inputs: Tuff samples will be taken in DP Canyon and analyzed for petroleum hydrocarbon contamination.

Utility: Tuff data will be plotted to determine whether diminishing spatial trends in total petroleum hydrocarbon (TPH) (and perhaps individual analytes) concentrations exist in the data set, indicative of having bounded the general extent of contamination. It is not expected that the auger hole data will be adequate to determine whether contamination has migrated to the canyon by way of fractures because locating and sampling contaminated fractures is problematic. Nevertheless, it is possible that the presence of fractures in a tuff core may confound the evaluation of spatial trends if they are not noticed and the information documented. An important input for data usability is to have the field team record any evidence that a tuff sample submitted for analysis contains fracture-fill material.

The location of tuff samples will be defined during the site survey described in Section 2.2.3.2, Activity 2. If the auger meets refusal at the specified location, actions will be taken to relocate the sampling as described in Section 3.3, Field Activities.

Contingencies: Because the petroleum hydrocarbons present in competent tuff beneath the channel are not immediately available to human or ecological receptors in the environment, no contingencies for immediate action based on the analytical results are planned.

Activity 5: Measure Organic Vapor Concentrations on the Walls of DP Canyon

The objective of this activity is to correlate high organic vapor concentrations at locations north, south, or west of the localized hydrocarbon sheen area in DP Canyon with the presence of subsurface petroleum-related product contamination that could be migrating to the sheen area. The purpose of obtaining this correlation is to support the interpretation of various pieces of information (chromatograms, spatial distribution of petroleum hydrocarbon contamination in sediments) in attributing a source to the contamination observed at the sheen area. Understanding the origin of petroleum hydrocarbon contamination at the sheen area and the pathway(s) by which it arrived there will be useful in predicting what will happen in the future. Potential decisions for the DP Canyon localized hydrocarbon sheen area directly supported by this information include no further action, monitoring, and human health and

ecological risk assessments or remediation options that include containment, in situ remediation, and removal.

Hypothesis 5: Petroleum hydrocarbon contamination found in DP Canyon has migrated from one or more mesa top sources by way of tuff fractures.

Inputs: Organic vapor concentrations will be measured in areas between the localized hydrocarbon sheen area and the locations of the possible mesa top sources to the north, south, or west of the sheen area.

Utility: The use of organic vapor measurements to attempt to identify subsurface petroleum-related product contamination in fractures that may be associated with the localized hydrocarbon sheen area is proposed for two reasons. First, the steep topography of DP Canyon renders the use of drilling apparatus larger than a power auger infeasible on the canyon walls, and the depth to affected fractures may be deeper than can be accessed. Second, as described in Section 2.2.3.2, the ability of borehole data to reflect the presence of contaminated fractures is limited even if affected fractures could be accessed directly by way of drilling. A basic assumption underlying the success of this activity is that petroleum-related products in fact arrived at the location of the sheen area by way of subsurface fracture flow rather than another mechanism, such as surface flow.

It is proposed to use direct PID measurements of air at the base of the auger holes in the field. A necessary input for initiating these measurements is the development of a standard field procedure to optimize the precision of these measurements among auger holes. However, as described in Section 2.2.3.2, the testing of instrument sensitivity at locations nearer the sheen area where vapors are expected is desirable to determine whether use of the method is feasible before developing a procedure. An unfortunate property of the conditional assumption that petroleum-related products reached the location of the sheen area by way of subsurface fractures is that it is difficult or impossible to disprove with confidence. If the PID measurements on the canyon walls do not identify organic vapors, it might not be possible to know whether this is because contaminated fractures are not present or is a consequence of inadequate instrument sensitivity, low vapor transmissivity in tuff, or other factors. In other words, positive measurements may be useful to support source attribution by way of fracture flow, but a series of nondetects in the auger holes might not convincingly support the conclusion that fracture flow was not a mechanism of petroleum-related product transport to DP Canyon.

DQOs associated with the use of a PID for selecting tuff core samples for fixed-laboratory analysis and for measuring the relative concentrations of organic vapors in auger holes are not rigorously specified in this work plan. PID measurements will not be used as a basis for determining the presence or absence of petroleum hydrocarbon contamination or as a basis for determining the specific concentrations of contaminants in air. The purpose of the PID measurements is to qualitatively discriminate between relatively high and low levels of organic vapors.

The relevant data quality criterion for use of the PID is, therefore, the specification of a difference between measurements that is significant. This significant difference is a measurement of precision. The precision of the PID measurements will be affected both by instrument precision as well as field-related factors, such as how tuff core samples are collected and screened, and by how auger holes are sealed and sampled for vapors. It is proposed that, in the addendum to this work plan to be produced after the initial site reconnaissance and surveying of sampling locations, a protocol for standardizing the use of the PID be included to optimize the overall precision of the PID measurements.

Contingencies: Because the actual PID values are not significant in this sampling event, no contingencies for elevated values are proposed.

Activity 6: Collect and Analyze Samples Near the Former Drain Pipes, Fill Ports, Berm, and Valve Boxes

The areas of the former pipes that drained runoff from the tank farm into DP Canyon and the fill ports used by tank trucks to fill the fuel tanks, the area up-slope of the former berm, and the area of the former valve boxes were not sampled in earlier investigations. However, these areas are considered to be those where residual surface and near-surface levels of petroleum-related product contamination might be present. The objectives of this sampling and analysis are to define the nature and extent of inorganic chemical and petroleum hydrocarbon contamination at these areas.

Hypothesis 6: The nature and extent of the petroleum hydrocarbon and inorganic chemical contamination associated with the former drain pipes, fill ports, and valve boxes at DP Tank Farm has not been adequately characterized in previous investigations.

Inputs: Input will be analyses of surface and near-surface soil and tuff samples taken in areas where petroleum-related product releases are most likely to have occurred.

Utility: The basic uses of the inorganic chemicals data for determining nature and extent are to compare with background data to determine if a release occurred and to identify spatial trends. For organic chemicals, the approach involves assessing detection status and preparing spatial plots that portray the concentrations distributions. As with Activities 1 and 3, information on potential physical confounding factors must be collected during the investigation.

Because it is not known whether significant releases have occurred at these locations, the initial sampling and analysis activities are limited in scope. It is assumed that, in addition to the former locations of the tanks and fill stations, those of the drain pipe and berm areas and drainages, the fill ports, and the valve boxes represent the most likely areas for finding petroleum-related product contamination. The drain pipes collected runoff from areas of the tank farm and some ponding might have occurred at their inlets and up-slope of the berm, contributing to settling of particulates and infiltration. Fill ports and valve boxes are critical points in any fueling system where spills could have occurred.

The concentrations of petroleum-related product contaminants at the drain pipe, fill port, and valve box locations, and near the locations of the former fill stations and tanks, are considered to represent the higher range of possible contaminant concentrations at the tank farm. Although there is a small chance of low levels of more widespread contamination at the site because of the historical operations [e.g., the presence of heavy truck traffic over a long period of time might have caused elevated levels of lead, and combustion products from exhaust or incidental leaks may be somewhat elevated across much of the site; Stoddard solvents (petroleum-distillate cleaning solvents) might have been used at the site; and oil might have been used for dust suppression], this investigation will focus on the characterization of contamination, if any, at the listed locations. These are expected to represent potential worst cases. If concentrations at these locations are not significant and the data do not indicate increasing concentrations with depth, the extent of petroleum-related product contamination will be considered bounded. Otherwise, further characterization activities will be planned.

The identification of the locations of former drain pipes, valve boxes, and fill ports are necessary inputs for implementing this activity. Depending on the accuracy with which their locations are specified (in

particular the former fill ports), the sampling strategy may be altered from that described in Section 2.2.3.2. Deviations from the proposed sampling strategy will be documented in an addendum to this work plan that will be prepared once Activity 1 is complete.

Contingencies: If measured levels of petroleum-related product contamination at these locations pose an imminent threat to human health and the environment, interim measures to restrict access and/or minimize the potential for further migration will be implemented. Because there are no readily available criteria for the concentrations of inorganic chemicals or petroleum hydrocarbons in soil associated with acute, as opposed to chronic, effects, the decision to take such actions will be made in concert with notification of the regulatory authority

Activity 7: Collect and Analyze Tuff Samples at the Locations of Former Tanks at DP Tank Farm

The objective of this activity is to determine the extent of petroleum-related product contamination in the subsurface beneath the former locations of tanks TA-21-ATF-6 and -10 and identify whether significant releases have occurred at the former locations of the other tanks that were not sampled in the 1994 RFI. The extent of tuff contamination below the former locations of tanks TA-21-ATF-6 and -10 will be defined relative to whole, competent tuff and is not expected to be defined relative to contamination that may exist in fractures within the tuff.

Hypothesis 7: The nature and extent of the petroleum hydrocarbon contamination associated with former fuel tanks at the DP Tank Farm has not been adequately characterized in previous investigations.

Inputs: Soil and tuff samples will be taken at the locations of former tanks at the DP Tank Farm and will be analyzed for organic and inorganic chemicals.

Utility: Inorganics data will be compared with background, and if elevated levels are indicated, spatial plots of the data will be prepared. Data will be separated by medium (soil and tuff) for these data analyses. For the organic chemical data, detection status will be evaluated, followed by spatial analysis of significant organic compounds. Results of analyses of tuff samples will be plotted to determine whether diminishing trends in petroleum hydrocarbon (and perhaps individual analytes) concentrations exist in the data set, indicative of having bounded the general extent of contamination. It is not expected that the borehole data will be adequate to determine whether contamination has migrated by way of fractures because locating and sampling contaminated fractures is problematic. Nevertheless, it is possible that the presence of fractures in a tuff core may confound the evaluation of spatial trends if they are not noticed and the information documented. An important input for data usability is to have the field team record any evidence that a tuff sample submitted for analysis contains fracture-fill material. Information on grain size and organic matter content, discussed above in the DQOs for Activities 1, 3 and 6, also pertain for similar reasons to the soil and fill samples collected under this activity.

The three boreholes proposed at the former locations of tanks TA-21-ATF-6 and -10 are intended to bound extent primarily in a vertical dimension but also, to some extent, in a horizontal direction. Because only one auger hole will be advanced at the former locations of the other tanks, information will only be available to bound extent in a vertical dimension. It is assumed that any migration of petroleum-related products in tuff because of releases near a tank would be primarily downwards by gravity and that dispersion laterally through the tuff matrix (rather than through fractures) would be minimal. Hence, spacing of boreholes should be relatively tight below the former locations of tanks TA-21-ATF-6 and –10, and a single borehole located within the footprint of a former tank should be adequate to confirm whether a significant release has occurred.

The identification of the locations of the former tanks is a necessary input for implementing this activity. If the locations of one or more tanks cannot be determined with sufficient accuracy to locate a borehole within the footprint, a different sampling strategy will be developed. Deviations from the proposed sampling strategy will be documented in the addendum that will be produced for this work plan.

Contingencies: Because petroleum hydrocarbons present in competent tuff are not immediately available to human or ecological receptors in the environment, no contingencies for immediate action based on the analytical results are planned.

3.2 Quality Assurance/Quality Control

QA/QC samples will be collected in conformance with the ER Project Quality Assurance Project Plan (QAPP) (LANL 1996, 53450). At least one blind duplicate field sample will be collected representing each distinct medium sampled: soil/fill on the mesa, channel sediment, and channel tuff. All samples will be obtained using the procedures described in Section 3.3. Calibration of field instrumentation will follow manufacture's guidelines.

Data generated by the analytical laboratories will be submitted to the Sample Management Office (SMO) following the requirements of the ER Project statement of work (SOW) for analytical services (LANL 1995, 49738) or the applicable version at the time of initiation of field activities. The reporting requirements include electronic and hard copy deliverables for routine analyses. The SMO is responsible for data verification, routine validation, and upload to FIMAD described in Sections D1 and D2 of the ER Project QAPP (LANL 1996, 53450).

3.3 Field Activities

Preliminary Health and Safety Survey

A health and safety survey of site will be provided by the site safety officer and/or by the ER site safety officer. No personnel will be allowed to enter the site until the site has been surveyed for health and safety issues. The site will be monitored for beta-gamma and alpha radiation and for safety hazards including confined space entry, slips, trips, falls, according to the site-specific health and safety plan (SSHASP). The results of the health and safety survey will be documented by the site safety officer on the ESH-1 Direct Survey Results form and by the field team leader (FTL) on the Daily Activity Log.

Engineering Surveys

Engineering surveys of the site will be performed to document the site conditions before conducting activities. The engineering surveys will include regular site inspections as the investigation progresses, such as photographic and narrative documentation of the site conditions. The results of the engineering surveys will be used to support the decision process. The engineering surveys will be documented by the FTL on the Daily Activity Logs, as described in Section 3.2.

Field Sampling

Planned sample locations will be located in the field before sampling and described and documented in the Daily Activity Log. The actual sample site and sampling conditions will be described and documented on the Sample Collection Log. The sample material will be described on the Sample Collection Log and/or on the Core Description Log, if applicable. Sample collection methods will be documented on the

sample collection logs. Surface samples, hand-auger boreholes, and hollow-stem auger drilling methods will be used to collect soil and sediment samples, as described below.

Soil samples will be field screened for gross alpha, beta, and gamma radiation and for volatile organic vapors at the time of sampling. The field-screening data will be recorded by the site safety officer on the Direct Survey Results form and by the FTL on the Sample Collection Log, as described in Section 3.2. The field screening equipment calibration information will be recorded by the Radiation Control Technician on the ESH-1 Direct Survey Results Log and by the FTL on the Daily Activity Log. The results of radiological screening will accompany all samples to the SMO.

All samples will be collected in accordance with ER Project standard operating procedures (SOPs), and field activities will be conducted in accordance with the approved project SSHASP for RFI Activities at Technical Area (TA) 21. Surface and/or shallow soil samples will be collected in accordance with LANL-ER-SOP-06.09 (most current version), Spade and Scoop Method for Collection of Soil Samples. Shallow boreholes and hand auger holes (generally less than 10 ft deep) will be drilled and samples collected in accordance with LANL-ER-SOP-06.10 (most current version), Hand Auger and Thin-Wall Tube Sampler. Decontamination of field and sampling equipment will be performed in accordance with LANL-ER-SOP-1.08 (most current version), Field Decontamination of Drilling and Sampling Equipment. All investigation-derived waste will be managed in accordance with the approved project Waste Characterization Strategy Form for TA-35 and LANL-ER-SOP-1.06 (most current version), Management of Environmental Restoration Project Wastes.

The data management scheme described in Sections A10 and B10 of the ER Project QAPP (LANL 1996, 53450) will be followed. Manually recorded data will be reviewed by the field team, as required by LANL-ER-SOP-01.01 (most current Version, General Instructions for Field Investigations; LANL-ER-SOP-01.04 (most current version), Sample Control and Field Documentation; and LANL-ER-SOP-03.12 (most current version), Field and Laboratory Notebook Documentation for Environmental Restoration Earth Sciences Studies.

Field Survey of Sample Locations

The sample locations will be surveyed by current surveying techniques upon completion of sampling. The FTL will document the location and description of the sample sites on the Daily Activity Log.

Sample Handling

All samples will be collected using the applicable ER Project SOPs for the collection, preservation, identification, storage, transport, and documentation of environmental samples, as described in Section B3 of the ER Project QAPP (LANL 1996, 53450). All samples will be identified in accordance with LANL-ER-SOP-01.04 (most current version), Sample Control and Field Documentation. Chain-of-custody requirements described in LANL-ER-SOP-01.04 will be implemented. The SMO will be consulted regarding the appropriate sample containers and preservation. Samples will be packaged and shipped according to LANL-ER-SOP-01.03 (most current version), Handling, Packaging, and Shipping of Samples.

Analytical Methods

Soil samples collected will undergo analyses for volatile benzene, toluene, ethylbenzene, and xylenes (BTEX) and semivolatile organic compounds (SVOC), and TPH segmented into diesel and lubricating oil ranges. All analyses will be performed at an ER Project-approved fixed-site laboratory. If the radioactivity

of any sample exceeds the limits for the external subcontractor laboratories, alternative arrangements will be made for analysis at a Laboratory internal facility.

The detailed analyte lists, estimated quantitation limits or estimated detection limits (EDLs), required quality control (QC) procedures, and the acceptance criteria for organic and inorganic analyses are found in the ER Project analytical services SOW (LANL 1995, 49738, or the version current at the time field activities are initiated). Certain modifications to the SOW criteria are required for this investigation and are discussed below.

Special Analytical Requirements

Inorganic Analysis

Methods comparable to SW-846 (EPA 1986, 31733), Update III or Draft Update IVA are required. The following SW-846 method combinations are satisfactory.

Analyte/Suite	Prep Method Options	Determinative Method Options
Metals Target Analyte List (TAL)	3050B 3051(3051A)	6010B
		6020(6020A) 7000 Series

Methods in parentheses pertain to Draft Update IVA. Any method combination may be used that meets the detection limit requirements and quality indicator goals. Deviations from these methods must be discussed with a DP Tank Farm project chemist. The hardcopy data package delivered to the Laboratory must specify the standard method (e.g. SW-846 series) and options employed by the laboratory.

Contract-required EDLs (determined in soil matrix extracts) are listed in the 1995 ER analytical SOW. The SOW-specific detection limits are closely linked to EPA Contract Laboratory Program contract-required detection limits. The complete TAL with comparisons to screening levels and SOW EDLs is shown in Table 3.3-1. Special detection limits are required where ER analytical SOW EDLs are greater than screening levels. The last column in Table 3.3-1, Special EDL Request, shows the required method detection limit we require. Note the values in bold type are lower than the standard SOW-specific detection limits.

Samples shall not be sent to a laboratory that does not commit to providing detection limits at least as low as those shown in Table 3.3-1 in soil and tuff digestates.

In addition to the normal reporting of quality indicators, special corrective action is required in the event that matrix spike (MS) or solid laboratory control sample (LCS) analyte recoveries fall outside the following criteria:

MS Criteria	Solid LCS Acceptance Criteria
60-120%	60-125%

Criteria are in percent recovery. If the laboratory's internal corrective actions do not result in recovery meeting these criteria, the laboratory shall contact a DP Tank Farm project chemist to discuss other possible corrective actions.

TABLE 3.3-1

COMPARISON OF SCREENING LEVELS (BACKGROUND VALUES), SOW REQUIRED EDLs, AND PROJECT-SPECIFIC EDL REQUIREMENTS FOR INORGAINC CHEMICALS

Metals TAL	Background Screening Level[a], Soil	Background Screening Level[a], Qbt 2,3,4	SOW EDL[a]	Special EDL Request[a,b]
Aluminum	29200	7340	40	40
Antimony	0.83	0.5	12	**0.4**[c]
Arsenic	8.17	2.79	2	**1**
Barium	295	46	40	**20**
Beryllium	1.83	1.21	1	**0.6**
Cadmium	0.4	1.63	1	**0.2**
Calcium	6120	2200	1000	1000
Chromium	19.3	7.14	2	2
Cobalt	8.64	3.14	10	**1.5**
Copper	14.7	4.66	5	**4**
Iron	21500	14500	20	20
Lead	22.3	11.2	0.6	0.6
Magnesium	4610	1690	1000	1000
Manganese	671	482	3	3
Potassium	3460	3500	1000	1000
Thallium	0.73	1.1	2	**0.4**
Vanadium	39.6	17	10	10
Zinc	48.8	63.5	4	4

a. BVs and EDL are given in mg/kg.
b. The special EDL must be met by the laboratory. The EDL must be established on a soil matrix.
c. EDLs that differ from the SOW appear in bold.

Organic Analysis

Use methods comparable to SW-846 (EPA 1986, 31733), Update III or Draft Update IVA are required. The following method (or equivalent) combinations are satisfactory.

Analyte Suite	Prep Method Options	Determinative Method Options	Target Analyte Additions	
			CAS No.	Analyte
BTEX	5035 3500 series (solvent extraction)	8260B 8021B	95-63-6	1,3,4-trimethylbenzene
			108-67-8	1,3,5-trimethylbenzene
SVOC	3540C/3550B	8270C	124-18-5	Decane
			692-78-7	Heptadecane
			112-95-8	Eicosane
			638-68-6	Triacontane
			1921-70-6	Pristane
DRO*	8015 (options)		Waste Oil (typical motor oil)	

* Diesel range organics

Deviations from these methods must be discussed with a DP Tank Farm project chemist. Note that each suite includes additions to the typical analyte list. The hardcopy data package delivered to the Laboratory must include calibration documentation for these additional analytes and specify the standard method (e.g., SW-846 series or equivalent) employed for the analyses.

No special detection limits are required for organic analytes. The standard detection limits given in the ER analytical SOW are satisfactory and are consistent with the current QAPP (LANL 1996, 53450).

In addition to the normal reporting of quality indicators, special treatment of the DRO/waste oil analysis results is requested. The laboratory shall run a check standard consisting of n-C10, n-C17, n-C30, and n-C40 before analysis of each prep batch to verify retention times and include these runs in the data package. Quantitate observed hydrocarbons against the most closely matching hydrocarbon standard (i.e., diesel, motor oil, jet fuel). If more than one petroleum product appears in a sample chromatogram, quantitate each product against its own standard.

Laboratory Communications

Several special requirements are placed on the service laboratories by this sampling and analysis plan and are discussed above. These requirements must be discussed with the service laboratory manager before shipment of any samples. Samples shall not be shipped without receiving an explicit agreement (in the form of a verbal, electronic, or written acknowledgement) that all special requirements can be met.

The laboratory shall contact the appropriate Laboratory project member if a problem arises in any phase of the sample analysis and reporting process so that possible corrective measures may be discussed and implemented. Any instructions to service laboratory managers or analysts must be approved by the SMO to maintain contract compliance. Laboratory contacts and areas of responsibility are provided below.

Title	Responsibilities
SMO	Sample shipping, contaminant of concern issues including lost or broken containers, lost holding times, analysis delays
DP Tank Farm Project Chemists	Analytical chemistry method selection, data review and sample analysis decisions, laboratory problem resolution, final focused data validation.
FTL	SMO and project chemists shall brief the FTL on all significant laboratory communications

Analyte Suites and Detection Limits

Table 3.3-1 presents background screening levels for soil and tuff and EDLs for analyses.

4.0 PROJECT MANAGEMENT

4.1 Project Scheduling and Reporting Requirements

This section will be developed late in the work plan peer review process.

4.2 Health and Safety Plan

A site-specific health and safety plan will be developed in accordance with the Environmental Restoration Project site-specific health and safety plan (LANL 1995, 56448).

4.3 Investigation-Derived Waste Plan

Investigation-derived waste, if any, will be handled in accordance with LANL-ER-SOP-1.06 (most current version), Management of Environmental Restoration Project Wastes, and all applicable Laboratory waste management procedures.

4.4 Community Relations Plan

Community relation are governed by the Public Involvement Plan in Chapter 7 of the 1996 installation work plan (LANL 1996, 55574)

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